

Measuring Word Reading and Pseudoword Decoding in Struggling Readers Using the  
Test Of Word Reading Efficiency-Second Edition (TOWRE-2) and the Wechsler  
Individual Achievement Test-Third Edition (WIAT-III)

By

Morgan E. Griffith

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Thesis Committee

Monica Wallace, Ph.D., Chair

James Herman, Ph.D.

James Rust, Ph.D.

I would like to dedicate this research to my late father, Terry Griffith.

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## ABSTRACT

The purpose of the current study was to determine whether the basic word reading skills measured by the Test of Word Reading Efficiency, 2<sup>nd</sup> Edition (TOWRE-2) provides sufficient information to diagnose dyslexia instead of using both the TOWRE-2 and Wechsler Individual Achievement Test, 3<sup>rd</sup> Edition (WIAT-III) as is current practice at the Tennessee Center for the Study and Treatment of Dyslexia. Benefits of using only one test might include reduced testing time, less child fatigue, more efficient use of staff resources and clearer diagnostic information. The TOWRE-2 assesses both fluency and decoding and the WIAT-III assesses only decoding. Reading researchers agree that dyslexia is characterized by poor word reading and decoding (e.g., Mody, & Shaywitz, 2006). TOWRE-2 mean scores were significantly lower than WIAT-III mean scores for both dyslexic and non-dyslexic groups suggesting that the TOWRE-2 provides the lowest estimate of decoding ability.

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## CHAPTER I

### INTRODUCTION

#### Overview

Dyslexia affects 15-20% of the general population (International Dyslexia Association, 2012). The current method for diagnosing dyslexia in schools recommended by the National Association of School Psychologists (NASP) is Response to Instruction and Intervention (RtI<sup>2</sup>) (National Association of School Psychologists, 2010). This method allows children who are falling behind to receive intervention sooner than with the previous commonly used discrepancy model, sometimes referred to as the “wait to fail” model. Early intervention with children at risk for dyslexia can greatly decrease the number of students with a disability in basic reading skills (Mathes, Denton, Fletcher, Anthony, Francis, & Schatsneider, 2005; Scammacca, Vaughn, Roberts, Wanzek, & Torgesen, 2007; Torgesen, 2002). However, despite effective instruction and intervention, some children still struggle learning to read. Children who do not respond adequately to intervention are referred for a special education evaluation to determine their need for a specific learning disability diagnosis (NASP, 2010).

The National Center for Education Statistics reported that 6.4 million students, or about 13% of the general population ages 3-21, receive special education services (2013). Of those 6.4 million students, 42% have a specific learning disability (National Center for Learning Disabilities, 2014). Specific learning disability (SLD) is the largest category in

special education, and reading disabilities account for about 85% of SLDs, with the majority classified under basic reading skills, or dyslexia (IDA, 2012).

Children with learning disabilities face challenges outside their area of academic deficit. Almost 20% of students with a learning disability will drop out of high school, one-third will be retained at least once, and one-half will face expulsion or suspension (National Center for Learning Disabilities, 2014). Only 21% of students with an SLD will attend a 4-year college compared to 40% of students without an SLD (National Center for Learning Disabilities, 2014). Children with an SLD in basic reading skills, including dyslexia, have deficits in fluent and accurate word reading and decoding (IDA, 2012). Some measures assess accuracy and fluency, while others only assess accuracy. There are multiple measures that can be used to assess word reading and decoding skills, but is one type of measure a more reliable diagnostic indicator than another?

### **Definition of Dyslexia**

The International Dyslexia Association (IDA) defines dyslexia as difficulty with accurate and/or fluent word reading, decoding, and spelling, with secondary consequences of reduced reading experience and reading comprehension problems (International Dyslexia Association, 2002). Reading researchers agree that dyslexia is characterized by poor word reading and decoding as well as difficulty connecting letters with sounds (e.g. Gabrieli, 2009; Shaywitz, Mody, & Shaywitz, 2006). Definitions of dyslexia from other organizations (e.g., Learning Disabilities Association of America, British Dyslexia Association) may include deficits in some other skill areas, but all

