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# Consistency Among Visual Memory Measures

Jeffrey A. Schloemer
*George Fox University*, jschloemer11@georgefox.edu

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Jeffrey A. Schloemer

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Jeffrey A. Schloemer

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Signatures:

Celeste Flachsbart, PsyD ABPP, Chair

Members:

Mark R. McMinn, PhD, ABPP

Robert Weniger, PsyD, ABPP

Date: 12/11/15

## Abstract

Many instruments have been developed to assess human visual memory functioning, though little research has been done to identify interrelationships among current visual memory measures with each other. The present study explores concurrent validity of the following visual memory tasks: Wechsler Memory Scale - IV (WMS-IV) Visual Reproductions I & II and Designs I & II subtests, the Wide Range Assessment of Memory and Learning, Second edition (WRAML2) Picture Memory and Design Memory subtests, the Brief Visuospatial Memory Test, Revised (BVMT-R), and the Rey Complex Figure Test (RCFT). Two age groups (18-25 and 65-79) of healthy adults were used to approximate the polar ends of adulthood. Findings demonstrated that the WRAML2 Picture Memory subtest stood apart from the others as a distinctive measure, exhibiting weak correlations with visual memory measures as well as with processing speed (WAIS-IV Coding) and verbal memory (WRAML2 Verbal Learning), regardless of age group measured. In addition, the BVMT-R highlighted significant differences between younger adult performance (compared to same-aged peers) and older adult performance (compared to same-aged peers), suggesting it may be a tool that is more sensitive to decline than other visual memory measures. Results suggest these two measures to be a prudent addition to any neuropsychological battery for their unique contribution.

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# Chapter 1

# Introduction

Human visual memory is a fascinating neurological phenomenon. All the colors, shapes, and designs of the world create a wonderful three dimensional canvas of "visual sensory" which can be further processed perceptually before being transferred to memory. Visual memory typically refers to the recall and recognition of stimuli entered through the visual system (McIntyre, 1997).

## Utility of Visual Memory Measures

Visual memory is a critical and complicated cognitive system. According to Luck and Hollingworth (2008), visual memory is more than information stored from visual reception. "To qualify as visual memory, the memory must retain properties of the original perceptual state when the memory was encoded" (Luck & Hollingworth, 2008, p. 3). The literature contains many sub-domains of visual memory including iconic memory, visual short-term memory, visual long-term memory, non-verbal memory, and visual working memory. Tests related to these sub-domains vary by stimuli exposure time (200 milliseconds to several minutes; (Lezak, Howieson, Bigler, & Tranel, 2012; McIntyre, 1997; Phillips & Baddeley, 1971), duration of delay prior to recall (seconds, minutes, hours, days to years; (Lezak et al., 2012; McIntyre, 1997), and amount of cognitive manipulation or reordering of visual stimuli for recall (no manipulation to reordering; Makovski, Watson, Koutstaal, Jiang, 2010; Phillips, 1974).

The capacity to hold items in memory for recall is sensitive to aging and is known as *age related decline* (Peich, Husain, & Bays, 2013; Spencer, & Raz, 1995). Disproportionate declines in visual memory have also been detected to predict early onset of Alzhiemers' disease (De Anna et al., 2014; Hori, Sanjo, Tomita, & Mizusawa, 2013; Smith & Bondi, 2013). According to Carlozzi, Grech, and Tulsky (2013), individuals who suffer from traumatic brain injury and mild cognitive impairment also experience a variety of memory deficits. Visual memory measures have been used for over 55 years to detect, measure severity, and monitor recovery from brain injury (Bender, 1938; Benton, 1990, as cited in Benton, Sivan, Hamsher, Nills, & Spreen, 1994; Gilbert, Levee, & Catalano, 1968; Graham, & Kendall, 1946, 1960; Meyers & Meyers, 1995; Payne, 1960; Spreen, 1960).

The literature shows that, in addition to traumatic brain injury, visual memory measures have been useful in assessing the impact of lateralized memory loss (Ariza et al., 2006; McIntyre, 1997) multiple sclerosis (MS; Tinnefeld et al., 2005), lateralized strokes, tumors, and lesions (Butters, Samuels, Goodglass, & Brody, 1970; Luukkainen-Markkula, Tarkka, Pitkänen, Sivenius, & Hämäläinen, 2011; McIntyre, 1997), epilepsy (Bonelli et al., 2010), visual agnosias (Ogden, 1993), generalized cerebral dysfunction (McIntyre, 1997), Huntington's disease (Lawrence, Watkins, Sahakian, Hodges, & Robbins, 2000), Parkinson's disease (Lee et al., 2010), as well as Alzheimer's Disease and other forms of dementia (Budson & Solomon, 2011; Kawas et al., 2003; Lezak et al., 2012).

Even relatively mild insults to the brain can significantly affect one's memory ability, including recall and recognition of visual stimuli (De Anna et al., 2014). Therefore, it is not surprising that many normed visual memory measures provide performance data for various

clinical samples, typically including brain insults, normal aging, alcohol abuse, dementia, neuro-cognitive diseases such as MS, as well as several psychiatric diagnoses such as intellectual disability, attention deficit/hyperactivity disorder, anxiety, depression, and schizophrenia (Lezak et al., 2012). To some researchers, visual memory measures provide such significant utility in detecting cognitive decline they consider a battery, which does not include a visual memory measure, to be inadequate (Smith & Bondi, 2013).

**Evolution of Visual Memory Measures**

While it is important to know the present state and utility of visual memory measures, it is also pertinent to understand the historical origins from which today's measures evolved. Researchers have been interested in investigating and measuring visual memory since the late 1800's and over the years visual memory measurement methods have undergone notable revisions and become increasingly sophisticated. Galton (1880; 1883), Ebbinghaus (1913), Whitehead (1896), Hawkins (1897), and Binet & Simon (1916), have contributed to the foundational understanding of visual memory through their research and formulation of methods to measure this construct. Their methods of measuring visual memory included asking participants to recall his or her breakfast table contents later in the day (Galton, 1880), recalling visual arrays of numbers, letters, or words (Ebbinghaus, 1913; Hawkins, 1897; Whitehead, 1896), pictures of faces (Galton, 1883), visual arrays of figures (Binet & Simon 1905, as cited in Becker, 2003), and documenting recall by using verbal description or drawn reproduction.

Among the first visual memory measures was Drawing Designs from Memory, a subtest from the original 1905-version of the *Binet-Simon Scale*, eventually evolving into drawing multiple designs in subsequent revisions (Becker, 2003). By using recall of novel figures instead

of letters or numbers Binet and Simon identified a method of measure visual memory using material far more difficult to verbally encode than alternative methods (Becker, 2003; Binet & Simon, 1916; Lezak et al., 2012; McIntyre, 1997), thus, forcing the examinee to rely heavily on his or her visual memory system. This method gained popularity when it was brought to the United States from France and was re-introduced as the Memory for Designs subtest in early editions of the *Stanford-Binet Intelligence Test* (Becker, 2003; Terman, 1916; Terman & Merrill, 1937; 1973). These early contributions provided a foundation for development of more sophisticated visual memory measures, such as the *Rey-Osterrieth Complex Figure Test* (Osterrieth,1944; Rey, 1941; as cited in Meyers & Meyers, 1995), Visual Reproductions subtest from the *Wechsler Memory Scale* (Wechsler, 1945), *Memory For Designs Test* (Graham & Kendall, 1946), and the *Visual Retention Test* (Benton, 1946). Each of these employed a similar testing format using a brief 5 to 10 second initial exposure to a printed visual array which the examinee was later asked to draw from memory (Benton, 1946; Graham & Kendall, 1946, 1960; Terman & Merrill, 1937, 1973).

Today's visual memory measures utilize recall, recognition, or both formats. The most common free recall method involves a brief exposure of 2 to 10 seconds to a visual array and then immediately and/or after a delay interval, the examinee is asked to demonstrate recall by drawing the array from memory (Benton, 1990; Benedict, Schretlen, Groninger, Dobraski & Shpritz, 1996; Brannigan & Decker, 2003; Meyers & Meyers, 1995; Randolph, 1998; Sheslow & Adams, 2003; Sivan, 1991). Measures utilize multiple intervals of delayed recall to measure the gradual decay in visual memory (Benedict et al., 1996; Meyers & Meyers, 1995; Wechsler, 2009).

Other measures utilize only a recognition format for measuring visual memory by sequentially exposing an examinee to up to a hundred or more geometric figures or simple pictures of objects, with several repeated target figures (Larrabee, Trahan, & Curtiss, 1992; Tombaugh, 1996; Trahan & Larrabee, 1997). The examinee is later asked using a forced-choice format to correctly identify the previously seen target from target and foil figure pairings (Larrabee et al., 1992; Tombaugh, 1996). Other visual recognition measures use novel visual arrays such as colored pictures of doors (Baddeley, Emslie, & Nimmo-Smith, 1994) or faces (Benton, 1990; Benton et al., 1994; Reynolds, & Voress, 2007; Wechsler, 1997) which also are briefly shown (two to three seconds) then later shown again to the participant while paired with one or more foil items. A participant must then identify a previously seen door or previously seen face when paired with a novel door or face (Lezak et al., 2012; Wechsler, 1997).

It is well known among visual memory researchers and clinicians that visual memory recognition is a robust memory system (Lezak et al., 2012). Most neurologically intact patients perform nearly perfectly on many visual recognition tasks (Cooperstien & Vitelli, 2001; Wechsler, 2009). Accordingly, using poor performances on a visual recognition measure has been developed as a method to evaluate possible test malingering (Tombaugh, 1996). Otherwise, results from visual recognition measures are typically most useful in cases of significant memory deficits, such as dementia (Lezak et al., 2012; Wechsler, 2009).

Finally, some measures utilize both recall and recognition formats. Some of these measures typically utilize a recognition trial following a recall trial in a subsequent fashion such as those used in the *Brief Visuospatial Memory Test, Revised* or the *Rey Complex Figure Test*. Other measures use a recall trial integrated with recognition trial. For example, the Designs

subtest from the *Wechsler Memory Scale-IV*, uses an original 4 x 4 grid containing unique geometric designs. The examinee is later asked to correctly identify the previously seen designs using a pile of cards, half of which are foils (Wechsler, 2009). Thereafter, spatial memory is assessed by having the examinee try to correctly place each card in its correct grid location. A similar format to assess visual memory recall and recognition is used by the Picture Memory subtest from the *Wide Range Assessment of Memory and Learning, Second edition* (Sheslow & Adams, 2003); examinees briefly view a scene of people engaged in everyday activities, and then immediately following are asked to detect scene alterations when shown a similar, but modified scene. Four trials using different scenes are administered. About 20 minutes later the examinee is shown different portions of those scenes each paired with an equal number of foils, and asked to correctly identify which of each pair belonged to an original or modified scene (Sheslow & Adams, 2003).

Since there are several terms that may be used to reference tests and their components, the following are defined in the manner they are used throughout this document. A measure is considered to be a stand-alone test or a subtest from a battery. The components used to make up index performances in these measures are referred to as trials (e.g., copy trial, immediate recall trial, delayed recall trial). Performance across trials generates a score that may sometimes be combined with other trial scores to comprise the total score of a test, or measure. The skill demands associated with these trials are referred to as tasks (e.g., drawing, circling, selecting cards from a pile, vocalizing, and pointing). For example, the *Wechsler Memory Scale-IV* is a memory battery with the Designs and Visual Reproductions subtest measures; each contains

immediate recall and delayed recall trials. These trials include tasks such as drawing with a pencil and selecting cards of previously seen items to reconstruct a visual grid.

**Known inter-relationships between visual memory measures.** As the number of published neuropsychological measures has increased authors such as Bradley and Kapur (2012), Lezak et al. (2012), Luck and Hollingworth (2008), and Strauss, Sherman, and Spreen (2006) have provided encyclopedic texts or chapters which describe numerous neuropsychological measures, their demonstrated utility, critiques and existing norms from a variety of sources; visual memory measures are among those included. Table 1 offers a representative sampling of that information.

Correlations between many of the visual memory measures listed in Table 1 are found in Tables 2 through 12. Table 1 was generated from inter-measure relationships reported in test manuals and the literature including Wechsler (1997; 2008; 2009), Sheslow & Adams (2003), Benedict et al. (1997), Meyers & Meyers (1995), Krishnan & Donders (2011), Johnstone & Wilhelm (1997), Hoelzle, Nelson, & Smith (2011), Spangenberg, Henderson, & Wagner (1997), Okura (2001), and Lezak et al. (2012). In Table 1 the reader will notice that visual memory measures of the WMS-III have been correlated with those of the WRAML2 and WMS-IV, however, the visual memory measures' relationship between WMS-IV and WRAML2 is not established. Similarly, the relationship between the RCFT and BVMT is known, and the relationship between RCFT and WMS-R is known. The relationships, however, between RCFT and the current editions of the BVMT-R and WMS-IV, are not established.

Among visual memory measures, it is critical to know that measures which each claim to measure the same construct seem to be doing so. This can be done by a comparison among

multiple visual memory measures, however, there are gaps between many of the current editions of visual memory measures commonly used today. Between six commonly used visual memory measures and their immediate and delay trials, only seven inter-relationships are known. Table 14 provides the reader with an example of the known and unknown interrelationships among the visual memory components of six contemporary visual memory measures. Only 7 of the 45 (16%) interrelationships have been established.

Some other interesting observations can be made in the tables that follow. In Table 4, the reader will notice correlations range from .18 - .54 between subtest each purporting to measure visual memory. For measures that assess the same construct, it should be expected that their interrelationships would have less variability. In Table 8 the reader will notice, in general, the measures which are most similar in format for measuring visual memory (e.g. RCFT and BVRT) are more highly correlated than those which use different formats, as expected. In Table 9, the WAIS-III Processing Speed and WMS-III Visual Immediate Index each were correlated at .42 with the WRAML2 Visual Memory Index. This seems contradictory since visual memory and processing speed are presumably independent constructs. Similarly, in Table 12, it can be seen that the WRAML2 Design Memory subtest correlates higher with the WRAML2 Verbal Learning subtest than with the WRAML2 Picture Memory subtest. Again, this seems contradictory since research suggests that visual memory and verbal memory are relatively independent constructs (Larrabee & Curtis, 1995; Okura, 2001). That is, visual memory measures are expected to correlate more highly with other visual memory measures and lower with non-visual memory measures. In Table 11, it can be seen that the RCFT and BVRT are more highly correlated than the relationships between the RCFT and non visual memory

measures, such as the WAIS-R subtests and the BVFD. However, the correlation differences between the same-construct and different-construct measures are less than would be expected for purportedly different constructs. In Table 15, the WAIS-IV non-visual reasoning subtests show correlations of .42 or less with visual memory measures and indexes of the WMS-III and WMS-IV. Finally, Tables 13, 14, and 15 summarize validity information taken from the test manuals of the WRAML2 (Sheslow & Adams, 2003), WMS-IV, (Wechsler, 2009), BVMT-R, (Benedict et al., 1997), and the RCFT (Meyers & Meyers, 1995). Each of the four measures claims to have discriminant validity with diagnostically similar clinical samples, but none has been correlated with a current edition of other visual memory measures found in this table. As the reader can note, for each measure there is a summary of available construct, discriminant, content, or concurrent validities data that exists.

Table 1

*Summary of Known Interrelationships among Visual Memory Measures*

| Measure & Subtest / Index | Published Date(s) | Edition | Other batteries or measures which have been inter-related with this measure |
|---|---|---|---|
| WMS VR | 1946 | First | WMS-R |
| WMS VR | 1987 | Second | RBANS; WMS; BVMT-R; RCFT; CVMT; HVOT; CERAD; WAIS-R |
| WMS Faces; WMS Family Pictures; WMS VR | 1997 | Third | WRAML; WRAML2; WMS-R; WMS-IV; TOMAL |
| WMS VR; WMS DE | 2009 | Fourth | CMS*; RBANS; WMS-III |
| D&P Doors | 1994 | First | WMS-III; TOMAL |
| WRAML Picture Memory; WRAML Design Memory | 2003 | Second | WMS-III; CMS; TOMAL2 |
| CVMT | 1988 | First | |
| | 1992 | Second | WMS-R; TOMM |
| BVMT | 1988 | First | |
| | 1997 | Second | RCFT; WMS-R |
| RCFT | 1995 | Second | BVRT; WMS-R; BVFD |
| MFD | 1946 | First | Bender-Gestalt Test; BVRT |
| TOMAL | 1994 | First | WRAML; WMS-III |
| | 2007 | Second | WRAML2; TONI3; WISC-R |
| TONI Facial Memory; TONI Abstract Memory; TONI Visual Sequence | 1997 | Third | TOMAL2; TONI2; WISC-III; WISC-R |
| CMS Visual Immediate; CMS Visual Delay | 1988 | First | WRAML2 |
| CMS Faces | | First | WMS-IV |

| Measure & Subtest / Index | Published Date(s) | Edition | Other batteries or measures which have been inter-related with this measure |
|---|---|---|---|
| RBANS Visuospatial Construction | 1998 | First | WMS-IV; WMS-R; WAIS-R |
| BVRT | 1992 | Fifth | RCFT; HVOT; BVFD |
| Stanford-Binet Memory For Designs | 1937 | First | WAIS |
| TOMM | 1996 | First | CVMT |
| BVFD | | | RCFT; HVOT; BVRT |
| TCFT | 2003 | First | RCFT |
| HVOT | 1983 | Second | RCFT; BVMT; BVFD |
| CERAD | 1997 | First | WMS-R |

*Note:* WMS = Wechsler Memory Scale; VR = Visual Reproductions; DE= Designs; D&P=Doors and People Battery; WRAML = Wide Range Assessment of Memory and Learning; CVMT = Continuous Visual Memory Test; BVMT = Brief Visuospatial Memory Test; RCFT = Rey Complex Figure Test; MFD = Memory For Designs; TOMAL = Test of Memory and Learning; TONI = Test of Nonverbal Intelligence; Visual Sequence = Visual Sequence Memory; CMS = Children's Memory Scale; CMS*= Clinical Memory Scale; RBANS = Repeatable Battery for the Assessment of Neuropsychological Studies; BVRT = Benton Visual Retention Test; Stanford-Binet = Stanford-Binet Intelligence Scale; TOMM =Test of Memory Malingering; BVFD = Benton Visual Form Discrimination; TCFT = Taylor Complex Figure Test; HVOT = Hooper Visual Organization Test; CERAD = Consortium to Establish Registry for Alzheimer's Disease.

Table 2

*Correlations betweenWRAML2, WMS-III, and CMS Visual Memory Indexes*

| | WMS-III Visual Memory Indexes | | CMS Indexes | |
|---|---|---|---|---|
| WRAML2 Indexes | Visual Immediate | Visual Delay | Visual Immediate | Visual Delay |
| Visual Memory | 0.42 | 0.38 | 0.37 | 0.12 |
| Visual Recognition | 0.43 | 0.36 | 0.32 | 0.12 |

*Note*: WRAML = Wide Range Assessment of Memory Learning, Second Edition; WMS-III = Wechsler Memory Scale, Third Edition; CMS = Children's Memory Scale. (Sheslow & Adams, 2003, pp. 131 - 132).

Table 3

*Correlations between WRAML2 Visual Memory Index and TOMAL Non-Verbal Memory Index*

| | TOMAL | TOMAL2 |
|---|---|---|
| WRAML2 | Nonverbal Memory Index | Nonverbal Memory Index |
| VM Index | | |
| Visual Memory | 0.58 | |
| Visual Recognition | 0.39 | |
| VM Subtest | | |
| Design Memory | | 0.37 |
| Picture Memory | | 0.64 |
| Verbal Learning | | 0.52 |

*Note*: WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; TOMAL = Test of Memory And Learning 2 = Second Edition. VM = Visual Memory. (Sheslow & Adams, 2003, p. 133; Reynolds & Voress, 2007, p. 105).

