1-1-2013

Interpretation of the WISC-IV Working Memory Index as a Measure of Attention

Talya J. Colliflower
collifl2@marshall.edu

Interpretation of the WISC-IV Working Memory Index as a Measure of Attention

Thesis Submitted to
Marshall University
Graduate College

In partial fulfillment of
the requirements for the degree of
Education Specialist
in the School Psychology Program

By

Talya J. Colliflower

Approved by:

Sandra S. Stroebel, Ph.D., Committee Chairperson
Peter Prewett, Ph.D.
Edna Meisel, Ed.D.

Marshall University

December 2013

DEDICATION

This study is dedicated to my loving and supportive family who stood by me through this entire process. Thank you all and I love you with my whole heart! A special thanks to Dr. Prewett for allowing me to join in on his research.

CONTENTS

Abstract

The WISC-IV Working Memory Index is often interpreted as a valid measure of attention and concentration. Students who score low on the WMI are frequently viewed as having attention difficulties. If the WMI is accurately interpreted as a measure of attention, then students who score low on this composite should present with attention deficits in the classroom. Data of students who were referred for an evaluation to determine special education eligibility were compared to determine the accuracy of the interpretation of the WMI and its relationship with the Inattention and other scales on the Conners 3rd Edition – Teacher Form. Students were enrolled in grades one through four and attended school in a large, urban school district. Data was compared using the t-test for independent means and the Pearson product-moment correlation. Results of this study found that performance on the WMI is unrelated to inattentive or hyperactive behaviors in the classroom.

Chapter One

Review of the Literature

The Wechsler Intelligence Scale for Children (WISC) is a popular choice among practitioners for assessing general intelligence. To date, there have been several revisions of this instrument, with the latest version-Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV)-published in the fall of 2003. The fourth edition includes four indexes-namely; the Verbal Comprehension Index, the Perceptual Reasoning Index, the Working Memory Index, and the Processing Speed Index-which comprise the Full Scale IQ (FSIQ) (Flanagan & Kaufman, 2009; Kaufman, Flanagan, Alfonso, Mascolo, 2006). Each index consists of two or three core subtests that require individuals to perform a variety of tasks. From these subtest tasks, practitioners are able to obtain measures of an individual's cognitive abilities, strengths, and weaknesses.

Brief History of the Wechsler Intelligence Scales

There has been a long-standing history on the concept of intelligence and intelligence assessments. Many theories exist on the nature of human intelligence and the factors or mental processes involved in determining intelligence. In the latter half of the 19^{th} century, an interest in testing intelligence arose and brought forth a testing movement involving decades of research, test developers, and a surplus of assessment batteries. Since then, federal legislation and educational programs have also played an important role in the testing movement and gradually shaped the development of standardized tests (Flanagan & Kaufman, 2009).

David Wechsler became an important part of the testing movement in the mid-1930s. His background of strong clinical skills and statistical training helped him in creating a test battery that practitioners could utilize to "obtain dynamic clinical information" (Flanagan &

Kaufman, 2009; Meyers, 2004). Wechsler purported that intelligence is exhibited by children through verbal and nonverbal means. To develop an intelligence scale, he examined other standardized testing; and in the end, decided on 11 subtests to form the first Wechsler intelligence test, the Wechsler-Bellevue Intelligence Scale (Meyers, 2004). This scale was the predecessor to the Wechsler Intelligence Scale for Children, which was published in 1949 as an extension to the aforementioned adult version (Dehn, 2008; Flanagan & Kaufman, 2009; Sattler, 2008). The WISC has since gone through multiple revisions.

Working Memory

In assessing working memory, the Wechsler intelligence scales have played a major role. The term “working memory” refers to the cognitive system that stores information in an accessible state; in addition to, the ability to temporarily hold several facts or thoughts in memory while solving a problem or performing complex mental tasks (Hill, Elliott, Shelton, Pella, O’Jile, & Gouvier, 2010; Sattler, 2008). It is thought to involve attention, concentration, and higher-order cognitive abilities as well as the ability to prevent the intrusion of irrelevant associations in the service of actively processing information (Abbott, 2007; Dehn, 2008; Sattler, 2008; Shipstead & Engle, 2012). An abundance of models exist on working memory and its structural components, with Baddeley’s three-unit system being at the forefront and dominating the field. His model, which “proposes a central executive component to manipulate data by means of controlled attention processes,” (Hill et al., 2010, p. 315), is the most well-known and frequently cited theory to date (Leffard, Miller, Bernstein, DeMann, Mangis, & McCoy, 2006).