definitions include the basic principles of slow word recognition, decoding, and spelling difficulties leading to poor reading fluency and comprehension (Youman & Mather, 2012). Dyslexia is a specific learning disability that is recognized by the Individuals with Disabilities Education Improvement Act, or IDEIA (IDEIA, 2004), and, as noted above, is one of the most common categories of special education classification (IDA, 2002). The term dyslexia dates back to the late 1800s, and at the time, was utilized only by medical professionals (Moats & Dakin, 2008). Currently the term is used by a myriad of professionals including medical doctors, educators, and mental health professionals. Additionally, parents and the general public are beginning to understand and use the term “dyslexia” to discuss this specific learning disability. The prefix *dys* means difficult or impaired, while the suffix *lexia* means reading (Merriam-Webster, 2006).

The Individuals with Disabilities Education Act of 1990 was reauthorized as the Individuals with Disabilities Education Improvement Act in 2004, also referred to as IDEIA 2004. This legislature requires all public school systems to include dyslexia under the category of specific learning disability in the area of basic reading skills (IDEIA, 2004). When schools use the term basic reading skills disability or specific learning disability in basic reading skills, they are referring to the same concept as dyslexia. The fifth edition of the Diagnostic and Statistical Manual of Mental Disorder (DSM-5) classifies dyslexia under the specific learning disability (SLD) category (American Psychiatric Association, 2013). This is the category used by clinicians when diagnosing dyslexia. The International Statistical Classification of Diseases and Related Health

Problems, or ICD-10, (World Health Organization, 1992) uses the term specific reading disorder (RD) when referring to dyslexia.

### **Core Phonological Deficit**

Research shows that a deficit in phonological processing has an important effect on reading and writing, and more often than not, children with a deficit in word reading and/or decoding have a deficit in one or more of these phonological areas (e.g., Berninger & Wagner, 2008; Moats & Dakin, 2008; Siegel, 2006; Wagner, Torgesen, Rashotte, & Pearson, 2013). Deficits in phonological processing can occur in three components: (a) rapid naming; (b) phonological awareness; and (c) phonological memory (Berninger & Wagner, 2008; Shapiro, Carroll, & Solity, 2013; Wagner et al., 2013). Wagner et al. (1997) showed that these phonological processes are distinct, but correlated. A deficit in the phonological component of language, a precursor to reading, is considered the source of reading difficulty (e.g., IDA, 2002; Wagner et al., 2013).

**Phonological awareness.** Phonological awareness is the component most closely related to reading ability, and is defined as the ability to recognize that speech is made up of individual words, syllables, and phonemes (e.g., Christo, Davis, & Brock, 2010; IDA, 2016; Kamhi & Catts, 2012; Lowell, Felton, & Hook, 2014). As a result, it is the most widely agreed upon deficit contributing to dyslexia among the dyslexia community (e.g., Christo, Davis, & Brock, 2010; Cummings, Kaminski, Good, & O'Neil, 2011; Kamhi & Catts, 2012). Konza (2006) describes phonological awareness as knowledge of the sounds of speech and how they work together.

Phonological awareness is a broad concept that encompasses a range of skills. One of the more specific skills is phonemic awareness (Konza, 2006), which refers to hearing sounds only, not seeing letters or words. Phonemes are the smallest units of sound that carry meaning in a word (Konza, 2006). Phonemic awareness requires understanding how changing one phoneme, or speech sound, can change the meaning of a word (Konza, 2006). These phonemes differ by language and are difficult to isolate (IDA, 2016). Phonological awareness skills build from easiest, isolating phonemes, to hardest, blending and deleting phonemes (Naess, 2016). Intensive instruction in phonological awareness for many children with dyslexia can usually result in increased reading ability (Anthony & Francis, 2005).

Deficits in phonological awareness have a direct relationship to reading ability. If an individual has a deficit in phonological processing, he/she will struggle to break down words into their sounds (i.e., use phonics skills to decode). If one struggles to learn the predictable sounds associated with a letter or group of letters, reading will be difficult (Lowell, Felton, & Hook, 2014). Phonics deficits can lead to poor decoding and word reading, which results in low fluency and comprehension (Lowell, Felton, & Hook, 2014). Phonics deficits are also related to poor spelling and writing ability (Lowell, Felton, & Hook, 2014).