Table 4

*Correlations between WMS-IV Visual Memory Subtests and CMS Visual Memory Subtests and Indexes*

| WMS-IV | CMS Faces I Subtest | CMS Faces II Subtest | CMS Visual Immediate Index | CMS Visual Delay Index |
|---|---|---|---|---|
| VR-I | 0.28 | 0.38 | 0.45 | 0.47 |
| VR-II | 0.18 | 0.33 | 0.45 | 0.47 |
| Designs I | 0.26 | 0.19 | 0.28 | 0.37 |
| Designs II | 0.22 | 0.28 | 0.37 | 0.24 |
| VMI | 0.34 | 0.39 | 0.46 | 0.44 |
| VWMI | 0.48 | 0.29 | 0.54 | 0.40 |

*Note*: WMS-IV = Wechsler Memory Scale, Fourth Edition; CMS = Clinical Memory Scale; VR-I = Visual Reproduction I; VR-II Visual Reproduction II; VMI = Visual Memory Index, VMWI = Visual Working Memory Index; VM = Visual Memory. (Wechsler, 2009, p. 73).

Table 5

*Correlations between WMS-IV Visual Memory Subtests and Indexes with RBANS Visual Memory Subtest*

| | Wechsler Memory Scale-IV | | | |
|---|---|---|---|---|
| | Subtests | | Indexes | |
| RBANS | Visual Reproduction I | Visual Reproduction II | Visual Memory | Visual Working Memory |
| V-S Construction | 0.53 | 0.41 | 0.50 | 0.52 |

*Note*: WMS-IV = Wechsler Memory Scale, Fourth Edition; RBANS = Repeatable Battery for the Assessment of Neurological Status, (Wechsler, 2009, p. 81); V-S Construction = Visual-Spatial Construction.

Table 6

*Correlation between RBANS Visual Memory Indexes, RCFT, and WMS-R Visual Memory Factors, Subtests and Indexes*

| | RBANS Memory Index | | |
|---|---|---|---|
| | Visual Spatial | Delayed | Immediate |
| WMS-R Attention/ Concentration | 0.59 | -- | -- |
| WMS-R Visual Reproduction % Retained | 0.30 | 0.38 | 0.06 |
| WMS-R Delayed Recognition | -- | 0.49 | 0.51 |
| Rey O Copy Total | 0.79 | 0.32 | -- |

*Note*: RBANS = Repeatable Battery for the Assessment of Neurological Status; WMS-R = Wechsler Memory Scale, Revised; Rey O = Rey Osterieth Complex Figure Test. (Randolph, 1998, pp. 48 - 52).

Table 7

*Correlation between TOMAL-2 Visual Memory Subtests and TONI-3 Total Score*

| | TOMAL2 Subtests | | | | |
|---|---|---|---|---|---|
| | Facial Memory | Abstract Visual Memory | Visual Sequence | Visual Selective | NonVerbal Memory Index |
| TONI3 | 0.40 | 0.27 | 0.57 | 0.22 | 0.46 |

*Note*: TOMAL2 = Test of Memory and Learning, Second Edition; TONI-3 = Test of Nonverbal Intelligence, Third Edition; Visual Sequence = Visual Sequential Memory; Visual Sequence = Visual Sequence Memory; Visual Selective = Visual Selective Reminding. (Reynolds & Voress, 2007).

Table 8

*Correlation between RCFT, BVRT, BVFDT, and HVOT Total Scores*

| RCFT | BVRT Total Correct | BVFDT VFD | HVOT VOT |
|---|---|---|---|
| Copy | 0.64 | 0.26 | 0.48 |
| Immediate Recall | 0.49 | 0.16 | 0.35 |
| Delayed Recall | 0.49 | 0.14 | 0.38 |

*Note:* RCFT = Rey Complex Figure Test; BVRT = Benton Visual-spatial Retention Test; BVFDT = Benton Visual Form Discrimination Test; VFD = Visual Form Discrimination. HVOT = Hooper Visual Organization Test; VOT = Visual Organization Test. (Meyers & Meyers, 1995, p. 70).

Table 9

*WRAML2 Correlations with Other Memory Measures and Visual Memory Indexes*

| Measure | WRAML2 Visual Memory Index |
|---|---|
| WMS-III Visual Immediate | 0.42 |
| WMS-III Visual Delay | 0.38 |
| CMS Visual immediate | 0.37 |
| CMS Visual Delay | 0.12 |
| TOMAL Nonverbal Memory | 0.58 |
| WAIS-III Processing Speed | 0.42 |
| WAIS-III Verbal IQ | 0.31 |
| WRAML2 Verbal Memory | 0.39 |

*Note:* WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; WMS-III = Wechsler Memory Scale, Third Edition; CMS = Children’s Memory Scale; TOMAL = Test of Memory and Learning; WAIS-III = Wechsler Adult Intelligence Scale, Third Edition. (Sheslow & Adams, 2003).

Table 10

*Correlations between Construct Validity Coefficients of BVMT-R, WMS-R and RCFT*

| Measure | BVMT-R Total Recall | BVMT-R Delayed Recall | BVMT-R Discriminant Index | BVMT-R Recognition Bias |
|---|---|---|---|---|
| WMS-R Visual Reproduction | 0.68 | 0.78 | 0.46 | 0.02 |
| RCFT Copy | 0.65 | 0.62 | 0.39 | 0.02 |
| RCFT Immediate Recall | 0.75 | 0.77 | 0.53 | 0.11 |

*Note:* BVMT-R = Brief Visuospatial Memory Test, Revised Edition; WMS-R = Wechsler Memory Scale-Revised; RCFT = Rey Complex Figure Test. (Benton et al., 1997, p. 29).

Table 11

*Correlations between RCFT-R, BVFD, BVRT, and WAIS-R Visual Memory Trials, Subtests and Indexes*

| Measure | RCFT Copy | RCFT Immediate | RCFT Delay | RCFT Recognition Total |
|---|---|---|---|---|
| WAIS-R Block Design | 0.58 | 0.46 | 0.45 | 0.17 |
| WAIS-R Picture Arrangement | 0.57 | 0.45 | 0.46 | 0.33 |
| WAIS-R Picture Completion | 0.40 | 0.38 | 0.32 | 0.49 |
| BVRT Total Correct | 0.61 | 0.49 | 0.49 | 0.59 |
| BVFD | 0.24 | 0.16 | 0.14 | 0.47 |

*Note*: RCFT-R = Rey Complex Figure Test and Recognition Trial; WAIS-R = Wechsler Adult Intelligence Scale-Revised Edition; BVRT = Benton Visual Retention Test; BVFD = Benton Visual Form Discrimination. (Meyers & Meyers, 1995, pp. 69-70).

Table 12

*Intercorrelations of the WMS-IV and WRAML2 Visual Memory and Verbal Learning Subtests*

| Measure | WRAML2 Design Memory | WRAML2 Picture Memory | WMS-IV Designs I | WMS-IV Visual Reproduction I |
|---|---|---|---|---|
| WRAML2 Design Memory | -- | -- | -- | -- |
| WRAML2 Picture Memory | 0.29 | -- | -- | -- |
| WRAML2 Verbal Learning | 0.35 | 0.25 | ? | ? |
| WMS-IV Designs I | ? | ? | -- | -- |
| WMS-IV Visual Reproduction I | ? | ? | 0.47 | -- |

Note: WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; VM = Visual Memory; WMS-IV = Wechsler Memory Scale, Fourth Edition; ? = unknown correlation. (Sheslow & Adams, 2003; Wechsler, 2009).

Table 13

*Additional Validity Information of Suggested Measures for Investigation*

| Battery / Measure | Sample of Validity Information Available on 4 Visual Memory Measures |
|---|---|
| WRAML2 | *Construct validity* was demonstrated with signficicant factor loads that included visual memory (Sheslow & Adams, 2003, p. 120). |
| | *Discriminant validity* was demonstrated using clinical groupsincluding alcohol abuse, Alzheimer's and Parkinson's disease, Traumatic Brain Injury, and learning disability (Sheslow & Adams, 2003, p. 141). |
| | *Concurrent validity* correlations are reported between three measures of visual memory, including WMS-III, CMS, and TOMAL (Sheslow & Adams, 2003, p. 130). |
| WMS-IV | *Construct validity* demonstrated using factor loading including that include visual and visual working memories. |
| | *Discriminant validity* was demonstrated using clinical groups including normal, Traumatic Brain Injury, Mild Cognitive Impairment; Mild, and Moderate Intellectual Disability, Alzheimer's disease, epilepsy, anxiety, depression, schizophrenia, and learning disability patients (Wechsler, 2009, pp. 84 - 106). |
| | *Content validity* is demonstrated by reported research supporting visual and other memory domains. |
| | *Concurrent validity* correlations are reported between measures of visual memory including WMS-III, WMS-III Abbreviated, CMS, WAIS-III, WAIS-IV, and RBANS (Wechsler, 2009, p. 63). |
| RCFT | *Construct validity* correlations are reported between the RCFT constructs including: Copy, time to copy, Immediate and delayed recalls, Recognition total correct, Recognition false positives, and Recognition false negatives. (Meyers & Meyers, 1995, pp. 67-82). |
| | *Discriminant validity* demonstrated using clinical groups of psychiatric and brain damaged patients. (Meyers & Meyers, 1995, pp. 67-82). |
| | *Convergent validity* demonstrated using correlations with other RCFT components, including: Visuospatial Recall, Visuospatial recognition, Response Bias, Processing Speed, and Visuospatial Constructional ability. (Meyers & Meyers, 1995, pp. 67-82). |
| | *Concurrent validity* has been demonstrated with correlations reported with the TCFT (Gagnon, Awad, Mertens, & Messier, 2003). |

| Battery / Measure | Sample of Validity Information Available on 4 Visual Memory Measures |
|---|---|
| BVMT-R | *Construct validity* intercorrelations have been reported among Total recall, Delayed recall, Discrimination Index, and Recognition Response Bias (Benedict, 1997, pp. 25-35).<br><br>*Discriminate validity* was demonstrated using clinical groups including psychiatric, and neurologic patients. (Benedict, 1997, pp. 25-35).<br><br>*Convergent validity* Convergent validity data not reported.<br><br>*Concurrent validity* Intercorrelations reported among its six alternate test forms. |

*Note*: WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; WMS-IV = Wechsler Memory Scale, Fourth Edition; WMS-III = Wechsler Memory Scale, Third Edition; CMS = Children’s Memory Scale; TOMAL = Test of Memory and Learning; WAIS-III = Wechsler Adult Intelligence Scale, Third Edition; WAIS-IV = Wechsler Adult Intelligence Scale, Fourth Edition; RBANS = Repeatable Battery for the Assessment of Neuropsychological Status; RCFT = Rey Complex Figure Test; TCFT = Taylor Complex Figure Test; BVMT-R = Brief Visuospatial Memory Test, Revised.

Table 14

*Example of Unknown Visual Memory Measure Interrelationships*

| | | WMS-IV | | | | WRAML2 | | RCFT | | BVMT-R | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measure | | DE I | DE II | VR I | VR II | DM | PM | Imm | Delay | Imm | Delay |
| WMS-IV | DE I | | | | | | | | | | |
| | DE II | 0.74 | | | | | | | | | |
| | VR I | 0.47 | 0.40 | | | | | | | | |
| | VR II | 0.41 | 0.41 | 0.6 2 | | | | | | | |
| WRAML2 | DM | ? | ? | ? | ? | | | | | | |
| | PM | ? | ? | ? | ? | 0.29 | | | | | |
| RCFT | Imm | ? | ? | ? | ? | ? | ? | | | | |
| | Delay | ? | ? | ? | ? | ? | ? | ? | | | |
| BVMT-R | Imm | ? | ? | ? | ? | ? | ? | ? | ? | | |
| | Delay | ? | ? | ? | ? | ? | ? | ? | ? | ? | |

*Note:* Imm = Immediate; WMS-IV = Wechsler Memory Scale, Fourth Edition; WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; RCFT = Rey Complex Figure Test; BVMTR = Benton Visuospatial Memory Test, Revised; DE I = Design I Immediate; DE II = Design II Delay; VR I = Visual Reproduction I Immediate; VR II = Visual Reproduction II Delay DM = Design Memory; PM = Picture Memory; Immediate = Immediate memory; Delay = Delay memory; ? = unknown correlation between visual memory measures and their recall trials.

Table 15

*Correlations Between WMS-III and WMS-IV Visual Memory, WAIS-IV Subtests, and WRAML2 Verbal Memory*

| Measure | WMS-III Visual Imm | WMS-III Visual Delay | WMS-IV DE I | WMS-IV DE II | WMS-IV VR I | WMS-IV VR II |
|---|---|---|---|---|---|---|
| WAIS-IV Symbol Search | 0.23 | 0.18 | 0.32 | 0.25 | 0.40 | 0.33 |
| WAIS-IV Coding | 0.13 | 0.14 | 0.36 | 0.26 | 0.38 | 0.28 |
| WAIS-IV Cancelation | 0.13 | 0.10 | 0.28 | 0.26 | 0.26 | 0.29 |
| WAIS-IV Information | 0.18 | 0.22 | 0.30 | 0.25 | 0.41 | 0.31 |
| WAIS-IV Digit Span | 0.18 | 0.20 | 0.36 | 0.34 | 0.38 | 0.30 |
| WRAML2 Verbal Memory | 0.41 | 0.32 | -- | -- | -- | -- |

*Note*: WMS-III = Wechsler Memory Scale, Third Edition; WMS-IV = Wechsler Memory Scale, Fourth Edition. (Wechsler, 2008, p. 83; Wechsler, 2009, p. 75; Sheslow & Adams, 2003)

It can be expected that visual memory measures claiming to assess the same construct should highly correlate. While viewing the tables just described, and as noted above, the visual memory measures usually correlate more highly with one another, and lower with non-visual memory measures. However, the magnitude of correlations in these relationships varies. In some cases, visual memory measures have revealed higher than expected inter-correlations with non-visual memory measures. Additionally, two or three visual memory measures have been used with similar clinical samples but their inter-relationships are unknown. Overall, it is evident that

variability exits among past and current editions visual memory measures in their reported inter-relationships with other visual memory measures and with non-visual memory measures.

**Gaps In Known Relationships Among Common Visual Memory Measures**

The reader will note in Tables 2 - 14 the relatively limited number of measures with known relationships with other visual memory measures, especially among the most current versions of the various measures. Updating these correlations with the current test editions needs to be done to make known their current interrelationships and to determine if the new relationships are similar to prior test versions. Relatedly, Lezak et al. states the following:

> Unfortunately, some new test revisions may carry the same name but with significant item, scoring, or norming differences; and newly published batteries may include some tests quite different from those in previous editions while omitting others. These changes, sometimes subtle, sometimes not, make it incumbent upon test users to compare and recognize when test data may be interchangeable and when they are not (2012, p. 103).

Until an updated multi-measure comparison is completed, the magnitude of correlations between currently used visual memory tests remains unknown.

In addition to the information found in the respective test manuals just reported, the assessment literature contains a limited number multi-measure investigations of visual memory. A Canadian research study in 1997 conducted by Nancy McIntyre provided an investigation of nearly a dozen visual recall and recognition measures for the purpose of developing a new visual recognition measure. The measures cited and reviewed in McIntyre's research included Visual Reproductions, Visual Paired Associates, and Figural Memory subtests from the Wechsler Memory Scale (Wechsler, 1945; 1997), the Benton Visual Retention Test (Benton, 1974), the

Rey Complex Figure Test (Osterieth, 1944; Rey, 1941), the Taylor Complex Figure Test (Taylor, 1969; 1979), the Biber Figure Learning Test (Glosser et al., 1989), the Picture Reproductions subtest from the Randt Memory Test (Randt & Brown, 1983; Randt, Brown, & Osborn, 1980), the Rivermead Behavioral Memory Test (Wilson et al., 1985), the Recognition Memory Test (Warrington, 1984), the Recurring Figures Test (Kimura, 1984), the Continuous Visual Recognition Test (Trahan et al., 1988). While descriptions of each of the measures were provided, unfortunately, correlations among these measures were not reported because presumably those data did not exist. Even if they had, most of the measures included by McIntyre (1997) have since been updated to more recent editions. Further, additional key visual memory measures currently available were published after McIntyre's review such as the visual memory measures from the WRAML2 (Sheslow & Adams, 2003) and WMS-IV (Wechsler, 2009). It is reasonable to conclude, given its established clinical utility, newer tests like the Designs (Wechsler, 2009), Picture Memory and Design Memory (Sheslow & Adams, 2003) measures would have been included in the research done by McIntyre (1997) if the study were to be repeated today (Dunn & Haynes, 2005). Similarly, the Brief Visuospatial Memory Test, Revised (Benedict et al., 1997) was released in the same year McIntyre's study was published and would likely have been another inclusion.

Other studies which have included multiple visual memory measures did so to conduct a factor analysis. Larrabee, Kane, Schuck, and Francis (1985) included the Visual Reproduction subtest, and the Benton Visual Retention Test and Larrabee and Curtis (1995) included the Continuous Visual Memory Test and Visual Reproduction of the WMS-R. The authors concluded that visual memory delayed reproduction trials were loaded as visual, non-verbal,

general memory factors and were also a more valid measure of visual memory than immediate visual reproduction trials (Larrabee et al., 1985; Larrabee & Curtis, 1995). The authors implored future researchers to consider examining these findings with other tests purporting to measure visual memory. Presently, there continues to be a gap in the research. There is a lack of studies providing evidence that current editions of these visual memory measures produce similar findings.

Okura (2001) performed a factor analysis using verbal and visual memory measures, including those from the WMS-III, WRAML, and TOMAL. Okura (2001) found that the visual memory measures contributed independent variance that was different from that generated by the verbal memory factor (Okura, 2001). Additional interrelationships among the WRAML2, TOMAL2, and WMS-III can be found in Tables 2 and 3. Since the data available are equivocal regarding relationships among and between verbal and non-verbal measures, Okura (2001) suggests clarity might result by an investigation using only current measures.

## Rationale for the Present Research Project

Lezak et al. (2012) implore researchers and clinicians to be keenly aware of the changes from previous to current editions of assessment measures. They echo the sentiment expressed by Brown (2009) who stated, “Practitioners must be confident that the tests and measures that they use to evaluate clients are assessing what they purport they do in a rigorous and robust manner” (p. 519). Consequently, given limited available data, an investigation which identifies performance similarities and differences across commonly utilized visual memory measures would assist clinicians wanting to select one or more of these measures. It is crucial for them to know if measures claiming to assess the same construct actually yield the same findings. For this

reason the present investigation has compared six commonly used visual memory measures in order to supply clinicians and researchers with current comparability data.

Since it is known that visual memory tends to naturally decline through aging (Peich et al., 2013), becoming most prominent after age 65 (Lezak et al., 2012), the current researcher employed the use of both younger adults and older adults with visual memory measures. An older adult age band of 65 - 79 is used in this investigation as well as a younger adult age band of 18 - 25. The use of these age groupings approximates polar ends of normal adulthood. Whether an adult's visual memory ability is poor or very superior each visual memory measure should yield consistent performance results for individuals in each age group.

In order to better understand whether these visual memory measures are principally measuring the same construct, each was correlated with a non-visual memory measure such as processing speed and verbal memory and magnitudes of those relationships were evaluated. A sample of previously established magnitude of relationships between visual memory measures and presumably different constructs commonly measured along with visual memory are found in Tables 3, 9, 11 12, and 15. As can be seen, each measure of processing speed has been correlated with visual memory measures at less than .42, suggesting small to low moderate relationships with visual memory. Such as in Tables 3 and 9, the WRAML2 Visual Memory Index has been correlated with the WAIS-III Processing Speed and Verbal IQ at .42 and .31, respectively, while also showing correlations with the Nonverbal Memory Index of the TOMAL and TOMAL2 are between .37 and .64. Similarly, as shown in Table 12, the WRAML2 Verbal Learning subtest, a measure of verbal memory, correlates with the WRAML2 visual memory measures of Picture Memory and Design Memory at or below .35 (Sheslow & Adams, 2003, p. 114). In Table 15, the

inter-relationships between visual memory, verbal memory, processing speed and verbal information are shown. Additionally, many of the correlations shown in Tables 1-15 are reported from many past editions or outdated measurers.