Research supports working memory as an integral part of the learning process (Alloway, Elliott, & Place, 2010; Martinussen & Major, 2011; Redick & Engle, 2006). Working memory is associated with a wide range of academic skills including written expression, reading and language comprehension, and mathematical problem-solving. Not only is it associated with academic skills, but it has been linked to self-regulation skills such as inhibition, shifting, planning and organizing information; and, academic tasks such as following directions (Alloway et al., 2010; Martinussen & Major, 2011; Redick & Engle, 2006). Working memory is necessary for the acquisition of skill mastery and also when dealing with novel information, problems, or situations; as well as, consciously retrieving information from long-term memory (Dehn, 2008).

Working memory plays such a crucial role in human cognitive functions it is recognized by theorists and practitioners as an area of high importance when evaluating cognitive abilities (Abbott, 2007; Dehn, 2008). Working memory components appear in several intelligence tests, including but not limited to, the Kaufman Assessment Battery for Children – Second Edition (KABC-II), the Reynolds Intellectual Assessment Scales (RIAS), the Stanford-Binet Intelligence Scales – Fifth Edition (SB5), and the Woodcock-Johnson III Tests of Cognitive Abilities (WJ-Cog III) (Naglieri & Goldstein, 2009). Since working memory is so important to learning, it is essential for practitioners to accurately assess an individual's working memory abilities (Abbott, 2007; Dehn, 2008). Plus, working memory performance can be influenced by a number of factors, including executive processes, attention, concentration, and processing speed (Dehn, 2008). Therefore, in order to provide practitioners with a better understanding of an individual's working memory abilities, the manner in which the working memory scale is assessed should be accurate.

Working Memory and Attention

Decades of research have shown a relationship to exist between working memory and attention (Alloway et al., 2010; Brose, Schmiedek, Lovden, & Lindenberger, 2012; Fougnie, 2008; Redick & Engle, 2006). According to Fougnie (2008), attention refers to "the processing or selection of some information at the expense of other information" (p. 2). In order to perform complex tasks, one must attend to the task at hand while selectively processing relevant information and ignoring extraneous variables in the environment. The relationship working memory shares with attention is a critical part of an individual's cognitive capacity; allowing an individual to actively process information, retain task-relevant information, and simultaneously manipulate that information (Alloway et al., 2010; Brose et al., 2012; Fougnie, 2008). Additionally, since the functions of working memory require various levels of attention, it is thought that the ability to control attention is linked to the interindividual differences found in working memory capacity (Brose et al., 2012; Redick & Engle, 2006).

The ability to control attention is carried out in the brain's frontal lobe and prefrontal cortex where a set of mental skills, known as executive functions, are managed and allow an individual to achieve goals and regulate his or her behavior (Barkley, 1998; Bhargava, 2012). Executive functions include the abilities to "manage time and attention, switch focus, plan and organize, remember details, curb inappropriate speech or behavior, and integrate past experience with present action" (Bhargava, 2012, p. 1). According to Barkley (1998), four different cognitive actions constitute what is collectively known as executive functions. These four mental actions are defined as: 1) operation of working memory, 2) internalization of self-directed speech, 3) self-regulation of mood, motivation, and level of arousal, and 4) reconstitution (Barkley, 1998). For this study, the focus will be on the operation of working memory.

Barkley (1998) defines the operation of working memory as "holding information in the mind while working on a task, even if the original stimulus that provided the information is gone" (p. 69). The ability of working memory to perform such an action is a key part of an individual's capacity to actively attend to and retain information, which in turn, affects his or her goal-directed behaviors such as completing complex tasks, meeting deadlines, or remembering important appointments. Imaging studies performed on the brain at the National Institute of Mental Health looked at executive functions and controlled attention processes. Their findings discovered regions in the brain that regulate attention to be smaller in size in children diagnosed with ADHD. This research suggests that children with ADHD may have a difficult time monitoring their behavior and resisting distractions, which largely affects how they respond to their environment (Barkley, 1998). Barkley (1998) states, "this lack of control makes them hyperactive, inattentive and impulsive" (p. 67).

Working Memory Index and Attention

On the WISC-IV, working memory is measured by the Working Memory Index or WMI. Earlier versions of the WISC called this the Freedom from Distractibility (FFD) factor. However, to align more with current research and the adult version of the Wechsler scales, this composite was changed to the Working Memory Index on the latest edition (Niolon, 2005; Flanagan & Kaufman, 2009; Kaufman et. al., 2006).

The WMI is comprised of the Digit Span (Forward and Backward) subtest and the newly added Letter-Number Sequencing subtest. The Arithmetic subtest, formerly part of the FFD, is now a supplemental subtest; a change that greatly diminishes the influence of mathematical skills (Flanagan & Kaufman, 2009; Kaufman et. al, 2006). The new subtest, Letter-Number Sequencing (LNS), requires examinees to recall numbers in ascending order and letters in alphabetical order from a given number and letter sequence. The Digit Span subtest contains two parts: Digit Span Forward (DSF) and Digit Span Backward (DSB). For Digit Span Forward, examinees are required to recall a series of numbers presented to them by the examiner; for Digit

Span Backward, the examinee is presented with a series of numbers and is required to repeat them in reverse order (Flanagan & Kaufman, 2009; Hill et. al., 2010; Leffard et al., 2006; Sattler, 2008).