The sound-symbol, or orthographic, relationship of decoding is supported by phonics skills (e.g., Kamhi & Catts, 2012; Lowell, Felton, & Hook, 2014). Orthography is defined as the representation of the sounds of a language by written symbols, or letters

(Orthography, n.d.). Strong orthographic knowledge, or the ability to attach sounds to letters quickly and efficiently, allows an individual to use memory routes for sight words to read quickly and accurately, rather than decoding every word (Kamhi & Catts, 2012).

**Rapid automatic naming.** Rapid automatic naming (RAN) tasks are used to assess the efficiency of retrieving phonologically coded information from long-term memory, called lexical access (Logan, Schatschneider, & Wagner, 2011). Norton and Wolf (2011) described RAN tasks as timed naming of randomly ordered stimuli, which are familiar to the individual, and which are presented in the typical left-to-right format. This format of RAN tests is referred to as continuous trial, because the stimuli are named one after the other (Kirby, Georgiou, Martinussen, & Parrila, 2010). A reader must be able to recognize letters in isolation rapidly before they can begin to automatically recognize sequences of letters, or sight words (Moats & Dakin, 2008). RAN tasks require a reader to recognize the letter, or orthographic representation, and remember the sound, or phoneme, associated with it (Moats & Dakin, 2008). RAN tasks are generally timed tests of letter, digit, color, or object naming (e.g., Arnell, Joanisse, Klein, Busseri, & Tannock, 2009; Norton & Wolf, 2012). The stimuli appear in rows, with several items in each row, often in a 5 × 10 grid (e.g., Arnell et al., 2009; Norton & Wolf, 2012). Rapid alternating stimuli (RAS) follows the same format, but alternates letters and numbers, and letters, numbers, and colors. The stimuli must be familiar to the examinee and must be presented in a random order (e.g., Kirby et al., 2010; Norton & Wolf, 2012). According to Norton and Wolf (2012), most tests of RAN will have a pretest to assure the examinee

recognizes the stimuli that will be presented. Errors and observations of their mistakes are not counted in the score, though they do contribute to lack of fluency and can provide qualitative information (Norton & Wolf, 2012). The score of interest is the amount of time it takes the examinee to name all of the items (Norton & Wolf, 2012).

Rapid automatic naming is a skill that can predict later reading ability (e.g., Moats & Dakin, 2008; Norton & Wolf, 2012; Shapiro et al., 2013; Wagner et al., 2013). RAN predicts reading ability because both tasks, RAN and reading, require identifying stimuli quickly and accurately (Arnell et al., 2009). RAN composite scores from the Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2) (Wagner, Torgesen, Rashotte, & Pearson, 2013), including letter and color naming, were found to have a statistically significant, positively correlated relationship with measures of reading ability in a study by Rebecca McCartney (2008). Discrete, or isolated trials, where single letters or numbers are presented, are less predictive than the continuous trial (Kirby et al., 2010; Logan et al., 2011). According to Moats and Dakin (2008), letter naming is the most important predictor of later reading for kindergarten and first graders. Kirby et al. (2010) say that rapid naming increases word recognition, which is an important factor in reading comprehension. Kirby et al. (2010) describe RAN impacting reading while controlling for other variables. Norton and Wolf (2012) also describe the relationship between RAN and reading as important, saying that countless studies have shown that an individual's reading can be accurate without being fluent. Children who are accurate but

slow readers may be identified with reading difficulty later on in school after struggling in other subject areas (Norton & Wolf, 2012).

**Phonological memory and working memory.** Phonological memory refers to the encoding and short-term storage of auditory information (Kamhi & Catts, 2012; Lowell, Felton, & Hook, 2014). Baddeley (1986) found that the most efficient way to hold verbal information in working memory is through speech-sound coding, or the phonological memory process. One theory as to why phonological memory is important in reading is that the speed of accessing phonological information may be slower in poor readers than in average readers (Mather & Wendling, 2012). A student with a phonological memory deficit trying to read a multisyllable word may forget the first syllable after they decode the last syllables (Lowell, Felton, & Hook, 2012), and this influences word identification and fluency.