Overall, visual memory tends to achieve lower correlations with verbal memory, verbal IQ, perceptual reasoning, and processing speed. Just like those with visual memory, many of the correlations between non-visual memory measures span one, two, or even three changes in updated editions of the reported measures. Presumably, if revised editions of visual memory and non-visual memory measures are modified to better assess their intended constructs, an evaluation of these current relationships should correspond with in their demonstrated relationships. That is, if only current editions of visual memory measures and current editions of non-visual memory measure are analyzed, it should be expected that same-construct measures (visual memory) achieve higher inter-relationship correlations with less variability while achieving lower inter-relationship correlations with non-visual memory construct measures. Similarly, the present investigation anticipates finding higher interrelationship correlations between current visual memory measures and lower relationship correlations between current visual memory and non-visual memory measures than many of those reported from past editions.

**Hypotheses for the present study**

Because of the lack of data regarding comparability across commonly used measures of visual memory, the following hypotheses will be investigated.

**Hypothesis 1.** The visual memory measures used in the present study will be significantly correlated with each other.

**Hypothesis 2.** The visual memory measures will correlate at lower levels with the non-visual memory measures.

**Hypothesis 3.** Across visual memory measures, immediate recall trials and delayed recall trials will generate comparable scores, respectively. That is, mean recall scores achieved across the various visual memory measures and the delayed recall scores will be comparable across measures.

**Hypothesis 4.** The magnitude of correlations across the various visual memory measures for each age group will be comparable.

**Hypotheses 5.** The mean scores achieved across the various visual memory measures will be comparable for the younger and older age groups.

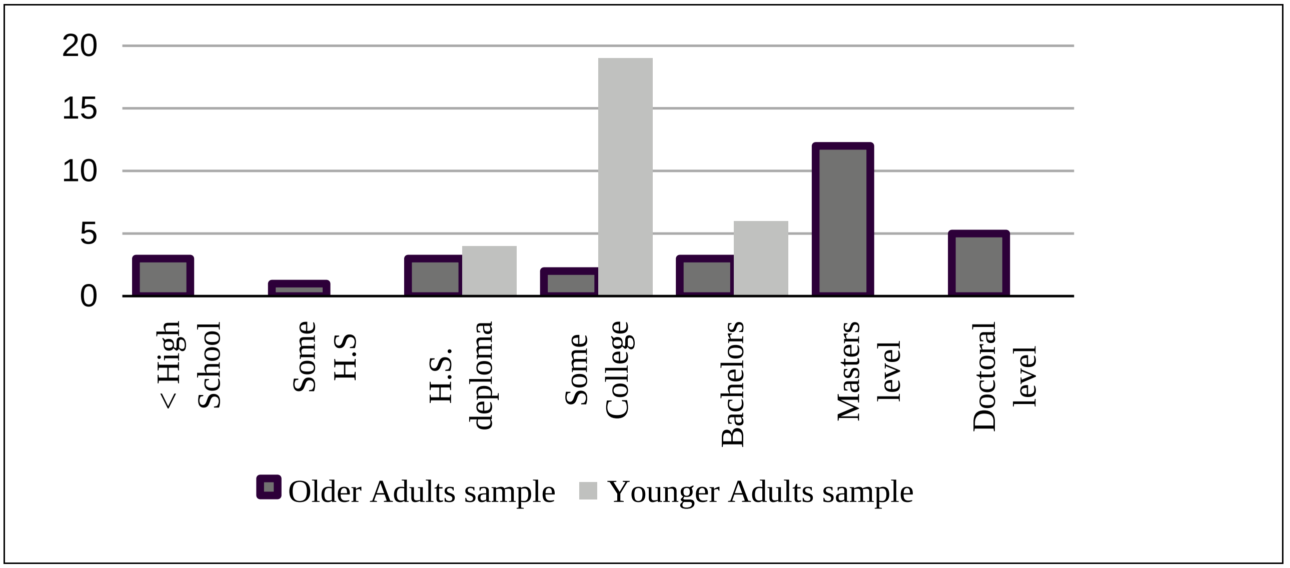
# Chapter 2

# Method

## Participants

Power analysis (Cohen, 1992) indicated a sample size of 60 participants were necessary for an assumed effect size of .50 and a power level of .80. This investigation utilized 60 participants separated into two age groups: 29 participants in the younger adult group, and 31 participants in the older adult group. The young adults were ages 18 to 25 with a mean of 20.7 and standard deviation (*SD*) of .4. The older adults were ages 66 - 79 with a mean of 72.9 and *SD* of .77. The sample was 81.7% European-American descent, 8.3% were of Asian descent, 6.7% were of Latino-American descent, 1.7% were of African-American descent, and 1.7% were of Native American descent. 3.3% of the sample reported less than a high school education, and 1.7% reported some high school education. 11.7% reported having a high school education, 31.7% reported some college, 21.6% reported having a college degree, 21.6% reported earning a Master's degree, and 8.3% reported having a doctoral level of education. The older adult sample was negatively skewed with higher education than the younger adult group ($\chi^2$ (6) = 37.12, $p <$ .001). This is determined to be credited to older adults having substantially more time to acquire further education than the younger adults. Below, Figure 1 shows the education levels for younger and older adults.

*Figure 1*. Frequency distribution for education of sample population.




*Note*: Frequency distribution of education is negatively skewed for the older adults compared to younger adults.

Older adults were selected from volunteers who respond to: (a) Community Announcements via Retirement Community Activities Directors/Advocate, (b) Church/community flyer announcement, or (c) word of mouth. A letter was given to the Retirement Community Activity Director for distribution to interested residents who desired to participate in this investigation. A copy of this letter can be found in Appendix A.

In order to complete the demands of this investigation, all older examinees were required to demonstrate basic abilities in several functional domains using a brief screening assessment. A copy of this assessment can be found in Appendix B. The details of this screening are described below. As part of the screening for participation, volunteers were queried for having a neurologically-based diagnosis associated with compromised cognition such as dementia, TBI,

Parkinson's Disease, seizure disorder (epilepsy), or MS: if reported, the volunteer was excluded from the study.

Screening for volunteer participation took place in two phases for all participants. The first phase, upon first contact, occurred in person or over the phone. The participant was thanked for their interest in volunteering for the study, and before beginning any testing the examiner asked a few questions to ensure the participant met inclusion criteria. These initial questions included,

1. "What is the year of your birth?"
2. "How much education have you received?"
3. "Do you wear corrective lenses or hearing aids?"
4. "Have you received a diagnosis of Alzheimer's'?, dementia?, Multiple Sclerosis?, Traumatic Brain Injury?, or anything which has significantly affected your ability to remember things?"
5. "Do your medications make it hard to remember things?"
6. "Can you use a pencil to draw some simple shapes?" and,
7. "This study has many tasks which will ask you to look at and remember things; are you still interested in being a part of this project?"

These questions were asked at a normal conversational volume and tone to assess for adequate hearing. Answers to these questions determined suitability to proceed. Answers to question 1 and 2, regardless of their content, were not grounds for exclusion. Answers to questions 3, 4, and 5 lead to exclusion of unqualified volunteers from the study. A volunteer who indicated a need for glasses or hearing aids was allowed to participate if their corrective lenses/hearing aids were with

them. If the volunteer expressed difficulty in hearing the examiner, it was permissible for the examiner to speak at a louder volume.

In the second phase of the screening, two tasks were administered to further establish adequate hearing, vision, and ability to draw simple shapes. The screening assessment took approximately two minutes.

For the purpose of assessing adequate drawing ability participants were asked to copy three rudimentary shapes using a number two pencil. These figures are items 10, 13, and 14 of the Wide Range Assessment of Visual Motor Abilities (WRAVMA) Visual-Motor Drawing subtest (Adams & Sheslow, 1995), and are shown in Appendix B. These items are estimated to be at a 5-to 7-year-old level of perceptual motor skill (Adams & Sheslow, 1995). These items were selected as they most closely simulated the demands of the drawing tasks of the visual memory measures used in the study. Scoring criteria provided in the WRAVMA *Manual* will be used to judge a pass or fail of each of the three shapes. The participant must pass at least two of the three shapes to be eligible for this study.

For assessing adequate visual acuity participants were asked to read a single 12-point font sentence typed in black ink on sheet of white, 8.5-inch by 11-inch paper, instructing the participant to use a pencil to circle one of five common shapes to be found below the sentence. The participants were to read the sentence independently and circle the correct shape to pass this component of the screening.

For those "passing" the screening procedure, a written informed consent procedure then followed; the examiner read the informed consent document aloud to the participant. The written

informed consent for younger adults and older adults can be found in Appendix C. Upon receiving written consent the formal testing procedure was started.

**Materials**

The measures utilized in this investigation were selected based on meeting six criteria: (a) assesses visual recall or visual recall and recognition, (b) demonstrates satisfactory reliability and validity, (c) shown to have clinical utility, (d) common enough to generate 16,000 or more hits in a literature search from 1995 to 2014, (e) can be appropriately administered to younger and older adults, and (f) takes no longer than 15 minutes to administer in order to allow several measures to be administered without exceeding one hour, thereby allowing adequate test comparisons without creating excessive cognitive fatigue. Below, a rationale for each of the six criteria is provided.

**1) Visual Recall and Recognition and Visual Recall Only.** Measures which use methods of recall and recognition or recall only to measure visual memory were selected since it has been shown that measures which utilize a free recall format when measuring visual memory are most sensitive to individuals with visual memory impairments (Tombaugh, 1996; Trahan & Larrabee, 1997; Wechsler, 2009). In contrast, recognition memory remains relatively intact until significant cognitive decline is experienced (Wechsler, 2009) The present study included adults whose histories are free of dementia, traumatic brain injury, or other neurological diagnoses associated with notable memory deficits, such as seizure disorder. Therefore, it was reasonable not to include visual measures which only utilize a visual recognition format.

**2) Satisfactory Psychometrics.** A minimum cut-off for test-retest reliability was chosen at $\geq$ .55, a correlation coefficient of $\geq$ .35 for relationships with at least several other visual

memory measures, and < .35 for relationships with several non-visual memory measures were chosen as reasonable cut-offs in order to allow for selection of visual memory measures that have, in the past, shown some adequate concurrent and divergent validities. Due to the complexity of reporting validity psychometrics, validity has not been reported in Table 16. For reference of specific known and unknown inter-relationship validity with other visual memory measures, the reader may reference Tables 1-15 for visual memory, and Tables 3, 9, 11, 12, and 15 for visual memory divergent relationships with verbal memory and processing speed matching >.35 and <.35 for visual memory concurrent and divergent relationships, respectively.

**3) Documented Review for Clinical Utility.** Visual memory measures selected will have been reviewed and documented to have clinical utility in the field by being included in a published peer reviewed publication such as the *Buros Mental Measures Yearbook*.

**4) Hits in Literature Search.** Each measure selected met an arbitrary minimum hit-rate of 16,000 hits in searches using the name of the measure with an applicable subtest, and “visual memory” as search terms within internet *Google Scholar*, from 1995 and 2014. Search criteria included the name of the measure and relevant subtest with “visual memory” as search terms. Table 16 records the number of search hits for each measure was uncovered; the reader will note a consistency among search hits for measures selected to be between 16,000 and 19,000.

**5) Age Range.** The measures which were selected had to accommodate ages ranging from young adult (age 18 - 25) to older adult (age 65 - 79). Since it is known that visual memory tends to decline with age (Peich et al., 2013), especially after age 65 (Lezak et al., 2012), examining test comparability at both younger and older ages is clinically meaningful. One exception has been made regarding the dual-age criterion in order to include the Designs I & II

subtests from the WMS-IV. The Designs subtest has a ceiling age of 64, however, given that the WMS-IV has been claimed to be one of the most widely used assessments of memory (Bradley & Kapur 2012; Strauss et al., 2006), it was decided to be included with the younger adult subgroup.

**6) Administration Time.** Although more measures could have been chosen, the present investigation limited the number of tests in order to minimize visual array confusion (i.e., the examinee will know what measure he/she is to recall from the several visual arrays which have been presented) and to minimize excessive cognitive fatigue, which increases with testing time. A total of one hour of testing was the limit that was set, allowing a reasonable number of measures to be used without incurring excessive inter-task confusion or significant fatigue.

Using the above criteria, six measures were selected for comparison. The measures and details related to how each measure satisfies the above criteria are shown in Table 16. Concurrent validity data are not presented in Table 16 since what few studies that are available have already been noted in Tables 2 - 15. The reader will notice two non-visual memory measures that will also be used as measures that will allow divergent validity comparisons. Divergent validity information has already been relayed in Tables 3, 9, 11, 12, and 15.

Measures which do not meet the above criteria despite being commonly used are not included in the present investigation. For example, the RBANS Visuospatial Construction subtest (Randolf, 1998) does not adequately achieve the desired hit rate and does not have an adequate age range, so it was not utilized for this study. The CVMT (Trahan & Larrabee, 1997) was not used for this study due to its recognition format of assessment. The TOMAL2 (Reynolds

& Voress, 2007) does not offer norms past age 59 and utilizes a recognition format of assessment, precluding its use in the present study.

As listed in Table 17, 10 visual memory scores and three non-visual memory scores are used in this investigation; they include the Design Memory and Picture Memory subtests from the WRAML2 (Sheslow & Adams, 2003), the Designs I and II and Visual Reproductions I and II from the WMS-IV (Wechsler, 2009), immediate, and delay recall trials of the RCFT (Meyers & Meyers, 1995), and the immediate and delay recall trials of the BVMT-R (Benedict, 1997). Non-visual memory measures and trials include the Coding subtest from the WAIS-IV (Wechsler, 2008), and the Immediate and Delay trials of the Verbal Learning subtest from the WRAML2 (Sheslow & Adams, 2003).

Table 16

*Summary of How Well the Six Tests Meet the Six Test Selection Criteria*

| Reviewed Measure | Google Scholar Search Hits | Test-Retest Reliability | Recognition / Recall / Both | Age Band | Test Time | Clinical Utility |
|---|---|---|---|---|---|---|
| WRAML2 Visual Memory | 19,200 | | | 5-90 | | |
| WRAML2 Picture Memory | 19,600 | 0.63 | Both | 5-90 | 5 | YES |
| WRAML2Design Memory | 19,800 | 0.59 | Recall | 5-90 | 5 | YES |
| WMS-IV Visual Memory | 16,200 | | | 16-90 | | |
| WMS-IV Visual Reproduction | 16,300 | 0.93 | Recall | 16-90 | 7 | YES |
| WMS-IV Designs | 16,100 | 0.85 | Both | 16-69 | 8 | YES |
| RCFT Visual Memory | 19,400 | 0.80 | Recall | 18-79 | 7 | YES |
| BVMT-R Visual Memory | 17,400 | .60-.84 | Recall | 18-79 | 12 | YES |
| WRAML2 List Learning | 21,300 | 0.78 | None | 5-90 | 4 | YES |
| WAIS-IV Coding | 10,400 | 0.86 | None | 16-90 | 2 | YES |

*Note:* WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; WMS-IV = Wechsler Memory Scale, Fourth Edition; RCFT = Rey Complex Figure Test; BVMT-R = Brief Visuospatial Memory Test, Revised Edition; TOMAL2 = Test of Memory and Learning, Second Edition; RBANS = Repeatable Battery for the Assessment of Neurological Status; CMS = Children's Memory Scale; CVMT = Continuous Visual Memory Test; D&P = Doors & People Battery; WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; WAIS-IV = Wechsler Adult Intelligence Test, Fourth Edition; Test Time = Administration Time in minutes.

Table 17

*Variables Used in the Present Study*

| Battery/Test | Subtest | Domain Measured | Dependent Variable to be Analyzed |
|---|---|---|---|
| WRAML2 | Design Memory | Visual Immediate Memory | Scaled Score |
| | Picture Memory | Visual Immediate Memory | Scaled Score |
| WMS-IV | Designs I | Visual Immediate Memory | Scaled Score |
| | Designs II | Visual Delay Memory | Scaled Score |
| | Visual Reproduction I | Visual Immediate Memory | Scaled Score |
| | Visual Reproduction II | Visual Delay Memory | Scaled Score |
| RCFT | Immediate | Visual Immediate Memory | T- Score |
| | Delay | Visual Delayed Memory | T- Score |
| BVMT-R | Trial I, II, & III | Visual Immediate Memory | T- Score |
| | Delay | Visual Delayed Memory | T- Score |
| WRAML2 | Verbal Learning | Verbal Immediate Memory | Scaled Score |
| | | Verbal Delayed Memory | Scaled Score |
| WAIS-IV | Coding | Processing Speed | Scaled Score |

*Note:* Designs I & II measures will only be administered to younger adults group.

The WRAML2 visual memory measures were selected for their use of meaningful depictions of people performing everyday activities as well as less meaningful tasks involving recall of shapes and spatial locations. The RCFT and BVMT-R measures were also selected for their use of novel figures and shapes in testing both immediate and delayed recall. Additionally, the WMS-IV measures were selected for their testing of immediate and delayed memory of

visual and spatial elements of minimally meaningful figures. They also require minimal fine motor skills in contrast with the RCFT and BVMT-R which each require, comparatively, more drawing to assess visual recall. The WAIS-IV Coding and the WRAML2 Verbal Learning subtests were chosen as divergent validity measures to serve for comparison with the visual memory tasks. The WAIS-IV Coding subtest was selected because it is a brief measure of processing speed known to have minimal correlations with at least some visual memory measures. The WRAML2 Verbal Learning subtest was selected for its use in measuring immediate and delayed verbal memory. Although completion of the Coding subtest requires visual perception as do visual memory tasks, the subtest, nonetheless shows low correlation with visual memory. For example, the RBANS Visuospatial/Construction and WMS-III Visual Immediate Indexes have yielded correlations of .15 and .14 respectively with the WAIS-IV Coding subtest (Randolph, 1998; Wechsler, 1997; 2009).

As listed in Table 16, the visual memory measures used in this investigation were selected for being frequently referenced in memory research publications. They also are commonly chosen to be included in various tests' technical manual's descriptions of concurrent validity. Additionally, each measure was selected because: (a) the author(s) explicitly claim that the respective procedure measures visual memory, provided some validity measures supporting that claim, (b) it was deemed to be in common use amongst current clinicians, and (c) the test demonstrated satisfactory psychometric characteristics. In addition, each measure has satisfactorily achieved the six criteria described Table 16. To summarize, these measures use immediate recall and delayed recall phases of assessment, as well as utilize drawing or reconstruction methods of measuring recall of visual stimuli with no demand for verbal output.

Though many of these measures also include recognition trials, the psychometrics of recognition subtests show healthy individuals perform quite well unless significantly impaired. For instance, the WMS-IV manual reports that apart from examinees with neurological damage most healthy individuals score nearly perfect on the recognition trials of the Designs recognition and Visual Reproduction subtests (Wechsler, 2009). As a result, the recognition-only portions were not included in the current study. Since this investigation did not intend to utilize clinical samples, it is reasonable to eliminate the recognition trials given the minimal variability found in non-clinical samples.

What follows are detailed descriptions of each measure and the intended trials used in this investigation.

**Design Memory and Picture Memory from the WRAML2 (Sheslow & Adams, 2003).** The WRAML2 is a memory battery containing measures of verbal, visual, and working memories. The battery was designed to be used either as an entire test, or as selected subtests of a domain of interest (Hartman, 2007). The two subtests comprising the battery's visual memory domain will be used: Design Memory and Picture Memory. The Design Memory subtest requires examinees to look at a 4 inch x 6 inch card on which is drawn simple geometric designs (e.g., line, circle, triangle, rectangle) and after a 5-second exposure and 10-second delay, to draw the designs in their proper places on a blank card. Five different cards, and therefore five separate trials are administered. The task takes about 5 minutes to administer. The total raw score across the five trials were converted into an age-based scaled score and used as a dependent measure for analysis.

The Picture Memory subtest asks clients to scan a scene of people doing everyday tasks for 10-seconds and then, using a similar scene, identify content that has been added, removed or changed. Four different scenes are sequentially administered, each accruing a score which accumulates a total score which was converted to an age-based scaled score and used as a dependent variable for analyzed. The Picture Memory subtest takes about five minutes to administer.