In the review of literature, multiple sources cite the WMI and FFD, and the subtests comprising these composites, as measures of attention and other specific cognitive abilities (Hale, Hoeppner, & Fiorello, 2002; Leffard et al., 2006; Livingston, Gray, Broquie, Dickson, Collins, & Spence, 2001; Niolon, 2005; Mayes & Calhoun; Sattler, 2008). Sattler (2008) states, "the Working Memory Composite measures working memory, short-term memory, the ability to sustain (including the ability to shift mental operations), and ability to self-monitor" (p. 366). Freedom from Distractibility was intended to be a measure of attention and was often interpreted as a correlate of attention; yet, numerous research findings suggest minimal correlation with attention, citing it as a poor measure of attention (Egeland, Sundberg, Andreassen, & Stensli, 2006; Malter & Frank, 1995; Siekierski, Jarratt, & Rosenthal, 2003). According to the results of one particular study, data showed FFD as sharing no significant relationship with measures of attention; and furthermore, FFD was found to share greater variance with measures of academic achievement (Siekierski et. al., 2003).

Even with questionable support and its weak empirical basis, the Wechsler intelligence scales and the FFD measure were utilized as a predictor of academic achievement and a measure of attention (Anastopolous, Spisto, & Maher, 1994; Malter & Frank, 1995). In the past, FFD scores were often used to confirm or reject the diagnosis of ADHD (Egeland et al., 2006; Anastopolous et al., 1994). Even with a controversial research history and scant evidence validating the index as a measure of attention, practitioners still relied on the FFD factor scores to determine the existence or absence of ADHD. More often than not, practitioners presumed that a low FFD score was a good indication of the presence of ADHD (Anastopolous et al., 1994) and referred the student to a medical doctor for further evaluation (Malter & Frank, 1995; Egeland et al., 2006). On the other hand, if a student performed well on the FFD factor then a referral for an evaluation of ADHD was deemed unnecessary (Anastopolous et al., 1994).

Although majority of the research suggests poor construct validity, there are some studies to suggest that the FFD and the WMI are indeed valid measures of attention. Significant correlations between the WISC-R FFD subtests and other recognized measures of attention have been found in previous studies and support the validity of this factor (Anastopolous et al., 1994; Hale et al., 2002). Studies in the past have found that individuals diagnosed with ADHD experienced difficulty with the FFD factor (Egeland et. al., 2006; Hale et. al., 2002), and also presented with "significantly lower means on the FFD relative to IQ than non-ADHD groups" (Mayes & Calhoun, 2002, p. 577), which suggests the involvement of attention.

According to a study carried out by Mayes and Calhoun (2002), evidence was obtained suggesting that the Gordon Diagnostic System and the Freedom from Distractibility factor measured both "similar and unique traits" commonly described in individuals diagnosed with ADHD, resulting in both being viewed as valid psychometric measures of attention. A recent study by Kuentzel, Arble, Swift-Godzisz, and Barnett (2012) looked at the WISC-IV subtests and hypothesized that they were objective measures of inattention and that the WMI subtests would be the most negatively affected by inattention. Results of this study found the WMI as being negatively affected by inattentive behaviors, especially the Letter-Number Sequencing subtest. Their findings suggest that an individual's performance will be impacted if he or she exhibits difficulty in sustaining attention. Another study conducted by Hale and colleagues in 2002, yielded results suggesting that the Digit Span subtest could be an informative tool in the assessment of attention; however, the Digit Span-Backward section was found to be related to measures of sustained attention and attention difficulties as reported by the teacher more than Digit Span-Forward.

Statement of the Problem

If the WMI subtests' tasks involve attention, concentration, and the ability to retain and manipulate pieces of supplied information, then one would assume an examinee's performance relies on his or her ability to attentively focus and maintain concentration in an effort to correctly recall each set of letters and/or numerals. If the WMI is an accurate measure of attention, then it could be hypothesized that an individual with a low score on the WMI would exhibit attention deficits in other areas of his or her day-to-day life.

On a typical day, attending to the task at hand while selectively processing information is an essential part of a student's performance in the classroom. So, if the WMI is accurately interpreted as a measure of attention, then do students who score low on the subtests of the WMI show attention and concentration problems in the classroom? This study will look at the accuracy of the interpretation of the working memory scale and the relationship between working memory, as measured by the WISC-IV WMI, and the Inattention and other scales on the Conners 3rd Edition – Teacher Form.

Chapter Two

Method

Participants

The participants of this study were 34 (18 female, 16 male) Caucasian elementary school students from a large, urban school district. Participants were enrolled in grades one through four divided in the following way: four students in 1st grade, fourteen in 2nd grade, five in 3rd grade, and eleven in 4th grade. Students ranged in age from 72 months to 124 months. Students were referred for an evaluation to determine special education eligibility because of academic (not behavioral) difficulties. In order to maintain confidentiality, names are not associated with scores. The WISC-IV was administered by a School Psychologist and the Conners 3 was completed by the student's classroom teacher within two weeks of each other. Approval from the Marshall University Institutional Review Board (IRB) was obtained, which can be found in the Appendix.

Instruments

WISC-IV. The Wechsler Intelligence Scale for Children was developed by David Wechsler and first published in 1949 by The Psychological Corporation (Flanagan & Kaufman, 2009; Kaufman et. al, 2006). Since then, the WISC has gone through several revisions with the fourth edition released in 2003. The WISC-IV contains 10 core subtests and five supplemental subtests that can be ordered to form four indexes and yield a Full Scale IQ. The indexes and subtests are organized in the following way:

- Verbal Comprehension (VCI): Core-Similarities, Vocabulary, and Comprehension; Supplemental-Information and Word Reasoning

- Perceptual Reasoning Index (PRI): Core-Block Design, Picture Concepts, and Matrix Reasoning; Supplemental-Picture Completion
- Working Memory Index (WMI): Core-Digit Span and Letter-Number Sequencing; Supplemental-Arithmetic
- Processing Speed Index (PSI): Core-Coding and Symbol Search; Supplemental-Cancellation (Kaufman et. al, 2006; Niolon, 2005, Sattler, 2008).

The WISC-IV can be administered to individuals aged 6 years 0 months to 16 years 11 months (Flanagan & Kaufman, 2009; Kaufman et. al, 2006; Niolon, 2005, Sattler, 2008). Administration time varies between 65 to 80 minutes, sometimes more or less, depending on the intelligence level of the child and the amount of additional subtests given (Flanagan & Kaufman, 2009; Niolon, 2005). Standard scores range from 40 to 160 (Flanagan & Kaufman, 2009).

Standardization of the WISC-IV was completed on a sample of 2,200 children separated into 11 age groups (200 children in each group), equally divided between boys and girls, and each chosen based on U.S. census data for age, gender, geographic region, ethnicity, and socio-economic status. Reliability coefficients of the composite scales are .94 for VCI, .92 for PRI, .92 for WMI, .88 for PSI, and .97 for FSIQ. Test-retest coefficients are .93 for VCI, .89 for PRI, .89 for WMI, .86 for PSI, and .93 for FSIQ, respectively (Flanagan & Kaufman, 2009; Kaufman et. al., 2006). Based on results of factor analytic studies conducted by Keith and colleagues in 2006, the WISC-IV structural validity is consistent with the CHC theory (as cited in Flanagan & Kaufman, 2009).

Conners 3rd Edition (Conners 3). The Conners 3rd Edition was developed by Conners and published by Multi-Heath Systems, Incorporated in 2008. The Conners 3 is the newest version of this assessment tool, which is used to measure ADHD and other existing problems/disorders in children. There are three types of Conners 3 questionnaires: a teacher rating form, a parent rating form, and a self-report form. The teacher and parent forms are for individuals aged 6 to 18 years, while the self-report form is for individuals aged 8 to 18 years. The items on these questionnaires are "based largely on the American Psychiatric Association's *Diagnostic and Statistical Manual, 4th Edition, Text Revision* (*DSM-IV-TR*) and principles of the *International Statistical Classification of Diseases and Health-Related Problems* (ICD)" (Kao & Thomas, 2010, p. 598).

The Conners 3 includes six Content scales: Inattention, Hyperactivity/Impulsivity, Learning Problems/Executive Functioning, Aggression, Peer Relations, and Family Relations (self-report form only). Also included are five DSM-IV-TR Symptoms scales: ADHD Inattentive, ADHD Hyperactive/Impulsive, ADHD Combined, Conduct Disorder, and Oppositional Defiant Disorder (Kao & Thomas, 2010; Conners 3 – Self-Report Assessment Report, 2007; Conners 3 – Teacher Assessment Report, 2007). The Content scales are described as follows:

- Inattention: May have poor concentration/attention or difficulty keeping his/her mind on work; may make careless mistakes; may be easily distracted; may give up easily or be easily bored; may avoid school work
- Hyperactivity/Impulsivity: High activity levels, may be restless or impulsive; may have difficulty being quiet; may interrupt others; may be easily excited
- Learning Problems/Executive Functioning: Academic struggles; may have difficulty learning and/or remembering concepts; may have executive deficits; may have difficulty starting or finishing projects; may have poor planning, prioritizing, or organizational skills