The WRAML2 test manual also reports test-retest reliability and validity data that provide an adequate basis to judge each subtest as a reliable and valid measure for both age groups utilized in this investigation. Person Separation Reliability for core subtest range from .85 to .92 for the Picture Memory and Design Memory, respectively (Sheslow & Adams, 2003). Coefficient alpha data reported for the 18 - 24 year age group for Design and Picture Memory subtests are .86 and .74 respectively (Sheslow & Adams, 2003). Similarly, for the age subgroups within the 65 - 75 year age range, coefficient alphas are .87 and .84 for the Design and Picture Memory subtests, respectively (Sheslow & Adams, 2003). Coefficient alpha reliability for WRAML2 Visual Memory Index ranges from .84 - .92 between the ages 18 and 79. Specifically, Coefficient Alpha reliability for Design Memory ranges from .86 - .89 between ages 18 and 74; and .74 - .88 between ages 18 and 74 for Picture Memory (Sheslow & Adams, 2003). WRAML2 earned a test-retest reliability of .59 for Design Memory, and .63 for Picture Memory with .69 for the Visual Memory Index (Sheslow & Adams, 2003). WRAML2 inter-correlations for ages 9 to adult earned .41 for both Design memory and Picture memory (Sheslow & Adams, 2003). For external validity psychometrics with other past and current measures noted in technical manuals and literature, reference Tables 1 - 3, 9, and 12 - 15. The administration instructions for both

Design Memory and Picture Memory subtests can be located in the *WRAML2 Administration and Technical Manual* (Sheslow & Adams, 2003, pp. 30 - 3; 40 - 41).

**Designs and Visual Reproduction subtests from the WMS-IV (Wechsler, 2009).** Like the WRAML2, the WMS-IV is a memory test battery comprised of multiple components which measure domains of verbal, nonverbal-visual, and auditory memories, and allow the examiner to assess immediate and delayed aspects of each domain. The two subtests comprising WMS-IV's visual memory battery include Designs I and II, and Visual Reproduction I and II. Together, scores from these test portions compile a Visual Memory Index (VMI).

The Designs subtest requires examinees to look at a 4 x 4 grid containing four, six, or eight, various basic geometric shapes (circles, lines, dots, squares, triangles, etc.) and after a 10-second exposure the examinee is immediately asked to select the figures just seen from an array of 8, 12, or 16 cards showing exact or foil design figures from the original grid and then correctly place these cards in a new, blank 4 x 4 grid. There are six, unique, grid arrangements for each of the six separate portions of the recall trial. The task takes approximately 10 minutes. The raw score over the six portions will be converted to an age based scaled score. This score was one of the dependent variables measured to be analyzed. The Designs subtest also contains a delay trial (Designs II). In this trial, 20 - 30 minutes following Design I, the examinee is asked to recall and correctly place the shapes previously seen on a blank 4 x 4 grid, just the same as the examinee did in Designs I. The examinee is asked to reconstruct each of the six grids, one at a time, in the same sequence it was introduced. The task takes approximately 10 minutes. Immediately following the delayed portion, a recognition trial is administered in which the examinee is presented with a page displaying a 4 x 4 grid containing both novel figures and figures

previously seen. The examinee is asked to point to the figures which were previously seen in the Designs trials and are also placed in their correct locations as when first seen. However, according to Wechsler (2009), most neurologically intact individuals achieve a perfect or near perfect score on this recognition task. Therefore, because the present study did not intend to examine clinical samples, the recognition portion was not included in this administration.

The Designs I and II subtests have been normed up to age 69 but norms have been removed for ages beyond 69 in the Older Adult battery due to very low ceiling performances, claiming the task is too difficult for older adults (Holdnak, Drozdick, Weiss, & Iverson, 2013; Wechsler, 2009). However, it has been claimed that the Wechsler Memory Scales are the best known, most scrutinized, and most widely used memory measure available (Bradley & Kapur, 2012; Strauss et al., 2006). For this reason, the present investigation used the Designs subtest with the younger adult group, but not with the older adult group.

In the Visual Reproduction (VR) subtest, examinees are presented a figure with elementary shapes (lines, triangles, dotes, squares, etc.) for 10 seconds. Immediately following the exposure, examinees are asked to draw the figure just seen from memory onto a new blank page. This is done for each of the five items. These five items accumulate a total raw score which was then transposed into age related scaled scores and analyzed for this investigation as one of the dependent variables. The task takes approximately 4 minutes to administer (Wechsler, 2009). Like the Designs subtest, the Visual Reproduction subtest also contains a delay portion administered 20 - 30 minutes following VR I. In the Visual Reproduction II portion of the subtests, examinees are asked to recall by drawing each of the figures presented earlier in the Visual Reproduction I task. The examinee is given five new record sheets for drawing each item

and asked to recall each item by drawing as much of each item as can be remembered, one at a time, in any order. Immediately following the delay portion, there is a recognition trial where the examinee is presented with a series of six figures, one of which the examinee was exposed to in Visual Reproduction I while the other are foil items. The examinee is asked to point to the figure previously seen. This is done for each of the five previous items in VR I. Raw scores accumulated from these sections were used to calculate age related scaled scores. Similarly to the Designs recognition trial, according to the *WMS-IV Technical Manual*, the recognition trial of the Visual Reproduction II is not adequately sensitive to detect varying performances, and most healthy individuals score nearly perfect (Wechsler, 2009). For this reason, VR II recognition trial was not included in this investigation. For the present investigation, the Visual Reproductions subtest recall trials were be copied onto a 5.5 inch x 8.5 inch WMS-IV record book to identify them separately from the other delay recall trials of other measures.

The WMS-IV test manual reports reliability and validity data that provide an adequate basis to judge each subtest as a reliable and valid measure for both age groups utilized in this investigation. WMS-IV Reliability coefficient Visual Memory Index for ages 18 - 79 range from .95 to .97. Reliability coefficients for Visual Reproductions subtest ranges from .88 - .94 for ages 18 - 79. Reliability coefficient for the Designs subtest range from .82 - .90 for ages 18 - 69. WMS-IV Test-retest reliability ranges between .67 for Visual Reproduction, .75 for Designs, and .81 for the WMS-IV Visual Memory Index. The test-retest reliabilities of the VR I range from .50 to .73 among the following groupings: Immediate Total, Content, and Spatial; and Delayed Total, Content, and Spatial. The VR subtest correlate significantly with other tests containing visual memory and visual-spacial problem solving (Lezak et al., 2012). The Delayed recall trial

correlated strongest with other visual memory tests (Larrabee, Kane, & Schuck 1983; Lezak et al., 2012). Regarding the subtests used in this investigation, Designs I and II correlate at .74, Visual Reproduction I and II correlate at .62; Designs I and Visual Reproduction I, and Designs II and Visual Reproduction II correlate at .47 and .41, respectively (Wechsler, 2009). Additional concurrent and divergent validity correlation with the WMS-IV visual memory information can be found in Tables 1, 4, 5, and 12 - 15. Administration instructions can be found in the WMS-IV Stimulus Book II on pages 57 - 79 and 201 - 227. Visual Reproductions I subtests Instructions for administration can be found on pages 27 - 47 of the Stimulus book I and pages 5 - 33 in Stimulus Book II.

**Rey Complex Figure Test (Meyers & Meyers, 1995).** RCFT is a visual memory measure which has four sections: Copy, Immediate Recall, Delayed Recall, and Recognition (Meyers & Meyers, 1995). In this investigation, the Copy, Immediate Recall, and Delayed Recall trials will be used. Examinees are given an 8.5 inch x 11 inch card containing a complex figure made up of elementary shapes (circles, triangles, lines, dots, squares, etc.). Examinees are asked to copy the observed figure onto a blank 8.5 inch x11 inch sheet of paper and then, after a three minute delay, they are asked to recreate this figure from memory by drawing in on a fresh, blank, 8.5 inch x11 inch paper. Thirty minutes following after the copy trial a Delayed Recall trial is given. The examinee is again asked to draw from recall the same figure on a blank 8.5 inch x 11 inch sheet. The subtest concludes with a recognition trial after the 30-minute Delayed trial. The participant is asked to identify portions of the original figure amongst components not part of the figure (Meyers & Meyers, 1995). The RCFT has a ceiling age of 89 for examinees (Meyers & Meyers, 1995). Not including the timed delays, the RCFT takes approximately 7 minutes to

administer: 3 minutes for the copy trial, 2 minutes for immediate recall trial, and 2 minutes for delayed recall trial. Each trial is scored and converted to an age related standard score. Due to the use of multiple visual arrays in the present study, lightly green colored sheets were used for the recall components to identify the RCFT apart from other visual arrays. The RCFT immediate and delay trials were introduced as the complex figure copied onto light green paper.

The RCFT test manual also reports reliability and validity data that provide an adequate basis to judge each subtest as a reliable and valid measure for both age groups utilized in this investigation. Inter-rater reliability coefficient ranged from .93-.99 with an average reliability of .94 (Meyers & Meyers, 1995). Inter-rater correlation coefficients were .88, .97, and .96 for the Copy, Immediate Recall, and Delayed Recall components, respectively (Liberman, Stewart, Seines, & Gordon, 1994). RFCT earned a test-retest reliability coefficient of .76 and .89 respectively for Immediate Recall and Delayed Recall trials (Lezak et al., 2012). A correlation of .33 was found between Copy and Immediate Recall trials, and .38 between Copy and Delayed recall trials (Meyers & Meyers, 1995). Immediate Recall and Delayed Recall trials were correlated at .88 (Meyers & Meyers, 1995). Validity measure information is found in Tables 1, 6, 8, 10, 11, 13, and 14. Instructions for administration of the RCFT Copy, Immediate Recall, and Delayed Recall trials can be found on pages 7 - 8 in the *Professional Manual* (Meyers & Meyers, 1995).

**Brief Visuospatial Memory Test - Revised (Benedict, 1997).** The BVMT-R is a measure used to assess a participant's visual memory by recall and recognition of figures. The measure was designed with multiple forms with the intention of repeatable administrations. The measure requires participants to look at a page containing six simple geometric figures arranged

in a 2 x 3 grid array. After a 10-second exposure, the examinee is asked to draw the observed figures in their proper locations using an empty 2 x 3 grid that is provided (Benedict, 1997; Lezak et al., 2012). Following this portion, the examiner again shows the participant the same 2 x 3 array for another 10 seconds. Then, the examinee is again asked to draw the shapes in their correct grid location. This is done for a third time in the same manner. Each of the three portions comprise an immediate recall trial score. Then, after a 25-minute delay, the examinee is asked to draw the designs in their correct location (Benedict, 1997; Lezak et al., 2012). A recognition trial, following the delay trial, then requires participants to identify each of the six target items from among six foils by answering in a “yes” or ”no” format to each figure presented to them by the examiner (Benedict, 1997; Lezak et al., 2012). The immediate and delay trials are performed in the exact same way for each of the BVMT-R’s six forms with unique 2 x 3 visual array for each form. (Benedict, 1997; Lezak et al., 2012). This design allows for repeated assessment with an examinee without gaining practice effects on an array (Benedict, 1997). Consistent with the other measures, the present investigation utilized only the immediate trials and delay trial. Only will Form 1 was used. The immediate (learning) and delay trials take approximately 8 minutes, and 4 minutes, respectively, to administer (Benedict, 1997). Due to the use of multiple visual arrays in the present study, lightly pink colored sheets will be used for the recall trials so as to identify the BVMT-R apart from other visual arrays.

The *BVMT-R Professional Manual* reports inter-rater reliability ranging from .96 to .97 on the three learning trials (immediate recall), and .97 in the delayed recall (Benedict 1997; Lezak et al., 2012). Test-retest reliability coefficients range from .60 to .84 for Learning Trials 1 through 3 (Benedict, 1997; Lezak et al., 2012). BVMT-R test-retest reliability across all six

forms revealed a range from .63 - .92, and .65 - .91, for Total Recall (summed Learning Trials 1-3) and Delayed Recall, respectively (Benedict, 1997). External validity information with other past and current measures noted in technical manuals and literature, has been referenced in Tables 1, 10, 13, and 14. Instructions for administration for Immediate Recall Trials 1-3 and Delay Recall trial can be found in the *BVMT-R Professional Manual* (Benedict, 1997. pp. 5-6).

For the purpose of demonstrating that the above visual memory measures are less related to non-visual memory tasks, two non-visual memory measures will be used: the WAIS-IV Coding subtest, which measures Processing Speed, and the WRAML2 Verbal Learning subtest, which measures verbal memory. When evaluating a group of tests purportedly measuring a particular domain it is also important to include measures which assess different domains. This allows tests to demonstrate how they are differentially correlate with related and unrelated domains. A test used to show a non-relationship is called a discriminant, or divergent, measure. A description of these two measures now follows.

**Coding subtest from the WAIS-IV (Wechsler, 2008).** The Coding subtest is a measure of processing speed. The task requires an examinee to view a row of nine vertically paired boxes with a number in the top part and special marking in the bottom part with each number containing its own special mark. Below these pairs are more pairs of boxes with numbers in the top part and empty boxes in the bottom parts (Wechsler, 2008). The examinee is to correctly enter the special mark for each number for as many of the empty boxes as possible within the 120-second time limit (Wechsler, 2008). Raw Scores are compiled by totaling the number of correct items completed. The WAIS-IV test manual reports reliability and validity data that provide an adequate basis to judge each subtest as a reliable and valid measure for both age

groups utilized in this investigation. WAIS-IV Cronbach's Coefficient reliability for the Coding subtest range from .85 to .89 for ages 18 - 90 (Wechsler, 2008, p. 42). Test-retest scores range from .86 for all ages, and .84 to .89 for ages 16 - 29 and 55 - 69, respectively, and .86 for ages 70 - 90 (Wechsler, 2008, p. 51). Age related scaled scores were obtained from the raw scores and used to create a divergent validity measure analysis in comparison to the visual memory measures noted in this investigation. For external past and present validity information with visual memory measures noted in technical manuals and literature, reference Tables 9 and 15. Administration instructions for Coding can be found in the *WAIS-IV Administration and Scoring Manual* pages 152 - 155 (Wechsler, 2008).

**Verbal Learning from the WRAML2 (Sheslow & Adams, 2003).** As noted previously, the WRAML2 is a memory battery which assesses verbal, visual, and working memories. The Verbal Learning subtest is of interest for its divergent relationship with visual memory. Verbal Learning is a brief measure of verbal memory which assesses an individual's ability to learn a list of words immediately after hearing them. The examinee is read a list of 16 words and then immediately asked to recall as many words as possible. This procedure is repeated for three additional trials. Total words recalled in each trial are compiled into a raw score. The subtest takes approximately four minutes to administer. Subsequently, a delayed recall trial of the list is gathered after an approximate 10-minute interval and used to assess delayed verbal memory. Age related scaled scores were obtained from the immediate and delay raw scores for analysis. The *WRAML2 Administration and Technical Manual* reports reliability scores of .85 for ages 18 - 24, and .84 - .88 for ages 65 - 79 (Sheslow & Adams, 2003, p. 98). Test-retest reliability for the Verbal Learning subtest is reported to be .78 (Sheslow & Adams, 2003, p. 102). External validity

information is provided in Tables 3, 9, 12, and 15. Administration instructions for Verbal Learning can be found in *WRAML2 Administration and Technical Manual* pages 38 - 39 (Sheslow & Adams, 2003).

**Procedures**

Upon the first meeting with each participant, the screening assessment described above was administered. An informed consent was read to the participants who passed the screening. Younger adults were not required to complete the screening. A copy of the written informed consent forms can be found in Appendix C. Upon receiving written consent, the various tests were then administered. Approximate administration times for each measure are found in Appendix D. Each measure was administered using the standardized instruction found in its respective manual.

Research by Ackerman and Kanfer (2009) on cognitive fatigue during college aptitude testing, showed that length of testing time did not adversely affect performances by individuals taking cognitively demanding tests for up to 5.5 hours. This suggests that fatigue is unlikely to impact performance on tests in the present investigation. However, research by Ackerman and Kanfer (2009) did not address cognitive fatigue when testing older adults, using only a younger adult sample. In order to guard against potential confounding effects of fatigue near the end of the battery, measures were administered in different orders. Due to required delay intervals for some measures, immediate recall trials were fixed into the administration prior to their associated delay trials while the remaining items shuffled. These fixed items included the RCFT copy, immediate, and delayed recall trials, the BVMT-R immediate memory trial and delayed recall trial, WMS-IV Designs I and Designs II, and Visual Reproduction I and Visual Reproduction II,

and the WRAML2 Verbal Learning immediate recall and delayed recall. The Design and Picture Memory subtests of the WRAML2 and the Coding subtest of the WAIS-IV were placed around and between the timed delays to minimize possible testing fatigue effects. Three administration arrangements were provided to accommodate the trial administration requirements. Additional administration could not be arranged without violation of the test administration time requirements. Each possible arrangement, found in Appendix E, accommodates the necessary timed delays and sequencing required by the WMS-IV, WRAML2, RCFT, and BVMT-R. Administrations for the older adults will replicate that of the young adults minus the administration of the Designs I & II of the WMS-IV.

At the conclusion of the testing session those in the younger group were thanked for their time and approved for the course credit they were promised to receive for their participation. Those in the older group were also thanked for their participation and given a $10 VISA gift card or reminded of the donation they wished to have made on their behalf.

# Chapter 3

## Results

The Statistical Package for the Social Sciences (SPSS, version 23.0) was used for all analyses. Differences found in all analyses were considered significant and reported, if reaching at least the .05 level of confidence.

Means and standard deviations for the entire sample are presented in Table 18. To compare each of the sample mean scores to the population mean of either 10 (on subtests that yielded scaled score) or 50 (on subtests that used T-scores), one-sample t-tests were performed. Significant differences between the whole sample (WS) mean score and the population mean score were found on the following subtests: WRAML2 Picture Memory ($t$ (59) = -4.76, $p <$ .001), WRAML2 Design Memory ($t$ (59 = -2.10), $p$ = .040), WMS-IV Designs II ($t$ (28) = 2.41), $p$ =.023), WMS-IV Visual Reproductions II ($t$ (59) = -5.05), $p$ <.001), and WAIS-IV Coding ($t$ (59) = 2.45, $p$ = .017). Results are displayed in Table 18, including significant differences. These comparisons were also completed with age groups separated. For the older adults (O), significant differences between the sample mean score and the population mean score were found on the following subtests: WRAML2 Design Memory ($t$ (30) = -3.98), $p$ < .001), WMS-IV Visual Reproductions II ($t$ (30) = -4.39), $p$ <.001), and BVMT-R Delayed Recall ($t$ (30) = -2.91), $p$ = .007). For the younger adults (Y), significant differences between the sample mean score and the population mean score were found on the following subtests: WRAML2 Picture Memory ($t$ (28) = -5.27), $p$ < .001), WMS-IV Designs II ($t$ (28) = -2.41), $p$ =.02), WMS-IV Visual

Reproductions I (t (28) = 2.09), *p* = .046), WMS-IV Visual Reproductions II (t (28) = -2.72), *p* = .011), BVMT-R Immediate recall (t (28) = 2.2), *p* = .036), and BVMT-R Delayed recall (t (28) = 2.94), *p* = .007). Skewness, Kurtosis, and normality of the subtest results were also explored for both the younger and older adults and are displayed in Table 19. Figures 2 - 8 also demonstrate the skewness, kurtosis, and normality of the entire sample performances on visual memory subtests and include a normal curve overlay. According to Stevens (2001), it is unlikely that skewness and kurtosis, though representing some deviance from normality, has a significant effect on Type I error.

Table 18.

*Sample mean scaled scores and T scores compared to population means*

| Subtest | Sample Mean (Standard Deviation) | Population Mean (Standard Deviation) | Significant Difference in *p* value |
|---|---|---|---|
| WMS-IV Visual Reproduction I | 10.47 (2.94) | 10 (3) | Y- $p = .046$ |
| WMS-IV Visual Reproduction II | 7.52 (3.81) | 10 (3) | WS- $p < .001$<br>O- $p < .001$<br>Y- $p = .011$ |
| WMS-IV Designs I | 10.76 (2.42) | 10 (3) | |
| WMS-IV Designs II | 11.14 (2.55) | 10 (3) | Y- $p = .023$ |
| BVMT-R Immediate recall | 51.05 (14.96) | 50 (10) | Y- $p = .036$ |
| BVMT-R Delayed recall | 47.75 (16.70) | 50 (10) | O- $p = .007$<br>Y- $p = .007$ |
| WRAML2 Verbal Learning | 10.63 (2.69) | 10 (3) | |
| WRAML2 Verbal Delay | 10.28 (2.75) | 10 (3) | |
| WRAML2 Picture Memory | 8.11 (3.07) | 10 (3) | WS- $p <.001$<br>Y- $p <.001$ |
| WRAML2 Design Memory | 9.18 (3.02) | 10 (3) | WS- $p =.040$<br>O- $p <.001$ |
| RCFT Immediate recall | 52.62 (17.64) | 50 (10) | |
| RCFT Delayed recall | 47.18 (19.33) | 50 (10) | |
| WAIS-IV Coding | 10.86 (2.71) | 10 (3) | WS- $p = .017$ |

*Note*: WS = Whole Sample; O= Older adults; Y = Younger adults; Population scores are reported in scaled scores which use a mean of 10 and standard deviation of 3, and T-scores which use a mean of 50 and standard deviation of 10; WMS-IV Designs subtests was not administered to older adult sample, therefore results are calculated only for younger adult sample.

Table 19.

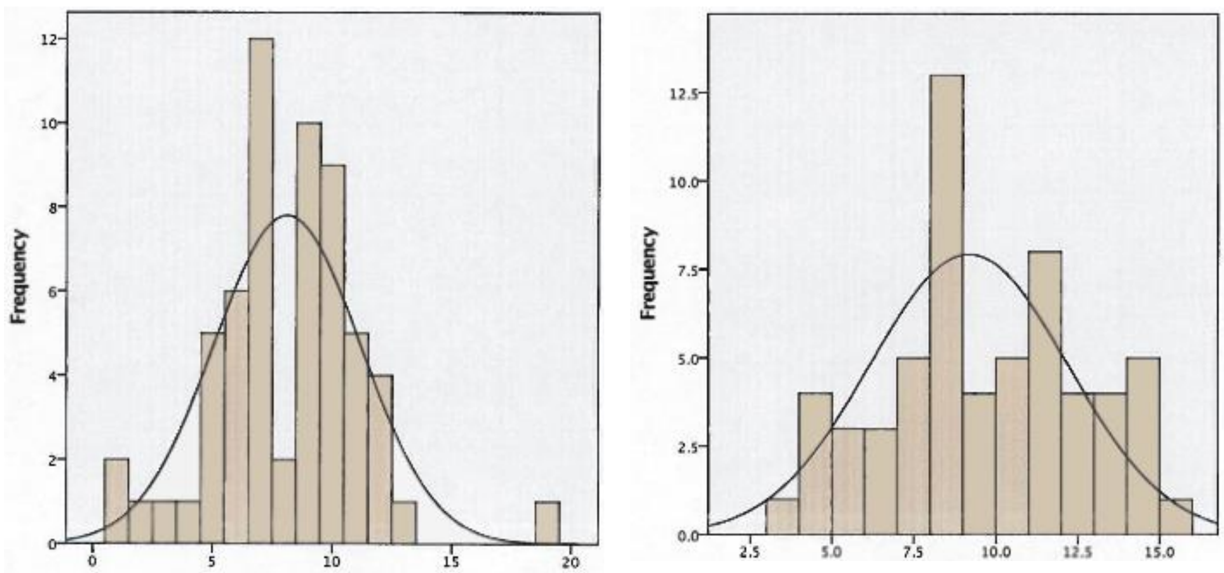
*Skewness, Kurtosis, and Normality of visual memory subtests*

| Subtest | Sample | Skewness | Kurtosis | Normality |
|---|---|---|---|---|
| WMS-IV Visual Reproduction I | Whole | -0.60 | 0.72 | .14* |
| | Older | -.42 | -.15 | .16 |
| | Younger | -.34 | -.47 | .2 |
| WMS-IV Visual Reproduction II | Whole | -0.10 | -0.58 | .11 |
| | Older | .09 | -.77 | .13 |
| | Younger | .23 | -1.06 | .13 |
| WMS-IV Designs I | Younger | -0.10 | -1.09 | .13 |
| WMS-IV Designs II | Younger | -2.77 | -0.76 | .15 |
| BVMT-R Immediate recall | Whole | -1.16 | 2.91 | .11 |
| | Older | -.64 | 1.53 | .08 |
| | Younger | -2.16 | 9.74 | .18* |
| BVMT-R Delayed recall | Whole | -0.56 | -0.92 | .23** |
| | Older | .23 | -1.6 | .16 |
| | Younger | -1.28 | 5.72 | .36** |
| WRAML2 Verbal Learning | Whole | 0.20 | 0.39 | .12* |
| | Older | -.37 | -.91 | .17* |
| | Younger | .19 | 1.29 | .12 |
| WRAML2 Verbal Delay | Whole | -0.16 | -0.41 | .12* |
| | Older | -.34 | -1.00 | .18* |
| | Younger | -.16 | -.01 | .12 |
| WRAML2 Picture Memory | Whole | 2.75 | 1.93 | .12 |
| | Older | .56 | 2.05 | .10 |
| | Younger | -.67 | .55 | .14 |
| WRAML2 Design Memory | Whole | -0.034 | -0.73 | .14* |
| | Older | .68 | .43 | .22** |
| | Younger | -.54 | -.21 | .13 |
| RCFT Immediate recall | Whole | -0.08 | .31 | .06 |
| | Older | -.24 | -1.3 | .13 |
| | Younger | -.35 | -.85 | .12 |
| RCFT Delayed recall | Whole | -0.18 | -.81 | .12* |
| | Older | -.07 | -1.2 | .14 |
| | Younger | -.67 | -.47 | .18* |
| WAIS-IV Coding | Whole | 0.05 | -.25 | .12* |
| | Older | -.33 | -1.04 | .19* |
| | Younger | .25 | .09 | .13 |

*Note*. * = $p < .05$, ** = $p < .01$, *** = $p < .001$

*Figure 2.* Participant scaled score performances on WRAML2 visual memory subtests.

*WRAML2 Picture Memory* *WRAML2 Design Memory*

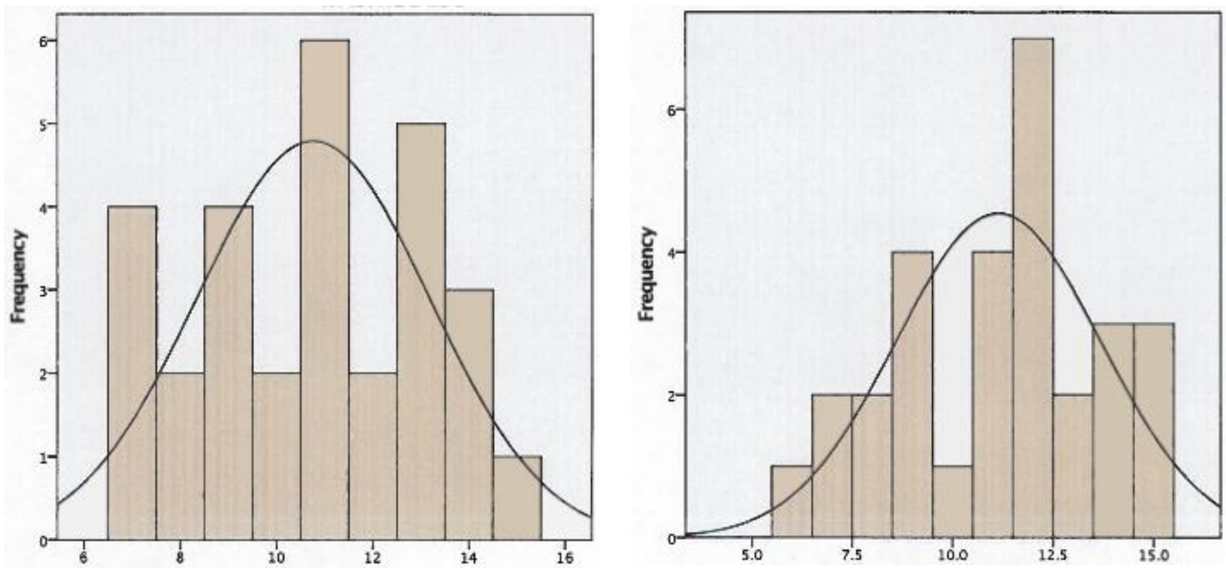



Frequency distributions of obtained scaled scores with overlay of the normal curve. WRAML2 = Wide Range Assessment of Memory and Learning, Second edition.

Related to the primary hypothesis of this study, relationships between visual memory subtests were explored. Pearson correlations were computed between mean performances of visual memory subtests. Results are found on Tables 20 - 22. It was assumed that visual memory measures used in the present study would be significantly correlated with each other. Analysis reveals that correlations range from the weak to very strong range (.11 - .86) for the total sample. These correlations were also run with age groups divided as *r's* can be seen in Tables 21 (older adults) and 22 (younger adults) range from -.33 to .80 for younger adults and from .23 to .86 for older adults.

*Figure 3.* Young Adult scaled score performances on WMS-IV Designs subtests.

*WMS-IV Designs I* *WMS-IV Designs II*



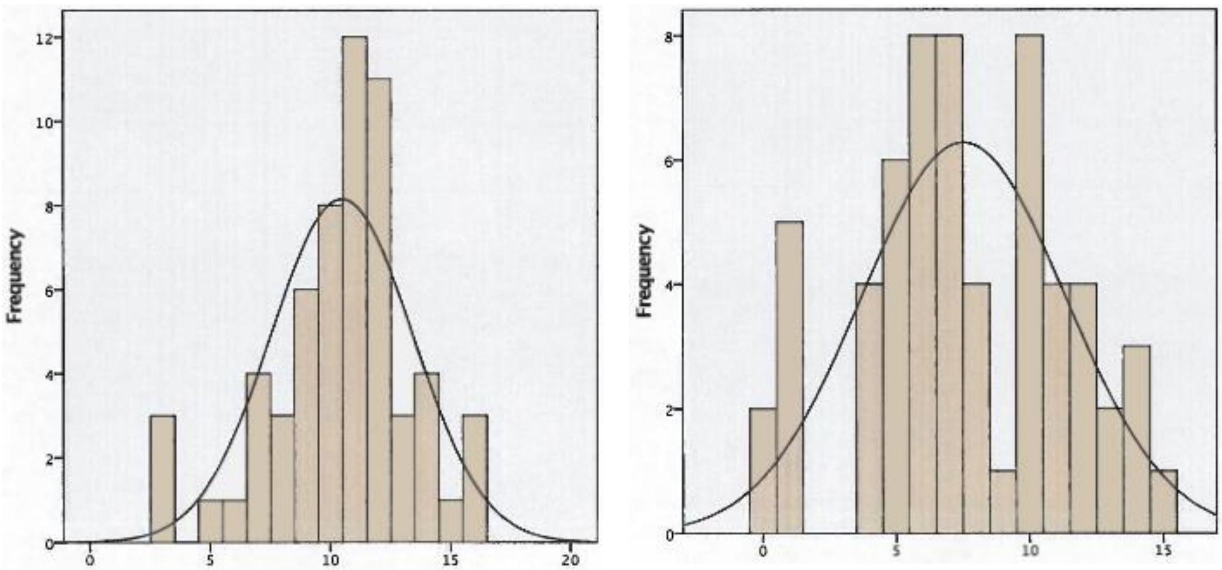

WMS-IV = Wechsler Memory Scale, Fourth edition. I = immediate recall, II = delayed recall.

For the entire sample, the highest shared relationships are seen between RCFT Immediate recall and RCFT Delayed recall (*r* = .86) while the least shared relationships are seen between WRAML2 Picture memory and RCFT delayed recall (*r* = .193), BVMT-R Immediate recall (*r* = .11) and BVMT-R Delayed recall (*r* = .11).

In the second hypothesis, the relationships between visual memory measures and non-visual memory measures were also explored to investigate discriminate validity. A Pearson Product-Moment Correlation Coefficient analysis revealed that while some visual memory measures correlated significantly lower with non-visual memory measures as expected

*Figure 4.* Participant of scaled score performances on WMS-IV visual reproductions subtests.

*WMS-IV Visual Reproduction I* *WMS-IV Visual Reproduction II*

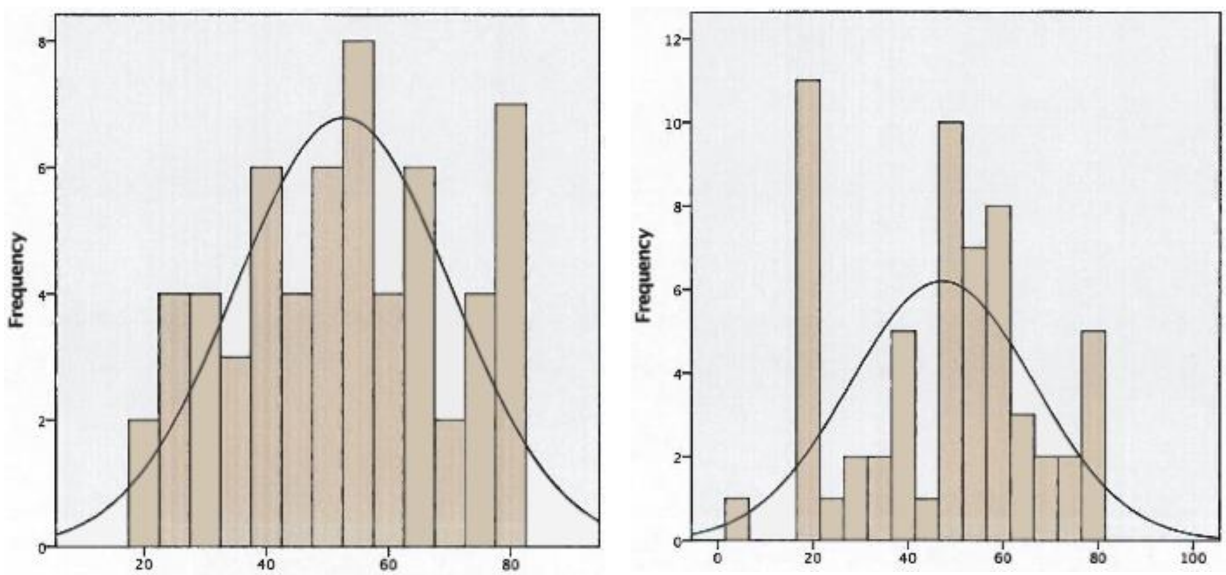



WMS-IV = Wechsler Memory Scale, Fourth edition. I = Immediate recall, II = delayed recall. Frequency distributions of obtained scaled scores with overlay of the normal curve.

(WRAML2 Picture Memory correlated with WAIS-IV Coding and WRAML2 Verbal Learning at $r = .06$, $p > .05$ and $r = .08$, $p < .05$, respectively), more than half of the visual memory measures used in this study demonstrated significant weak to moderate correlations with non-visual memory measures. The majority of these significant correlations were with the WRAML2 Verbal Learning Immediate and Delay trials. The magnitudes of these relationships for the entire sample are found in Table 23. A similar pattern was found with age groups divided. Below, the correlations between visual and non-visual memory measure performance scores can be found for older adults (Table 24) and younger adults (Table 25). For the entire sample, the WRAML2

*Figure 5.* Participant T-score performances on RCFT immediate and delayed recall trials.

*RCFT Immediate* *RCFT Delayed*

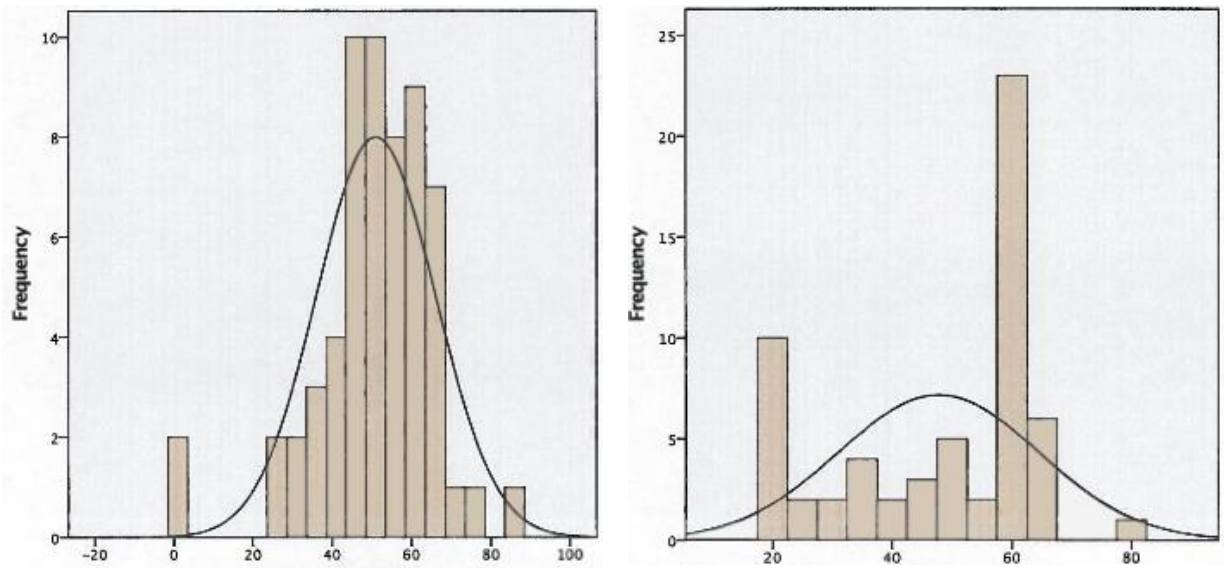



RCFT = Rey Complex Figure Test. Frequency distributions of obtained T-scores with overlay of the normal curve.

Verbal Learning subtest showed significant weak to moderate correlations with WRAML2 Design Memory ($r = .47$, $p < .01$), WMS-IV Designs II ($r = .46$, $p < .05$), Reproduction I ($r = .27$, $p < .05$) & II ($r = .37$, $p < .01$), RCFT Immediate ($r = .46$, $p < .01$) and Delay Recall ($r = .44$, $p < .01$), BVMT-R Immediate Recall, ($r = .41$, $p < .01$) and BVMT-R Delayed Recall ($r = .35$, $p < .01$). The WRAML2 Verbal Learning delayed recall subtest showed weak to strong significant relationships with all visual memory tasks except the WRAML2 Picture Memory subtest. As expected, the WAIS-IV Coding subtest achieved weak correlations with visual memory subtests with the exception of the WMS-IV Designs I ($r = .42$, $p < .05$). As consistent with previous research, the WAIS-IV Coding subtest did not exceed a correlation value greater than $r = .42$ with visual memory measures.

*Figure 6.* Participant T-score performances on BVMT-R immediate and delayed recall trials.