- Aggression: Physically and/or verbally aggressive; may show violent or destructive tendencies; may bully others; may be argumentative; may have poor control of anger and/or aggression; may be manipulative or cruel; may have legal issues
- Peer Relations: May have difficulty with friendships, poor social skills, limited social skills; may appear to be unaccepted by group (Conners 3 – Teacher Assessment Report, 2007, p. 6)
- Family Relations: May feel that parents do not love or notice him/her; may feel unjustly criticized and/or punished at home (Conners 3 – Self-Report Assessment Report, 2007, p. 4)

Scoring the Conners 3 can be done by hand, online, and/or by using a computer software program (Kao & Thomas, 2010). The rating scale produces raw scores which are then converted to T-scores that range from <40 (Low Score), 40-59 (Average), 60-64 (High Average), 65-69 (Elevated), and 70 and Above (Very Elevated). Scores ≥70 are considered to be clinically significant and indicate "many more concerns than are typically reported" (Conners 3 Interpretive Update, 2009).

Standardization was normed on 3,400 participants divided into 1,200 parent rating forms, 1,200 teacher rating forms, and 1,000 self-report forms. A Cronbach's alpha was run to measure internal consistency resulting in the following mean alphas for the Content scales: .91 (parent form), .94 (teacher form), and .88 (self-report form). Multiple factor analyses and correlation tests were conducted to measure validity of the Conners 3. Exploratory factor analyses (EFAs) and confirmatory factor analyses (CFAs) indicated consistency across demographic groups and moderate scale interrcorrelations, which meets theoretical expectations. Convergent and divergent validity scores indicated moderate correlations when compared to similar assessment tools. Tests of discriminant validity showed that the Conners 3 accurately discriminated between clinical and general population groups (Kao & Thomas, 2010). Despite a computerized search conducted in March of 2013 using Academic Search Premier, ERIC, Mental Measurements Yearbook, Primary Search, PsycARTICLES, and PsycINFO, no documented studies of validity were found on the Conners 3.

Procedures

As previously stated, students included in this study were referred for an evaluation to determine special education eligibility due to academic difficulties. Within two weeks of each other, the WISC-IV was administered by a Licensed School Psychologist and the Conners 3rd Edition – Teacher Form was completed by the student's classroom teacher.

Statement of the Hypotheses

1. Students that are rated equal to or greater than seventy on the Inattention scale on the Conners 3rd will obtain significantly lower scores on the WISC-IV WMI than students who are rated equal to or below sixty-five on the Inattention scale on the Conners 3rd.
2. Students that are rated equal to or greater than seventy on the Hyperactivity scale on the Conners 3rd will obtain significantly lower scores on the WISC-IV WMI than students who are rated equal to or below sixty-five on the Hyperactivity scale on the Conners 3rd.
3. Students that are rated equal to or greater than seventy on the Learning Problems scale on the Conners 3rd will obtain significantly lower scores on the WISC-IV WMI than students who are rated equal to or below sixty-five on the Learning Problems scale on the Conners 3rd.
4. There will be a negative correlation between the WMI and the Conners 3 Inattention Index.

5. There will be a negative correlation between the WMI and the Conners 3 Hyperactivity Index.

6. There will be a negative correlation between the WMI and the Conners 3 Learning Problems Index.

Chapter Three

Results

Referring to Table 2, results of the t-test for independent means (two sample assuming equal variances) used to investigate the difference between students who were rated equal to or greater than seventy on the Conners 3rd Inattention scale (M = 84.29, SD = 9.86) and students that were rated equal to or below sixty-five [(M = 86.43, SD = 10.28), $t(26)$, $p = 0.58$] on the Inattention scale was not significant. The difference between students rated equal to or greater than seventy on the Conners 3rd Hyperactivity scale (M = 85.17, SD = 10.56) and students who were rated equal to or below sixty-five [(M = 84.17, SD = 10.85), $t(22)$, $p = 0.82$] was not significant. Lastly, results of the t-test for independent means used to look at the difference between students rated equal to or greater than seventy (M = 83.08, SD = 10.68) and students rated equal to or below sixty-five [(M = 89.33, SD = 9.06), $t(22)$, $p = 0.14$] on the Conners 3rd Learning scale was not significant.

Table 1

Means and Standard Deviations for the Conners 3rd Scales and WISC-IV WMI***

Scale	*M* (n = 34)	*SD*
WMI	85.35	9.42
Inattention	64.91	14.20
Hyperactivity	61.71	17.24
Learning Problems	69.24	8.94

*Conners scales have a mean of 50 and a standard deviation of 10
**Working Memory Index

Table 2

Mean Performance of Students and t tests for WISC-IV WMI and Conners 3^{rd} Scale by Group

Scale	Group	*n*	WMI *M*	WMI *SD*	*t*
Inattention	$\geq$70	14	84.29	9.86	$t = -0.56$; $p = 0.58$
	$\leq$65	14	86.43	10.28	
Hyperactivity	$\geq$70	12	85.17	10.56	$t = 0.23$; $p = 0.82$
	$\leq$65	12	84.17	10.85	
Learning Problems	$\geq$70	12	83.08	10.68	$t = -1.55$; $p = 0.14$
	$\leq$65	12	89.33	9.06	

Table 3 reveals that the relationship between the WMI and the Conners 3 Inattention, Hyperactivity, and Learning Problems Indexes was not significant.