*BVMT-R Immediate* *BVMT-R Delayed*

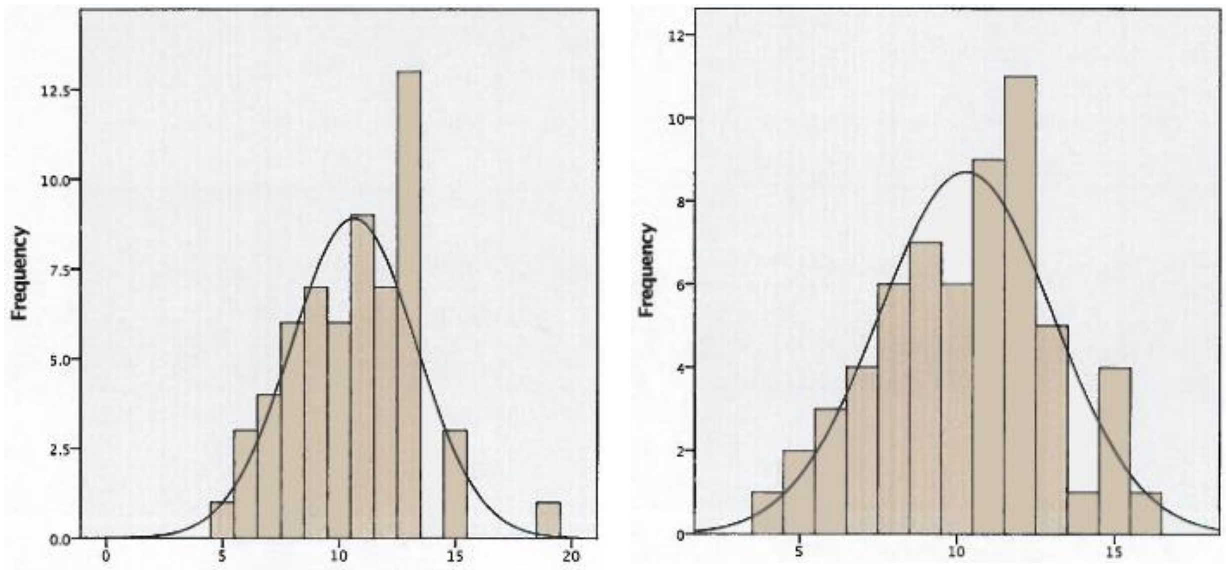



BVMT-R = Brief Visuospatial Memory Test, Revised. Frequency distributions of obtained T-scores with overlay of the normal curve.

Related to the third hypothesis, it was assumed that participants in this study would generate comparable mean scores across immediate recall trials for each measure and delayed recall trials for each measure. These relationships were explored with the whole sample (Table 20), and divided into younger adults only (Table 21) and older adults (Table 22) only. In the entire group, the immediate recall trials achieved moderate to large correlations ($r$ = .33 - .57). The delayed recall trails also achieved moderate to large correlations ($r$ = .40 - .62) with the exception of the BVMT-R Delayed Recall which achieved weak correlations ($r$ =.26 - .29) with WMS-IV Designs II and the RCFT Delayed Recall. For the older adult group, the immediate recall trials achieved correlations which ranged from moderate to large ($r$ = .40 - .67); the

*Figure 7.* Participant scaled score performances on WRAML2 verbal learning subtests.

*WRAML2 Verbal Learning* *WRAML2 Verbal Learning Delay*



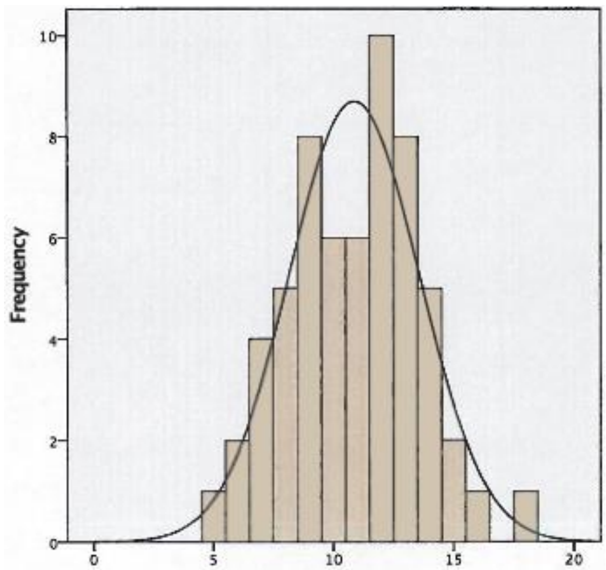

WRAML2 = Wide Range Assessment of Memory and Learning, Second edition. Frequency distributions of obtained scaled scores with overlay of the normal curve.

delayed recall trials achieved large correlations (*r* = .51 - .66). The younger adult group achieved weak to strong correlations (*r* = .16 - .57) for the immediate recall trials and (*r* = .02 - .63) for the delayed recall trials.

Taken overall, within immediate recall trials, weaker correlations were found with the younger adult group than with the older group. However, within the delayed recall trials, correlation sizes were approximately equal between age groups. Of the delayed recall subtests, though, stronger correlations were found with the older adults than with the younger adults on the BVMT-R delayed trial specifically. For reference, Table 28 is shown below to demonstrate the mean scores for both the younger adults and older adults for both recall trials. In order to

*Figure 8.* Participant scaled score performances on WAIS-IV coding subtest.

*WAIS-IV Coding*




WAIS-IV = Wechsler Adult Intelligence Test, Fourth Edition. Frequency distributions of obtained scaled scores with overlay of the normal curve.

explore differences between age groups on immediate and delayed recall scores, an independent samples t-test was used. Significant differences were found between age groups on BVMT-R immediate recall (t (58) = 2.30) *p* = .025) and BVMT-R delayed recall (t (47.68) = 3.99, *p* < .001). Results are shown in Figure 9.

The fourth hypothesis stated that correlation magnitudes across the various visual memory measures would be comparable between age groups. In order to compare correlations between older adults (Table 25) and younger adults (Table 26), correlations were converted to Fisher *z*-scores. To test for significant differences, a Fisher's *z* test for differences between

Table 20.

*Correlations of Mean Scores Among Visual Memory Measures for Entire Sample*

| | Picture Mem. | Design Mem. | DE I | DE II | VR I | VR II | RCFT Imm. | RCFT Delay | BVMT-R Imm. |
|---|---|---|---|---|---|---|---|---|---|
| Design Mem. | 0.23 | | | | | | | | |
| DE I | -0.28 | 0.44* | | | | | | | |
| DE II | -0.33 | 0.45* | 0.69** | | | | | | |
| VR I | 0.25 | 0.46** | 0.44* | 0.56** | | | | | |
| VR II | 0.25 | 0.60** | 0.54** | 0.40* | 0.57** | | | | |
| RCFT Imm. | 0.30 | 0.4** | 0.57** | 0.53** | 0.56** | 0.58** | | | |
| RCFT Delay | 0.19 | 0.37** | 0.53** | 0.63** | 0.50** | 0.57** | 0.86** | | |
| BVMT-R Imm. | 0.11 | 0.53** | 0.38* | 0.19 | 0.33* | 0.49** | 0.36** | 0.30* | |
| BVMT-R Delay | 0.11 | 0.58** | 0.36 | 0.26 | 0.37** | 0.49** | 0.35** | 0.29* | 0.60** |

*Note*: Picture mem. = Picture Memory subtest of the WRAML2, Design Mem. = Design Memory subtest of the WRAML2, DE I = Designs immediate recall subtest of the WMS-IV, DE II = Designs delayed recall subtest of the WMS-IV, VR I = Visual Reproductions immediate recall subtest of the WMS-IV, VR II = Visual Reproductions delayed recall subtest of the WMS-IV. RCFT Imm. = Immediate recall of the Rey Complex Figure Test, BVMT-R Imm = Immediate recall of the Brief Visuospacial Memory Test, Revised, immediate recall trials.

independent correlations was used (Bruning & Kintz, 1997). Results are listed below in Table 27. With the exception of a few, correlation magnitudes were not significantly different between age groups. Exceptions included significant differences on correlation magnitudes between the RCFT Delayed Recall and BVMT-R Immediate Recall (Fisher's $z$ (30, 28) = .27, $p < .05$), and between RCFT delayed recall and BVMT-R delayed recall (Fisher's $z$ (30, 28) = .25, $p < .05$). In

Table 21.

*Pearson r Correlation Coefficients for Younger Adult Performances on Visual Memory Measures*

| | Picture Mem. | Design Mem. | DE I | DE II | VR I | VR II | RCFT Imm. | RCFT Delay | BVMT-R Imm. |
|---|---|---|---|---|---|---|---|---|---|
| Design Mem. | 0.18 | | | | | | | | |
| DE I | -0.28 | 0.44* | | | | | | | |
| DE II | -0.33 | 0.45* | 0.69* | | | | | | |
| VR I | -0.03 | 0.41* | 0.44* | 0.56** | | | | | |
| VR II | 0.15 | 0.36 | 0.54** | 0.40* | 0.34 | | | | |
| RCFT Imm. | 0.22 | 0.49** | 0.57** | 0.53** | 0.40* | 0.66* | | | |
| RCFT Delay | 0.07 | 0.33 | 0.53** | 0.63** | 0.30 | 0.57** | 0.80** | | |
| BVMT-R Imm. | 0.13 | 0.41* | 0.38* | 0.19 | 0.16 | 0.45* | 0.22 | -0.03 | |
| BVMT-R Delay | 0.03 | 0.49 | 0.36 | 0.26 | 0.26 | 0.29 | 0.32 | -0.02 | 0.55** |

*Note*: Picture mem. = Picture Memory subtest of the WRAML2, Design Mem. = Design Memory subtest of the WRAML2, DE I = Designs immediate recall subtest of the WMS-IV, DE II = Designs delayed recall subtest of the WMS-IV, VR I = Visual Reproductions immediate recall subtest of the WMS-IV, VR II = Visual Reproductions delayed recall subtest of the WMS-IV. RCFT Imm. = Immediate recall of the Rey Complex Figure Test, BVMT-R Imm = Immediate recall of the Brief Visuospacial Memory Test, Revised, immediate recall trials.

Table 22.

*Pearson r Correlation Coefficients for Older Adult Performances on Visual Memory Measures*

| | Picture Mem. | Design Mem. | DE I | DE II | VR I | VR II | RCFT Imm. | RCFT Delay | BVMT-R Imm. |
|---|---|---|---|---|---|---|---|---|---|
| Design Mem. | .51** | | | | | | | | |
| DE I | .[b] | .[b] | | | | | | | |
| DE II | .[b] | .[b] | .[b] | | | | | | |
| VR I | .41* | .50** | .[b] | .[b] | | | | | |
| VR II | .41* | .67** | .[b] | .[b] | .66** | | | | |
| RCFT Imm. | 0.29 | .59** | .[b] | .[b] | .67** | .65** | | | |
| RCFT Delay | 0.23 | .58** | .[b] | .[b] | .61** | .66** | .89** | | |
| BVMT-R Imm. | 0.23 | .50** | .[b] | .[b] | .40* | .46** | .58** | .61** | |
| BVMT-R Delay | 0.35 | .47** | .[b] | .[b] | .40* | .51** | .59** | .57** | .56** |

*Note*: * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed); b. Cannot be computed because the older adults were not administered the Designs I & II subtests of the WMS-IV due to exceeding the maximum age for normed scores; Picture mem. = WRAML2 Picture Memory, Design Mem. = WRAML2 Design Memory, DE I = WMS-IV Designs immediate recall, DE II = WMS-IV Designs delayed recall, VR I = WMS-IV Visual Reproductions immediate recall, VR II = WMS-IV Visual Reproductions delayed recall. RCFT Imm. = Rey Complex Figure Test Immediate recall, BVMT-R Imm = Brief Visuospacial Memory Test, Revised.

Table 23.

*Correlations between Visual Memory and Non-Visual Memory Measures for Entire Sample*

| | WAIS-IV Coding | WRAML2 Verbal Learning | WRAML2 Verbal Delay |
|---|---|---|---|
| WRAML2 Verbal Learning | 0.01 | | |
| WRAML2 Verbal Delay | 0.05 | .65** | |
| WRAML2 Picture Memory | 0.06 | 0.08 | 0.17 |
| WRAML2 Design Memory | 0.23 | .47** | .35** |
| WMS-IV Designs I | .42* | 0.31 | .60** |
| WMS-IV Designs II | 0.23 | .46* | .60** |
| WMS-IV Visual Reproduction I | 0.14 | .27* | .48** |
| WMS-IV Visual Reproduction II | 0.18 | .37** | .49** |
| RCFT Immediate recall | 0.19 | .46** | .59** |
| RCFT Delayed recall | 0.25 | .44** | .56** |
| BVMT-R Immediate recall | -0.05 | .41** | .35** |
| BVMT-R Delayed Recall | 0.09 | .35** | .27* |

*Note*: *. Correlation is significant at the 0.05 level (2-tailed), **. Correlation is significant at the 0.01 level (2-tailed).

Table 24.

*Correlations between Visual Memory and Non-Visual Memory Measures for Older Adults*

| | WAIS-IV Coding | WRAML2 Verbal Learning | WRAML2 Verbal Delay |
|---|---|---|---|
| WRAML2 Verbal Learning | -0.03 | | |
| WRAML2 Verbal Delay | -0.14 | .78** | |
| WRAML2 Picture Memory | 0.21 | 0.34 | 0.29 |
| WRAML2 Design Memory | 0.22 | .47** | .48** |
| WMS-IV Designs I | .[b] | .[b] | .[b] |
| WMS-IV Designs II | .[b] | .[b] | .[b] |
| WMS-IV Visual Reproduction I | 0.24 | .36** | .54** |
| WMS-IV Visual Reproduction II | 0.25 | .5** | .54** |
| RCFT Immediate recall | 0.18 | .63** | .56** |
| RCFT Delayed recall | 0.09 | .60** | .57** |
| BVMT-R Immediate recall | -0.13 | .43* | .49** |
| BVMT-R Delayed Recall | 0.18 | .42* | .44* |

*Note*: *. Correlation is significant at the 0.05 level (2-tailed), **. Correlation is significant at the 0.01 level (2-tailed), [b] = correlations cannot be computed due to Designs subtest not administered to older adults.
.

Table 25.

*Correlations between Visual Memory and Non-Visual Memory Measures for Younger Adults*

| | WAIS-IV Coding | WRAML2 Verbal Learning | WRAML2 Verbal Delay |
|---|---|---|---|
| WRAML2 Verbal Learning | 0.02 | | |
| WRAML2 Verbal Delay | 0.28 | -0.08 | |
| WRAML2 Picture Memory | -0.08 | .55** | -0.12 |
| WRAML2 Design Memory | 0.27 | 0.31 | .47** |
| WMS-IV Designs I | .42* | .57* | .60** |
| WMS-IV Designs II | 0.23 | 0.22 | .60** |
| WMS-IV Visual Reproduction I | -0.01 | 0.28 | .43* |
| WMS-IV Visual Reproduction II | 0.10 | .43* | .57** |
| RCFT Immediate recall | 0.24 | .38* | .61** |
| RCFT Delayed recall | .45* | .40* | .52** |
| BVMT-R Immediate recall | 0.00 | .37* | 0.32 |
| BVMT-R Delayed Recall | -0.06 | 0.02 | 0.31 |

*Note*: *. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

the case of the RCFT Delayed Recall and the BVMT-R Immediate Recall, the older adults yielded a very strong correlation of $r$ = .72 while the younger adults yielded a weak correlation of $r$ = .03. In the case of the RCFT Delayed Recall and the BVMT-R Delayed Recall, the older adults yielded a strong correlation of $r$ = .66 while the younger adults yielded a weak correlation of $r$ = .02.

Table 26.

*Results of Test for Differences between Independent Correlations of Age Group Performances*

| | Picture Mem. | Design Mem. | DE I | DE II | VR I | VR II | RCFT Imm. | RCFT Delay | BVMT-R Imm. |
|---|---|---|---|---|---|---|---|---|---|
| Design Mem. | 0.18 | | | | | | | | |
| DE I | b | b | | | | | | | |
| DE II | b | b | b | | | | | | |
| VR I | 0.16 | 0.05 | b | b | | | | | |
| VR II | 0.11 | 0.19 | b | b | 0.17 | | | | |
| RCFT Imm. | 0.03 | 0.06 | b | b | 0.15 | 0.01 | | | |
| RCFT Delay | 0.07 | 0.12 | b | b | 0.16 | 0.06 | 0.13 | | |
| BVMT-R Imm. | 0.04 | 0.11 | b | b | 0.11 | 0.01 | 0.17 | 0.27* | |
| BVMT-R Delay | 0.01 | 0.01 | b | b | 0.06 | 0.11 | 0.14 | 0.25* | 0.01 |

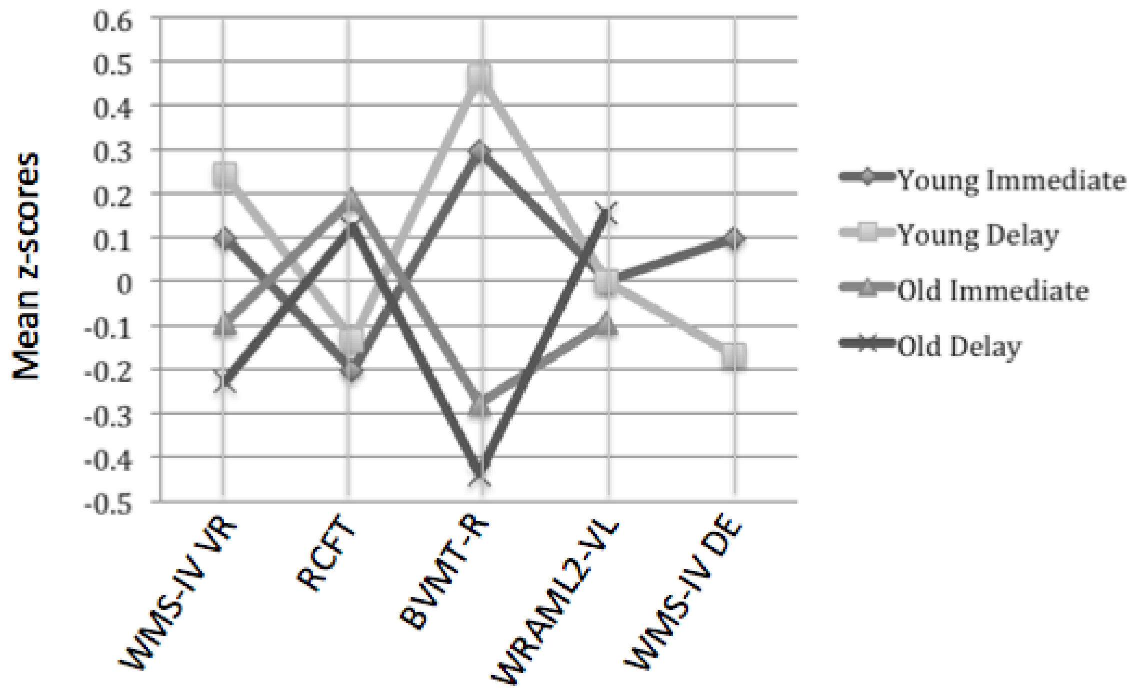
*Note*: *A *z scores* larger than 1.96 is significant at the .05 level using a two-tailed test. A significant *z* indicates that two correlation values are likely really different (Bruning & Kintz, 1997); b. Cannot be computed because the older adults were not administered the Designs I & II subtests of the WMS-IV due to exceeding the maximum age for normed scores.

Finally, the fifth hypothesis explored differences in mean scores related to age, type of task (immediate versus delay), and the specific visual memory task used. However, the various measures used yielded different types of scores (either T-scores or scaled scores). For the purpose of this comparative analysis, all scores were converted to Fisher *z*-scores. Means and

standard deviations for mean scores transformed to z-scores are reported, below, in Table 28. A 3 (task) x 2 (age group) x 2 (immediate versus delay) repeated-measures analysis of variance was used to explore the main effects of immediate versus delayed recall, the specific visual memory task used (WMS-IV Visual Reproductions, RCFT, and BVMTR), and age (younger or older). Figure 9, below, shows a mean score comparison with age grouping and immediate versus delayed differentiated. Of the three main effects explored, none reached significance. However, power estimates ($1-\beta$) ranged from .05 to .07, indicating that there was not enough power to detect main effects. Thus, a larger sample size would be required to confirm the null hypothesis.

Interactions between the above factors were also explored. Significance was reached in the interaction between specific visual memory test used and age [$F(6, 58) = 11.705$, $p < .001$, partial $\eta^2 = .291$, power $(1-\beta) = .94$]. The older adults were observed to demonstrated better performances, by comparison, on the BVMT-R Immediate Recall trial than the younger adults, however, they showed a worse performance on the Delayed Recall trial. This may suggest that the BVMT-R was an easier task for the younger adults who more frequently achieved the ceiling performance on the Delayed Recall trial due to a ceiling effect (earning a T-score of > 80). Meanwhile the older adults' performance seemed to generally decline more than expected over a delay. Also, since research has shown that testing memory for meaningless figures tends to factor as an executive functioning and organizational task more than memory for conceptual pictures, this may also contribute the difference in performances between younger adults and older adults (Lezak et al., 2012).