Table 3

Pearson Correlations (r) Between the WISC-IV WMI and the Conners 3^{rd} Scales (*n*=34)

	Inattention	Hyperactivity	Learning Problems
WMI	0.02	0.03	-0.25

$p>.05$ for all correlations

Chapter Four

Discussion

Although performance on the WMI is said to be related to the ability to attend and sustain attention (Anastopolous et al., 1994; Egeland et al., 2006; Hale et al., 2002; Kuentzel et al., 2012; Mayes & Calhoun, 2002), the results of this study indicate that performance on the WMI is not related to inattentive or hyperactive behaviors in the classroom. That is, teacher ratings of a student's attentive and hyperactive behaviors did not predict how well a student performed on the WMI. Students that were rated as highly inattentive or hyperactive in the classroom did just as well on the WMI as students who were rated as not having problems with attention or activity level in the classroom. In fact, the correlations between the WMI and the Conners Inattention scale (0.02) and the Hyperactivity scale (0.03) indicate that performance on the Working Memory Index of the WISC-IV has almost no relationship with perceived attentiveness and activity level in the classroom as rated by the teacher.

Yet, past research has documented results indicating that the Wechsler subtests purporting to measure working memory and attention, such as Digit Span, are objective measures of attention (Hale et al., 2002). In the study conducted by Hale and his colleagues (2002), which looked at the Digit Span subtest and its relationship with attention as measured by the Gordon Diagnostic System Vigilance Task, the Trail Making Test-Part B, and the Achenbach Child Behavior Checklist and Teacher Report Form, it was found that children who performed poorly on Digit Span-Backwards were more likely to present with deficits in attention, working memory, and/or executive functions. Although Digit Span Forward and Backward are both measures of working memory, Digit Span Forward primarily involves rote memory and auditory sequential processing; whereas, Digit Span Backward involves these cognitive processes and, in addition, places more demands on working memory in order to transform and manipulate information while maintaining that information in short-term memory storage (Hale et al., 2002; Sattler, 2008). Executive functions, which also involve the ability to control attention (Barkley, 1998), are what allow an individual to manipulate or transform information and execute complex mental operations (Hale et al., 2002).

Another study carried out by Kuentzel et al. (2012) looked at the relationship between performance on the Continuous Performance Test (CPT) and subtests from the WISC-IV WMI. Their discoveries indicated that a significant correlation existed between the WMI subtests, especially Letter-Number Sequencing, and the errors of omission and commission on the CPT. These findings supported their claim that the WISC-IV WMI subtests are the most negatively affected by inattentive behavior and impulsivity. Letter-Number Sequencing also places more demands on working memory, because the subtest requires an individual to attend to a series of numbers and letters, arrange the numbers in ascending order, then arrange the letters in alphabetical order, all while retaining the series of letters and numbers being presented (Sattler, 2008). In order to carry out these mental activities, one must be able to self-monitor their behavior, control their attention, and perform mental manipulation on a series of letters and numbers, which involves the self-regulatory skills of executive functions (Barkley, 1998; Hale et.al., 2012). The results of this study are inconsistent with previous research. Possible reasons for the current findings includes the sample size used in this study, the use of a classroom measure that has not been validated in the literature, and the use of only students who have been referred for an evaluation.

In regards to practicing school psychologists and evaluators, the findings of this study suggest the need to interpret a student's performance on the WMI in regards to attention with caution; being mindful of the fact that a low score on the WMI is not necessarily due to the inability to sustain attention. If a school psychologist speculates that a student's poor performance on the WMI is related to his or her inability to maintain attention in the classroom, then additional measures of attention should be administered to rule out or confirm inattentiveness as being a factor in a student's poor working memory abilities. Since a lack of focus and attention during administration of the WMI subtests seems to adversely affect student performance, it does not necessarily mean that the student exhibits significant attention problems in the classroom. On the contrary, just because a student is inattentive in the classroom, does not mean that the student will be inattentive during administration of the WMI.

When a student is suspected of having deficiencies in his or her working memory, it is important for practitioners to perform a comprehensive evaluation for the purpose of gathering more data. Using multiple test batteries to collect more data, enable school psychologists to be thorough and make better informed decisions about a student's working memory. Making informative decisions based on data is a key component of both assessment and research. For assessment and research purposes, the point at issue is whether or not working memory and attention are related. Is performance on the WMI mostly related to working memory and attention is merely a variable factor, or is it possible that students referred for an evaluation are more inclined to have working memory and attention issues; yet, the two are not related?