*Figure 9.* Mean scores converted to z-scores for immediate and delayed performances among younger and older adult participants

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*Note*: WMS-IV VR = Wechsler Memory Scale, Fourth Edition, Visual Reproductions subtests; BVMT-R = Brief Visuospacial Memory Test, Revised; RCFT = Rey Complex Figure Test; WMS-IV DE = Wechsler Memory Scale, Fourth Edition, Designs Subtests; The older adults age span exceeds that of the normed scores for older adults on the WMS-IV Designs I & II subtests. Therefore, older adult scores are not shown in this table.

Table 27.

*Mean z-Scores on Visual Memory Measures for Younger and Older Adult Groups Arranged by Immediate and Delay Recall Subtests.*

| Immediate | Age Group | *M* | SD | *n* |
|---|---|---|---|---|
| WMS-IV VR I | Younger Adult | 0.10 | 0.67 | 29 |
| | Older Adult | -0.09 | 1.24 | 31 |
| RCFT Immediate | Younger Adult | -0.20 | 0.83 | 29 |
| | Older Adult | 0.19 | 1.12 | 31 |
| BVMT-R Immediate | Younger Adult | 0.30 | 0.90 | 29 |
| | Older Adult | -0.28 | 1.03 | 31 |
| WRAML2 Verbal Learning | Younger Adult | 0.10 | 1.21 | 29 |
| | Older Adult | 0.16 | 0.77 | 31 |
| Delayed | | | | |
| WRAML2 Verbal Delay | Younger Adult | -0.17 | 0.88 | 29 |
| | Older Adult | 0.16 | 1.10 | 31 |
| BVMT-R Delay | Younger Adult | 0.47 | 0.61 | 29 |
| | Older Adult | -0.44 | 1.10 | 31 |
| RCFT Delay | Younger Adult | -0.13 | 0.88 | 29 |
| | Older Adult | 0.12 | 1.10 | 31 |
| WMS-IV VR II | Younger Adult | 0.24 | 0.81 | 29 |
| | Older Adult | -0.22 | 1.11 | 31 |

*Note*: z-scores are reported as mean of 0 and standard deviation of 1. *n* = Total number of participants. SD = Standard Deviation. *M* = Mean. VR = Visual Reproductions subtest.

# Chapter 4

## Discussion

This investigation compared six commonly used visual memory measures among 60 participants (younger adults and older adults) to determine their comparability as well as their divergence from two non-visual memory measures. Aims of the study were to expand existing knowledge regarding concurrent validity and interrelationships among measures which each purport to test the same domain.

Related to Hypothesis 1, visual memory measures demonstrated weak to very strong correlations with one another. This range is even greater than that seen in previous interrelationship studies of visual memory. Multiple correlations in the present study achieved statistical significance for the entire sample. In this observation it is also noted that none of the visual memory measures utilized in this study correlated significantly with the Picture Memory Subtests of the WARML2. It is estimated that this is due to the uniqueness of this measure as the other measures share more in common in their methods of testing visual recall. For example, these visual memory measures have been demonstrated to share approximately fifty percent variance with executive functioning measures (Duff, Schoenberg, Scott, Adams, 2005), and executive functioning as well as visual memory performances on measures are known to have age-related declines (Peich et al., 2013; Spencer, & Raz, 1995).

Interestingly, the weakest correlations were between the WRAML2 Picture Memory subtest and the RCFT Delayed recall ($r$ = .19) and between the WRAML2 Picture Memory and

both BVMT-R recall trials ($r$ =.11). This suggests that the WRAML2 Picture Memory subtest measures something different than the RCFT and BVMT-R. This is possibly explained by the recall and recognition of contextual (meaningful) visual stimuli rather than using geometric or symbolic (meaningless) figures. Despite these task demand differences, the correlations attained still seem surprisingly low. This is consistent with previous research that indicates that visual memory correlations vary greatly depending on the methods used in measuring visual recall. Research also suggests when visual memory is difficult to differentiate from other memory subdomains, it can be attributed to the tapping into a general memory factor (Larrabee & Curtiss, 1995; Larrabee et al., 1985).

While tasks that use similar methods of measuring visual memory attained moderate or large correlations, this was not consistent among all analyzed measures which use similar methods. For example, the BVMT-R and the WMS-IV Visual Reproductions (VR) subtest are similar in the administration and recall demands (10 second exposure and immediate visuomotor -drawing- recall). However, for the younger adults only, these tasks correlated more weakly than expected in the cases of the immediate recall trials ($r$ = .16) and between VR-I and the delayed trial of the BVMT-R ($r$ = .26). Similarly, the delay trials of the BVMT-R and RCFT share similar tasks, yet achieve a weak correlation ($r$ = .29). Also of note, some measures that use quite different methods of testing visual memory achieved a strong correlation. For example, the WMS-IV Designs II subtest and RCFT delay recall correlated at $r$ = .63. Presumably, this is a result of both measures sampling the same construct in visual memory recall despite difference in stimuli encoding.

Measures which relied upon visuomotor recall (drawing) correlated more weakly with those employed other methods. For example, the WRAML2 Picture Memory consistently correlated lower with WRAML2 Designs, and both recall subtests of the WMS-IV Visual Reproductions, RCFT and BVMT-R. Meanwhile, WRAML2 Picture Memory was the only measure to generate negative correlations with the WMS-IV Designs I and II subtests. Not surprisingly, WRAML2 Picture Memory and WMS-IV Designs subtests rely less heavily on visuomotor construction for recall than the other measures. As this would suggest, measures that utilized visuomotor methods of measuring recall correlated more highly with one another.

Another presumed contributing factor to some of the significant findings in this study is the limited floor and ceiling on the RCFT and BVMT-R. Scores on these visual memory measures are used to detect clinical significance and may not necessarily be psychometrically sensitive to minute performance differences beyond $T < 20$ and $T > 80$.

Regarding Hypothesis 2, alternatively than expected, more than half of the visual memory correlations produced moderate relationships with non-visual memory. Past research concludes moderate correlations exist between visual memory recall and verbal memory due to the heavy use of verbal encoding of visual stimuli (Lezak et al., 2012; Okura, 2001; deBros, 2014). Of the other visual memory measures explored, WRAML2 Picture Memory stood apart as most differentiated in demonstrating lower correlations with the WRAML2 Verbal Learning and WAIS-IV Coding subtests. One possible explanation for this finding might be the distinct method which the WRAML2 Picture Memory measures visual memory, minimizing visuomotor demands while still requiring visuospatial recall. Interestingly, the WRAML2 Picture Memory

also did not correlate strongly with other visual memory measures (correlations ranging between .11 to -.33), further demonstrating the subtests distinctiveness.

Hypothesis 3 explored intercorrelations on immediate recall tasks and delayed recall tasks. When relationships were explored between immediate recall performances and delayed recall trials, mixed results were found. Correlations were all in the moderate range with the exception of two weak correlations. Correlations ranged from moderate to strong for the older adults. Correlations were mixed for the younger adults (weak to strong) as well. For the younger adults, the BVMT-R again showed the weakest correlations with other visual memory measures.

Another finding revealed that mean scores on related immediate recall and delayed recall measures demonstrated the same size of correlation. That is, for a given set of immediate and delay trials of two different measures, the immediate and delayed trials achieved approximately equal strength correlations. For example, in the case of the WMS-IV Designs subtest and the RCFT, the Immediate Recall trials achieved a strong correlation at $r = .57$, and the Delayed Recall trials also achieved a strong correlation at $r = .63$. The same principle also held true when the magnitudes of immediate trials were compared to delayed trials.

Hypothesis 4 explored age group differences on the above-reported immediate recall intercorrelations and delayed recall intercorrelations. As expected, visual memory correlations were not different between age groups, with the exception of two instances. That is, visual memory performance, regardless of age, was not different across the measures of visual memory. The two exceptions were age-group differences on the weak correlational relationships between BVMT-R Immediate Recall and RCFT Delayed Recall ($r = .27$) and the relationship between

BVMT-R Delayed Recall and RCFT Delayed Recall ($r$ = .25). This appears to suggest something unique about the BVMT-R.

Finally, Hypothesis 5 explored group differences on mean scores, specifically exploring main effects and interactions related to age, type of task (immediate versus delay), and the specific visual memory task used. Not surprisingly, results yielded only one significant interaction which was between age and specific test used (BVMT-R). These findings demonstrated that younger adults demonstrated less decline on the BVMT-R trials, compared to their peers, and older adults demonstrated more decline than their peers on the BVMT-R trials. Although age-related declines are not uncommon, particularly in the elderly (Lezak et al., 2012), the BVMT-R demonstrated more divergent results between younger and older performances than the other measures. A previous study, deBros (2014) compared multiple measures of visual memory between clinical and non-clinical samples noted a similar observation. The researcher attributed this to the BVMT-R demonstrating a higher sensitivity to decline than the other measures (deBros, 2014).

**Conclusion/Implications**

In sum, the present study builds on past research finding that commonly-used visual measures correlate moderately with one another and correlate more weakly with non-visual memory measures. Of the measures used, this study highlights the utility of the WRAML2 Picture Memory subtest and the BVMT-R as visual memory measures with discriminant validity. Both measures were identified as standing apart from other commonly used visual memory measures. Of the measures utilized, the WRAML2 Picture Memory demonstrated lower correlations with non-visual memory measures as well as consistently achieved weak

correlations with other well-established measures of visual memory. This suggests that the WRAML2 Picture Memory may measure some unique aspect of visual memory not captured by the other measures.

Second, findings demonstrated greater inconsistencies in strength of relationship between the BVMT-R and other visual memory measures, as well as greater performance differences between immediate and delayed recall. Particularly, with the older adult sample, the BVMT-R demonstrated more exaggerated differences between immediate and delayed recall performances than the other measures. This suggests, concurrent with past research, that the BVMT-R may be a more sensitive measure of visual memory. The present study offers current interrelationship data which contributes to the available comparative data for visual memory measures frequently utilized in memory and neuropsychological batteries.

**Limitations**

This study presents several limitations that may limit the generalizability of the findings. First, and probably the most notable limitation, is the lack of a clinical comparison sample for ecological and functional validity. A comparative matched sample with a clinical population of individuals with Alzheimer's Disease, Dementia, Mild Cognitive Impairment, Parkinson’s Disease, Multiple Sclerosis or other neurological conditions would likely add clinical relevance and generalizability to this study. Second, many of the correlations explored reached significance, though not all. Future studies in this would benefit from including a larger sample size in order to establish the correlation significance of the relationships used in the present study, it is suggested that a larger sample should be used. Third, the sample used in the present study had a higher level of education than that represented in the educational strata of the U.S.

census. Future studies would benefit from more closely aligning their sample with the current U.S. census data. The higher education in this sample may have contributed to the stronger than expected significant correlations between verbal memory and visual memory. In addition, the sample used in this study contained fewer non-Caucasian older adults than provided in the ethnicity strata of the U.S. census, bringing to question the generalizability of the results within the older adult sample. Fourth, future studies may wish to decrease the number of recall tasks required of participants. Observationally, it appeared that completing the number of tasks involved in this study was challenging, even for some members of a non-clinical sample. Stimuli confused across tasks occurred more frequently for the older adults than the younger adults. Finally, the visual memory subtests used in this study utilized subtest scaled scores or T-scores. Since index scores are more reliable than individual scaled scores, additional valuable data may be uncovered from more exploration at the index score level (Adams & Reynolds, 2009).

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**Appendix A**

*Letter to Older Adult Participant:*

*Dear Resident,*

*You have the opportunity to help a local student from George Fox University with his doctoral dissertation by being a part of a study. I have spoken with Mr. Schloemer and have approved the activities in this study as suitable for Friendsview residents. The activities will take about an hour of your time. For those who would like to help, Jeffrey has offered to give a small thank you gift of $10 in the form of a VISA gift card which you can use just about anywhere to make purchases. If you're interested in helping out, or would like to know more about this project, Mr. Schloemer can be reached by phone (360 540 0079) or by email (jschloemer11@georgefox.edu). Thanks for considering this student's request.*

*Sincerely,*

*Activities Director of Friendsview*

*Retirement Community*

______________________________ *Date* ____ / _____ / __________

## Appendix B

*Screening Administration Instructions and Procedure.*

*[To be administered BEFORE written Informed consent is given.]*

*SAY: "Thank you for interest in volunteering for this study. Before we get started with this project, I want to make sure you'll be a good fit for the things I will have you do. I have some questions for you to answer, and a few tasks for you to try. First, tell me . . . ?" [These questions are to be asked at a normal conversational volume tone to assess for adequate hearing.]*

1 What is the year of your birth? ____________________

2 How much education have you received? _________________________

3 Do you wear corrective lenses or hearing aids?_____________________________

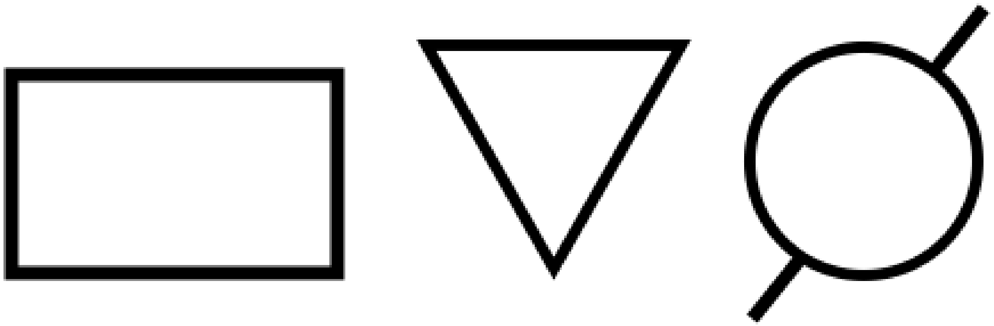
**4 Have you ever been diagnosed with any of these conditions?**

**Multiple Sclerosis, Y__ N__? Traumatic Brain Injury, Y__ N__? Seizures or epilepsy, Y__ N__? Dementia ,Y__ N__? Do you take medication that affects your ability to remember things, Y__ N__?**

5 Can you use a pencil to draw some simple shapes, Y__ N__?

NEXT: [Administer pencil and WRAVMA items]

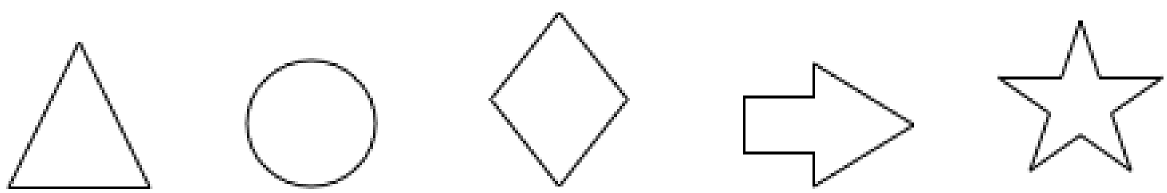
SAY: In the spaces below, I'd like you to copy these three shapes using this pencil.



SAY: **Please read this sentence here [**point to sentence below line**] and follow what it instructs you to do**.

---

There are five items below this sentence; please circle the shape that looks like a diamond.



---

*If examinee is unable to read and follow the instructions requesting them to circle an item, OR if examinee cannot adequately copy two of the three figures, the examinee must be excused.*

*SAY: Thank you for giving such a good effort, your time is quite valuable. I noticed that you seemed to have difficulty with [Name item(s) participant struggled with]. Since the nature of these tasks demand much in the areas you seemed to struggle, it would seem to give you unnecessary stress to have to complete them. Thank you for your time, you are free to go.*

*If the examinee adequately follows the directions to circle the correct shape AND adequately copies 2 of the 3 the shapes, administer the written INFORMED CONSENT.*

*SAY: Here is a form which describes what we will be doing today, I'll need your signature before we can begin. [Read form aloud to participant, unless they wish to read the form for themselves.] After obtaining the participants signature, begin the visual memory battery.*

*SAY: Very good. Now we can move on to start the what you came here to do. Thank you for volunteering for this project. We will be doing a variety of different tasks today which ask you to remember things I will show you. Some tasks will be easy for you and some may be difficult. In order for our time to be useful, a good effort is needed throughout the entire session, so please try your best. Do you have any questions?"*

## Appendix C

**INFORMED CONSENT**
to Participate in a Research Study
**Form for Younger Adult Group**

In this study, we want to compare tasks that each say they measure how well we remember things we see. We want to see if the tasks give us the same results. Some of the tasks will ask you to look at figures then draw them later. Other tasks will have you try and remember parts of a picture. And other tasks will have you remember words. Remembering some shapes, pictures, or words may be easy and some may be hard. Just try your best. The total time needed should be about an hour.
How you do on these tasks will not be shared with anyone else, but instead your results will be de-identified and included with other peoples' results for analysis.

You may feel a little tired during or after helping out with this project, but that is normal. Most people find the tasks interesting. If you finish the whole test, I will want to say thanks by recording one full hour of class credit.

Being in this study is voluntary. You may choose to stop at any time. However, if you choose to stop before the tasks are all finished, you will not be able to receive course credit

If you have any questions or concerns about this testing you may feel free to contact me or Wayne Adams, Ph.D. (503-554-2370).

I have read and understood the details written above and I would like to help out with this study.

___________________________________
Printed Name

___________________________________ Date: ______/______/______

Signature

*Participant / Examiner Copy*

**INFORMED CONSENT**
to Participate in a Research Study
**Form for Older Adult Group**

In this study, we want to compare tasks that each say they measure how well we remember things we see. We want to see if the tasks give us the same results. Some of the tasks will ask you to look at figures then draw them later. Other tasks will have you try and remember parts of a picture. And other tasks will have you remember words. Remembering some shapes, pictures, or words may be easy and some may be hard. Just try your best. The total time needed should be about an hour.
How you do on these tasks will not be shared with anyone else, but instead your results will be included anonymously with other peoples' results for analysis.

You may feel a little tired during or after helping out with this project, but that is normal. Most people find the tasks interesting. If you finish the whole test, I will want to say thanks by giving you a ten dollar Visa gift card that you may spend in any store that accepts charge cards, which is just about everywhere! Or, instead, I can donate those $10 to a charity of your choice on your behalf. ________________________________(participant preference)

Being in this study is voluntary. You may choose to stop at any time. However, if you choose to stop before the tasks are all finished, you will not be able to receive the little thank you gift.

If you have any questions or concerns about this testing you may feel free to contact me or Wayne Adams, Ph.D. (503-554-2370).

I have read and understood the details written above and I would like to help out with this study.

________________________________
Printed Name

________________________________ Date: ______/______/______

Signature

*Participant / Examiner Copy*

**Appendix D**

*Approximate Administration Time by Measure and Trial*

| Battery / Measure | Subtest / Trial | Time in Minutes |
|---|---|---|
| WMS-IV | Designs I | 10 |
| WMS-IV | Designs II | 10 |
| WMS-IV | Visual Reproduction I | 4 |
| WMS-IV | Visual Reproduction II | 8 |
| BVMT-R | Immediate Recall Trial 1-3 | 8 |
| BVMT-R | Delayed Recall | 4 |
| RCFT | Copy | 2 |
| RCFT | Immediate | 2 |
| RCFT | 30 Minute Delay | 2 |
| WRAML2 | Design Memory | 5 |
| WRAML2 | Picture Memory | 5 |
| WRAML2 | Verbal Learning | 4 |
| WRAML2 | Verbal Learning Delay | 1 |
| WAIS-IV | Coding | 2 |
| Total Time | ------------ | 60 |

*Note:* Abbreviations for Measure name: WMS-IV= Wechsler Memory Scale, Fourth Edition; BVMT-R= Brief Visuospatial Memory Test-Revised; RCFT= Rey Complex Figure Test; WRAML2= Wide Range Assessment of Memory Learning Second edition; WAIS-IV= Wechsler Adult Intelligence Test Fourth edition.

**Appendix E**

*Test Battery Arrangements*

| Order | Arrangement A_ | Arrangement B | Arrangement C |
|---|---|---|---|
| 1 | RCFT Copy | BVMT-R Immediate | BVMT-R Immediate |
| 2 | WAIS-IV Coding | Verbal Learning I | WMS-IV Visual Reproduction I |
| 3 | RCFT Immediate | RCFT Copy | RCFT Copy |
| 4 | WMS-IV DE I | Verbal Learning II | Verbal Learning I |
| 5 | BVMT-R Immediate | RCFT Immediate | RCFT Immediate |
| 6 | Verbal Learning I | WMS-IV VR I | WMS-IV Designs I |
| 7 | WRAML2 Design Memory | WMS-IV DE I | BVMT-R Delay |
| 8 | RCFT Delay | BVMT-R Delay | Verbal Learning II |
| 9 | WMS-IV VR I | WRAML2 Design Memory | WMS-IV Visual Reproduction II |
| 10 | Verbal Learning II | WRAML2 Picture Memory | WRAML2 Picture Memory |
| 11 | WMS-IV DE II | RCFT Delay | WRAML2 Design Memory |
| 12 | BVMT-R Delay | WMS-IV VR II | RCFT Delay |
| 13 | WRAML2 Picture Memory | WAIS-IV Coding | WAIS-IV Coding |
| 14 | WMS-IV VR II | WMS-IV DE II | WMS-IV Designs II |

*Note:* WMS-IV VR I = Wechsler Memory Scale, Fourth Edition Visual Reproduction Immediate; WMS-IV VR II = Wechsler Memory Scale, Fourth Edition Visual Reproduction Visual Reproduction Delay; WMS-IV DE I = Wechsler Memory Scale, Fourth Edition Design Immediate; WMS-IV DE II = Wechsler Memory Scale, Fourth Edition Designs Delay; WRAML2 = Wide Range Assessment of Memory and Learning, Second Edition; RCFT = Rey Complex Figure Test; BVMT-R = Brief Visuospatial Memory Test, Revised.

**Appendix F**


# Jeffrey A. Schloemer

2222 E. Isaacs Ave, #B101 Walla Walla, WA 99362
Direct: 971-232-7169 Email: jeffrey.a.schloemer@gmail.com


## EDUCATION

2011 - Pres. **George Fox University** Newberg, OR
*Graduate Department of Clinical Psychology:* ***APA Accredited***
- Doctoral Candidate of Clinical Psychology
- Anticipated Completion: May, 2016
- Dissertation: "*Consistency Among Visual Memory Measures"*

2013 **George Fox University** Newberg, OR
*Graduate Department of Clinical Psychology:* ***APA Accredited***
- Masters of Arts in Clinical Psychology

2010 **Corban University** Salem, OR
- Bachelor of Arts, Psychology
- Minor: Religious Studies
- Dean's List Student: 2008 - 2010

## SUPERVISED CLINICAL EXPERIENCE

2015 - Pres. **Jonathan M. Wainwright VAMC** Walla Walla, WA
- Psychology Intern/Resident: APA accredited
- General Mental Health major rotation
- Residential Rehabilitation Unit and Substance Abuse minor rotation
- Acceptance and Commitment Therapy and Psychodynamic clinical supervision
- Personality and cognitive screening assessments for out/in-patients
- Use of Evidenced Based Treatments: CPT, PE, Seeking Safety, Interpersonal Therapy, and ACT
- Utilization of individual and group psychotherapies

2013 - 2015 **Behavioral Health Crisis Consultation Team** Yamhill County, OR
- Crisis on-call risk assessments for local county hospitals
- Low SES to middle class individuals from suburban and rural communities.
- Inpatient hospitalization arrangement and local resource assignment
- Consultations to physicians in the emergency department (ED), intensive car unit (ICU), medical/surgical, and maternity units with patients who exhibit suicidal or homicidal ideation, or psychosis/cognitive confusion and need potential inpatient placement and/or diagnostic clarification
- Supervisors: Mary Peterson, PhD; Bill Buhrow, PsyD; Joel Gregor, PsyD.

2014 - 2015 **Willamette Family Medical Center** Salem, OR

- Individual psychotherapy and psychological assessment for ages 4 - 90 in primary care
- Low SES and uninsured families from suburban and rural areas
- Brief behavioral health interventions with patients and consultations with medical providers on issues including: diabetes, exercise, medication compliance, suicidal ideation, grief, anxiety, depression, relational conflicts, smoking cessation, behavioral problems, attention and school related problems.
- Supervisor: Joel Gregor, PsyD.

2013 - 2014 **Concordia University Counseling & Student Services** Portland, OR

- Student disabilities evaluations and assessments with standard batteries including cognitive, behavioral, attention, personality, effort, and achievement measures including: WAIS-IV, SB5, WJ-III, MMPI2, PAI, MCMI, Conners, BASC2, CPT, 21 Item test.
- 6 - 30 sessions of individual therapy (Cognitive Behavioral; Solution Focused; Psychodynamic) with undergraduate and graduate students with concerns related, but not limited to: depression, anxiety, phase of life, autism spectrum, drug and alcohol, organization, relationships, family systems, and characterological traits.
- Supervisors: Joel Gregor, PsyD; Jaklin Peake, MA

2012 - 2013 **George Fox University Health and Counseling Center** Newberg, OR

- University outpatient mental health with undergraduate students with concerns related to: Eating disorder, grief/bereavement, depression, anxiety, insomnia, and adjustment
- Modalities: Brief/Solution Focused and Cognitive-Behavioral Therapies
- Supervisors Bill Buhrow, Psy.D; Kristina Kays, PsyD

2012 - 2013 **George Fox University Career Services** Newberg, OR

- Career counseling aimed at exploring career related strengths and weaknesses, areas of interest, and professional development.
- Administrative: Resume/cover letter editing and feedback
- Connecting students with internship resources for professional experiences
- Organization of Graduate school fair including 10 graduate programs.
- Guest lectures and presentation for undergraduates interested in graduate school
- Supervisors: Bonnie Jerke, M.A.; Bill Buhrow, Psy.D

2011 - 2012 **Pre-Practicum I & II** Newberg, OR

- George Fox University
  Individual outpatient person-centered psychotherapy with volunteer undergraduates
- All sessions video recorded and reviewed with supervision
- Report writing, case presentations and consultations with supervision
- Supervisors: Mary Peterson, Ph.D.; Rusty Smith, M.A

2010 - 2011 **Salem Community Placement Center: Youth Mentor** Salem, OR

- Non-Profit Community Organization for behaviorally challenged youth and foster home youth ages 8 -18 with Reactive Attachment, Autism, Aspergers, Depression, Anxiety, pervasive developmental delay, and conduct disorder diagnoses.
- Coached social skills with youth and provided documentation of services
- On-call rotations for youth medical transport to/from respite locations
- Supervisor: Garth Taft, MA

## RELEVANT TRAINING/EDUCATIONAL EXPERIENCE

2012 - 2015 **Clinical Team / Case Conference** Newberg, OR

- Weekly faculty facilitated small group case review and clinical mentoring
- De-identified client case presentations, discussion and assessment: Using bio-psycho-social, Bronfenbrenner, and ADDRESSING models of conceptualization coupled with chosen theoretical orientation of the presenter
- Instructors: Bill Buhrows, PsyD, Erica Tan, PsyD; Mark McMinn, Ph.D.; Wayne Adams, Ph.D

2013 - 2014 **Psychodynamic Psychotherapy Consultation Group** Beaverton, OR

- Monthly case presentation and consultation with small group
- Focus on Object Relations based on Fred Pine’s model of Drive, Ego, Object relations, Self (DEOS) Psychology.
- Lead consultant: Kurt Free, Ph.D - licensed Psychologist

2009 - 2010 **Marion County Juvenile Justice Department**

- Undergraduate internship experience
- Intensive supervision unit: assistant case management of juvenile sex offenders
- Case file reviews, home visits, and monthly meetings addressing “high needs” youth
- Supervised individual counseling with juveniles with substance abuse
- Supervisors: Patty McNeff, MSW; Annette Brundridge, MSW

## CONSULTATION

2014 **Behavioral Health Clinic (BHC) Psychological Assessment**

- Consultative psychological assessment services to community mental health clinic
- Supervisor: Robert Weniger, PsyD, ABPP - Board Certified Neuropsychologist

2014 **Oregon Psychological Association Ethics Committee (EC) Call Data**

- Provided evaluation and analysis of EC call data from 2006 to 2012 and provided consultation for improvement in providing and documenting ethics consultations to Oregon psychologists.

2013 - 2015 **Providence Newberg Medical Center / Willamette Valley Medical Center**

- Provide consultation to attending physicians and staff in Emergency Departments, Intensive Care, and Medical-Surgical Units regarding level of risk for patients presenting with harm to self, harm to others or psychosis/confusion, and need for possible psychiatric placement.

2013 **Concordia University Resident Assistant Training**

- Provided consultation and psychoeducation to university undergraduate Resident Assistants about student-suicide risk, depression, risk/protective factors and appropriate responses.

## RESEARCH, PRESENTATIONS & PUBLICATIONS

2013 - 2015 **Doctoral Dissertation: *Consistency among Visual Memory Measures***

- Exploring differences in performance between younger and older adults across commonly-used visual memory measures including:
  - Wide Rang Assessment of Memory and Learning-2: Picture and Design Memory subtests
  - Wechsler Memory Scale-IV: Visual Reproductions I & II, and Designs I & II subtests
  - Rey Complex Figure Test
  - Brief Visuospatial Memory Test, Revised
- **Defended: December 11, 2015**

2014 Jasper, L., Koch, C., Lowen, J., **Schloemer, J.**, Kays, D. (2014, August). Changes in verbal memory during youth football. Poster presented at the *122$^{nd}$ American Psychological Association* Annual Convention, Washington, D. C.

2014 Henderson, J., Stewart, C., Duncan, A., Smith, S., Schimmel, L., Grosscup, S., Paez, K.,**Schloemer, J.,** & Trent, E. Positive ethics in approaching challenging clinical scenarios. Presentation at the *Oregon Psychological Association* RegionalConference, Portland, Oregon.

2014 **Schloemer, J.,** Seig, C., Van Meter, A., Galindo, D., & Flores, M. (2014). Review of local psychologists' ethical concerns as reported to the Oregon PsychologicalAssociation Ethics Committee. Poster presented at the *Oregon Psychological Association* Regional Conference, Portland, Oregon.

2014 Jasper, L., Koch, C., Lowen., J., **Schloemer, J**., & Kays, D. (2014). Changes in verbal memory during youth football. *The Clinical Neuropsychologist. 28*(4), 686 - 702.

2013 Hansen, H., Simmons, J., Adams, W., **Schloemer, J.**, Ulrich, J. (2013). Developmental Anomalies of the WAIS-IV Digit Span Subtest. Poster Presented at the *121st American Psychological Association*. Honolulu, HI.

2013 Stewart, C.; Henderson, J.; Duncan, A; Trent, E.; Martindale, E.; **Schloemer, J;** Leland, M.; Grosscup, S.; Smith, S; Schimmel, L. (2013, May). Using Ethical Decision Making Models in Addressing Ethical Dilemmas: A process approach. Presented at the *Oregon Psychological Association Regional Conference*, Eugene, Oregon.

2014 Trent, E.J. & **Schloemer, J.** (2014). Ethical considerations in cultural adaptations to evidenced based treatments. *Oregon Psychologist Bulletin, 33*(2), May Issue.

2013 Engle, N.; **Schloemer, J.**; & Webb, B. (2013). Ethical webs: Multiple relationships and practicum training sites. *Oregon Psychologist Bulletin, 32*(1), 11-12.

## RELEVANT TEACHING AND ACADEMIC EXPERIENCE

2014 **Teaching Assistant:** Forensic Psychology Assessment - PSYD 597
- Review and grade student case assignments for various forensic reports
- Distribute materials and professional documents
- Guest lecture on Police and Public Safety Psychology
- Professor: Paul Stolzfus, PsyD

2014 **Teaching Assistant:** Ethics for Psychologists - PSYD 517
- Review and grading ethics course assignments
- Assist student development in ethical considerations through case study scenarios, and familiarization of Federal (HIPPA), State (Oregon Revised Statutes), and APA laws and guidelines for ethical practice for psychologists.
- Professor: Rodger Bufford, Ph.D

2014 **Teaching Assistant:** Advanced Counseling - PSYC 382
- Small group leader: Coaching undergraduate psychology students with fundamental therapeutic techniques including empathetic listening and accurate reflections; emphasis in theory-based counseling, and practice in ethical considerations
- Professor: Kristina Kays, PsyD

2013 **Teaching Assistant:** Cognitive Behavioral Therapy - PSYD 572
- *Graduate Department of Clinical Psychology*, Newberg, Oregon.
- Facilitated and coached Cognitive Behavioral Therapy techniques and interventions through scenario role-plays and skills coaching with individual students
- Co-Lectured on topics such as Acceptance and Commitment Therapy, and How to use the Triple Column technique in therapy

2012 **Lecturer** on *How to Get Into Graduate School*
- George Fox University undergraduate

- Modified, updated, and presented Career Services "Materials for professional Success"
- Professors: Bonnie Jerke, MA; Lori Smith, MA

2012 **Administrator**

- *Seminary and Graduate School Fair* for undergraduate students at George Fox University
- Scheduled, organized, and coordinated catering and program representatives to showcase respective graduate school programs for an all-day event

## PROFESSIONAL TRAININGS

### *DIVERSITY TRAINING*

2013 **Afro-Centric Counseling** Newberg, OR
George Fox University: *Marcus Sharpe, PsyD; Dannette Haynes, LCSW*

2012 **Homosexuality, Clients, and Therapy** Newberg, OR
George Fox University: *Erika Tan, PsyD*

2012 **Transgender Issues in Therapy** Newberg, OR
George Fox University: *Erika Tan, PsyD*

2013 **Ethical Considerations In a Multicultural World** Eugene, OR
Oregon Psychological Association Regional Conference- *Melba Vasquez PhD, ABPP*

2013 **Relationship between Internalized Homophobia and Gender Roles in Gay Men**
Oregon Psychological Association Annual Regional Conference Eugene, OR
*Alexander Levine BA & Brad Larson, PsyD*

### *ETHICS TRAINING*

2014 **Ethical, Legal, and Clinical Considerations in Assessment and Treatment of Suicidal Clients** Portland, OR
Oregon Psychological Association Annual Regional Conference- *Paul Cooney, JD. & Eric Johnson, PhD, ABPP*

2013 **Anticipating and Preventing Licensing Board Complaints: Ethical,** Eugene, OR
**Legal, and Risk Management Consideration**
Oregon Psychological Association Annual Regional Conference- *Paul Cooney, JD; Eric Johnson, PhD, ABPP*

2014 **Using Ethical Decision-Making Models in Addressing Ethical Dilemmas** Portland, OR

Oregon Psychological Association Annual Regional Conference *O.P.A Ethics Committee*

***ASSESSMENT TRAINING***

2014 **Updates and changes with the WISC-V & WJ-IV** Newberg, OR
Northwest Assessment Conference

2013 **Using tests of Effort in Psychological Assessment**
Newberg, OR
**& Assessing Mild Cognitive Impairment and Dementia,**
*Paul Green, PhD*; *Mark Bondi, PhD, ABBP/CN*
Northwest Assessment Conference

2013 **Rewards & Challenges In Work With Traumatic Brain Injury Survivors** Eugene, OR
*Nancy Holmes, PsyD*
Oregon Psychological Association annual regional conference

2012 **Didactic Training on Mild Cognitive Impairment (MCI)** Newberg, OR
George Fox University: *Chicarah. Ph.D*

***CLINICAL TRAINING***

VETERANS

2015 **Prolonged Exposure with Veterans** Walla Walla, WA

2015 **CBT for Insomnia with veterans** Walla Walla, WA
Jonathan M. Wainwright VAMC - *Shaunce Skidmore, PhD*

2014 **Cognitive Processing Therapy: 9 hour web-based training** Web-Based
*Medical University of Southern Carolina*

2014 **Working in a Veterans Administration hospital using Cognitive Processing Therapy and Prolonged Exposure Therapy** - *David Beil-Adaskin, PsyD* Newberg, OR

PRIMARY & INTEGRATED CARE

2014 **Behaviorist Boot Camp** Newberg, OR
Intensive multi-day training for brief behavioral interventions and consultations within a primary care setting - *Joel Gregor, PsyD, Dr. Ojimaua, PsyD, Jeri Tergusen, PsyD.*

2014 **Treatment of Post-Concussion Syndrome: Strategies for Psychologists** Portland, OR
Oregon Psychological Association Annual Regional Conference *B.J. Scott, PsyD.*

2014 **Integrating Care: Does One Model Fit All?** Portland, OR
Oregon Psychological Association Annual Regional Conference *Ryan Dix, Psyd; Peter Grover, PhD; Lynnea Lindsey-Pengelly, PhD; Sondra Marshall, PhD; & Brian Sandoval, PsyD*

2013 **Integrated Primary Care Psychology Now and the Future** Newberg, OR
George Fox University - *Brian Sandoval, PsyD; Juliette Cutts, PsyD. - Salude Medical Center*

2013 **Redesigning Primary Care: Mental Health Clinics of the Future** Eugene, OR
*Benjamin Miller, PsyD; Robin Henderson, PsyD.* Oregon Psychological Association Annual Regional Conference

2012 **Oregon Health Science University Pain Day: Why do so many drugs fail?** Portland, OR
*Stephen Arneric, Ph.D., Sue Aicher, Ph.D., Julie Ann Smith, DDS, MD.*

2013 **Motivational Interviewing: Two day Training Workshop** Newberg, OR
*George Fox University: Michael Fulop, PsyD*

MISCELLANEOUS

2015 **Changes in ICD-9 to ICD-10 and associated billing codes** Walla Walla, WA
Jonathan M. Wainwright VAMC

2014 **"Face Time," In an Age of Technological Advancement** Portland, OR
Oregon Psychological Association Annual Regional Conference: *Doreen Dodgen-Magee, PsyD.*

2014 **The Impact of Technology On Our Brains and Our Lives** Portland, OR
Oregon Psychological Association Annual Regional Conference- *Garry Small, MD.*

2014 **DSM-V: Changes in Form and Function**
Newberg, OR
*Jeri Turgeson, PsyD; Mary Peterson, PhD, ABBP*

2013 **The Person in the Therapist: How Spiritual Practice Weaves with Therapeutic Encounters** Newberg, OR
George Fox University: *Brooke Kuhnhausen, PhD.*

2012 **Mindfulness and Christianity** Newberg, OR
*George Fox University: Erica Tan, Psy.D.*

## COMMUNITY INVOLVEMENT / VOLUNTEERISM

2013 - Pres. **Oregon Psychologist Association (OPA) Ethics Committee (EC)**
- Student Member (2 year position)
- Monthly meetings to discuss de-identified cases of ethics inquiries and consultation
- OPA EC records evaluation of ethics consultation call data from 2006 - 2012
- Co-authored articles circulated through the OPA community in the *OPA Bulletin*

2010 **Corban University Student "Think-Tank" team member**
- Faculty/student committee for student-body decisions and campus milieu development

2009 - 2010 **Corban University Student Psi Chi Chapter President**
- Organized and facilitated psychology department-wide topical discussions on research of psychology and religion.
- Student psychology department ambassador and student liaison

2012 -2014 **New-Student Mentor** Newberg, OR
- Mentoring and oversight for new incoming PsyD students
- Facilitate acclimation to professional development as a PsyD student

2011 - 2012 **George Fox University Annual Student "Serve-Day"** McMinnville, OR
- University-wide volunteering day
- Landscaping, painting, cleaning, organizing for Juliet's House, a non-profit home and therapy center for children who have been victims of sexual abuse.

## AWARDS

2008 - 2010 Corban University *Deans list* student

2009 Central Europe Study Abroad

2006 - 2010 Corban Collegiate *Cross Country and Track Scholarship* team member

## PROFESSIONAL AFFILIATIONS /MEMBERSHIPS

2013 - Pres. Oregon Psychological Association: Ethics Committee - Student Member

2013 - Pres. Oregon Psychological Association - Student Affiliate

2011 - Pres. American Psychological Association - Graduate Student Member

2009 - Pres. Psi Chi National Honor Society

## REFERENCES

*References Available Upon Request. Please contact me at jeffrey.a.schloemer@gmail.com to request professional, academic, or personal references.*