Limitations of this study include using a small sample size of only referred students and using eight different teachers to complete the Conners 3. Also, this study looked at only one measure of working memory and one measure of attention. Furthermore, a comparison of the overall working memory score was used and not individual subtest scores to identify significant differences. Future research should include a more diverse population in regards to demographics including other school districts, upper and lower grade levels, referred and not referred students, and various racial backgrounds. Additionally, future studies should investigate other working memory measures that purport to be indicators of attention as being related to attention. A comparison should be made between other working memory measures and different measures of attention to see if a relationship exists. Furthermore, studies conducted in the future should compare a participant's performance on individual subtests of the WISC-IV WMI (i.e., DSF, DSB, and LNS) with measures of attention to identify significant differences. Lastly, future studies should explore whether or not inattentive behaviors displayed during an assessment are correlated with performance on the WMI. Also, other classroom rating scales should be utilized in future research, and the WISC-IV WMI and other working memory measures should be compared to determine if one is more accurate than the other in assessing attention.

References

Abott, E.N. (2007). *Comparative study of the working memory scales of the WISC-IV and the SB5 in referred students.* Master's thesis retrieved from Marshall University Electronic Theses and Dissertations.

Alloway, T.P., Elliott, J., & Place, M. (2010). Investigating the relationship between attention And working memory in clinical and community samples. *Child Neuropsychology*, *16,* 242-254. DOI: 10.1080/09297040903559655

Anastopoulos, A.D. Spisto, M.A., & Maher, M. (1994). The WISC-III Freedom From Distractibility factor: It's utility in identifying children with Attention Deficit Hyperactivity Disorder. *Psychological Assessment*, *6*, 368-371. DOI: 10.1037/1040-3590.6.4.368

Barkley, R. A. (1998). Attention Deficit Hyperactivity Disorder. *Scientific American*, 66-71.

Bhargava, H.D. (2012). What is executive function? Retrieved from http://www.webmd.com/add-adhd/executive-function

Brose, A., Schmiedek, F., Lovden, M., & Lindenberger, U. (2012). Daily variablity in working memory is coupled with negative affect: The role of attention and motivation. *Emotion, 12* (3), 605-617. DOI: 10.1037/a0024436

Conners 3 Interpretive Update. (2009). In *Multi-Health Systems Psychological Assessments and Services.* Retrieved from https://ecom.mhs.com/(S(0yqhtuyfpjrputr5vroi30jh))/product.aspx?RptGrpID=MCC

Conners 3 – Self-Report Assessment Report (Sample). (2007). In *Psychological Assessments Australia.* Retrieved June 17, 2013, from http://www.psychassessments.com.au/products/127/prod127_report5.pdf

Conners 3 – Teacher Assessment Report (Sample). (2007). In *Western Psychological Services.* Retrieved June 17, 2013, from http://portal.wpspublish.com/pdf/ML-21.pdf

Dehn, M.J. (2008). Introduction and overview. *Working memory and academic learning: Assessment and intervention* (pp. 1-8). Hoboken, NJ: John Wiley and Sons, Inc.

Egeland, J., Sundberg, H., Andreassen, T.H. & Stensli, O. (2006). Reliability and validity of Freedom from Distractibility and Processing Speed Factors in the Norwegian WISC-III-Version. *Nordic Psychology*, *58* (2), 136-149.

Flanagan, D. P., & Kaufman, A. S. (2009). Introduction and overview. In A.S. Kaufman & N.L. Kaufman (Eds.), *Essentials of WISC-IV assessment* (Second ed., pp. 2-51). Hoboken, NJ: John Wiley and Sons, Inc.

Fougnie, D. (2008). The relationship between attention and working memory. In N. Johansen (Ed.), *New Research on Short-term Memory* (pp 2-4). N.p.: Nova Science Publishers, Inc.

Hale, J.B., Hoeppner, J.B., & Fiorello, C.A. (2002). Analyzing Digit Span components for assessment of attention processes. *Journal of Psychoeducational Assessment, 20,* 128-143. DOI: 10.1177/073428290202000202

Hill, B.D., Elliott, E.M., Shelton, J.T., Pella, R.D., O'Jile, J.R., & Gouvier, W.D. (2010). Can we improve the clinical assessment of working memory? An evaluation of the Wechsler Adult Intelligence Scale-Third Edition using a working memory criterion construct. *Journal of Clinical and Experimental Neuropsychology, 32* (3), 315-323. DOI: 10.1080/13803390903032529

Kao, G.S. & Thomas, H.M. (2010). Test review: C. Keith Conners Conners 3rd Edition Toronto, Ontario Canada: Multi-Health Systems, 2008. *Journal of Psychoeducational Assessment, 28,* 598-602. DOI: 10.1177/0734282909360011

Kaufman, A.S., Flanagan, D.P., Alfonso, V.C., & Mascolo, J.T. (2006). Test review: Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV). *Journal of Psychoeducational Assessment, 24,* 278-295. DOI: 10.1177/0734282906288389

Kuentzel, J.G., Arble, E., Swift-Godzisz, K., & Barnett, D. (2012). *Associations between WISC-IV subtests and an objective measure of inattention and impulsivity.* Paper presented at the Annual Conference of the American Psychological Association Orlando, FL.

Leffard, S.A., Miller, J.A., Bernstein, J., DeMann, J.J., Mangis, H.A., & McCoy, E.L.B. (2006). Substantive validity of working memory measures in major cognitive functioning test batteries for children. *Applied Neuropsychology, 13* (4), 230-241.

Livingston, R.B., Gray, R.M., Broquie, J.P., Dickson, T.L., Collins, A.L., & Spence, S. (2001). Construct validity of Wechsler factor scores. *Perceptual and Motor Skills, 93,* 78-80.

Malter, R. & Frank, L.M. (1995). *Freedom from Distractibility or auditory processing & memory: A critical look at the WISC-III 3rd factor.* Paper presented at the Annual Conference of the Learning Disabilities Association, Orlando, FL.

Martinussen, R. & Major, A. (2011). Working memory weaknesses in students with ADHD: Implications for instruction. *Theory Into Practice, 50,* 68-75. DOI: 10.1080/00405841.2011.534943

Mayes, S.D. & Calhoun, S.L. (2002). The Gordon Diagnostic System and WISC-III Freedom from Distractibility Index: Validity in identifying clinic-referred children with and without ADHD. *Psychological Reports, 91,* 575-587.

Meyers, R.S. (2004). *Incremental validity and the Wechsler intelligence scales.* (Master's thesis, The Graduate School, University of Wisconsin-Stout). Retrieved from http://www.2.uwstout.edu/content/lib/thesis/2004/2004meyersr.pdf

Naglieri, J.A. & Goldstein, S. (2009). *Practitioner's guide to assessing intelligence and achievement.* (First ed., pp. 61-229). Hoboken, NJ: John Wiley & Sons, Inc.

Niolon, R. (2005, August). History of the WISC-IV. In *Resources for Students and Professionals.* Retrieved from http://www.psychpage.com/learning/library/intell/wisciv_hx.html

Redick, T.S. & Engle, R.W. (2006). Working memory capacity and Attention Network Test Performance. *Applied Cognitive Psychology, 20*, 713-721. DOI: 10.1002/acp.1224

Sattler, J. M. (2008). *Assessement of children: Cognitive foundations, Fifth Edition*. San Diego, CA: Jerome M. Sattler, Publisher, Inc.

Shipstead, Z. & Engle, R.W. (2012). Interference within the focus of attention: Working memory tasks reflect more than temporary maintenance. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* Advance online publication. DOI: 10.1037/a0028467

Siekierski, B.M., Jarratt, K.P., & Rosenthal, E.N. (2003). *WISC-III Freedom from Distractibility Index and measures of attention in children.* Paper presented at the 111th Annual Conference of the American Psychological Association, Toronto, ON, Canada. Abstract retrieved from ERIC database. (Accession No. ED480490)

MARSHALL UNIVERSITY
www.marshall.edu

Office of Research Integrity

June 14, 2013

Sandra S. Stroebel, Ph.D., NCSP
Associate Dean/Program Director
Professor
School Psychology Program
Marshall University
100 Angus E. Peyton Drive
South Charleston, WV 25303-1600

Dear Dr. Stroebel:

This letter is in response to the submitted abstract for Talya Colliflower to compare the WISC-IV Working Memory Index and the Conners 3rd Edition – Teacher form data using the t-test for independent means and the Pearson product-moment correlation. After assessing the abstract it has been deemed not to be human subject research and therefore exempt from oversight of the Marshall University Institutional Review Board (IRB). The Code of Federal Regulations (45CFR46) has set forth the criteria utilized in making this determination. Since the information in this study consists solely of deidentified data provided by an Ohio school district it is not human subject research and therefore not subject to Common Rule oversight. If there are any changes to the abstract you provided then you will need to resubmit that information for review and determination.

I appreciate your willingness to submit the abstract for determination. Please feel free to contact the Office of Research Integrity if you have any questions regarding future protocols that may require IRB review.

Sincerely,

Bruce F. Day, Th.D., CIP
Director

401 11th Street, Suite 1300 • Huntington, West Virginia 25701 • Tel 304/696-7320
A State University of West Virginia • An Affirmative Action/Equal Opportunity Employer