In children with a deficit in phonological memory, working memory also is often impaired (Mather & Wendling, 2012). Working memory is the ability to manipulate information stored in short-term memory (Mather & Wendling, 2012). The phonological loop, which is a critical component of working memory, processes auditory information and holds it to be used within a few seconds (Mather & Wendling, 2012).

Memory span is one way that phonological memory can be assessed. This involves presenting the child with a series of numbers or words increasing in difficulty, or in some cases a nonsense word, and asking them to repeat it back verbatim, usually within a few seconds (e.g., Kamhi & Catts, 2012; Mather & Wendling, 2012). Kamhi and



Catts (2012) assert that nonsense word repetition is one of the best ways to assess phonological memory because it is not affected to the extent that number and word series are by attention and rehearsal factors.

**Automaticity and word recognition.** Automaticity of word reading is important for comprehension, as the reader does not have to switch between decoding and understanding the text (Ehri, 2005). Automaticity includes recognizing the pronunciation and meaning of a word without explicitly thinking about it (Ehri, 2005). Accurate and fluent word reading is a core deficit in people with dyslexia (e.g. Christo, Davis, & Brock, 2010; IDA, 2002; Kamhi & Catts, 2012; Lowell, Felton, & Hook, 2014; Pennington, 2009; Vellutino & Fletcher, 2005). The importance of the association between fluent word identification and comprehension, the ultimate goal of reading, has been established for many years (Perfetti, Landi, & Oakhill, 2005). Comprehension is less limited by word recognition as readers become more fluent (Perfetti et al., 2005). Decoding every individual word causes the reader's fluency and comprehension to decrease (Ehri, 2005). The ability to read words from memory is essential because readers can concentrate on the meaning of the text (Ehri, 2005).

### **Assessment of Dyslexia**

Accurate assessment is critical for the diagnosis of dyslexia. It is vital to confirm patterns of deficits consistent with dyslexia by identifying which skill deficits (e.g., phonological awareness, rapid automatic naming, or phonological memory) are contributing to the reading problem. Assessment of dyslexia includes fluency, accuracy,

and comprehension (e.g., IDA, 2016; Schulte-Körne, 2010). The International Dyslexia Association also recommends evaluating phonological processing skills, vocabulary knowledge, and oral language skills (IDA, 2016). There are many tests that can identify deficits in these skill areas, including the Wechsler Individual Achievement Test, Third Edition (WIAT-III), Woodcock-Johnson Tests of Achievement, Fourth Edition (WJ-IV ACH), Comprehensive Test of Phonological Processing, Second Edition (CTOPP-2), Test of Word Reading Efficiency, Second Edition (TOWRE-2), and other achievement tests.

Norm referenced achievement measures, such as the Wechsler Individual Achievement Test, Third Edition (WIAT -III), include subtests that assess many of the components included in the dyslexia definition, such as Word Reading and Pseudoword Decoding, Reading Comprehension, Listening Comprehension, Spelling, and Oral Reading Fluency (Psychological Corporation, 2009). Another way to measure these skills includes using curriculum-based measures (CBM), and norm-referenced assessments. CBMs base scores on knowledge of a particular skill or learning standard.

Assessment of word recognition is more complex than some other reading skill deficits because of the many ways children learn to read words. It is important to recognize the ways in which children learn to accurately and fluently read written words in order to accurately identify and provide intervention for reading disabilities. There are at least five different ways that words can be identified: a) identifying and blending individual phonemes, b) blending familiar spelling patterns, c) reading by sight, d)

making analogies to known words, and e) using context clues (e.g. Ehri, 2005; Kamhi & Catts, 2012).

Assessment of dyslexia should include measures of how quickly and accurately an individual can read words of increasing difficulty (Lowell, Felton, & Hook, 2014; Mather & Wendling, 2012). Word reading and pseudoword decoding tests are used to assess word recognition. Tests should include both real words and nonsense words, or pseudowords, with regular and irregular spelling patterns (Mather & Wendling, 2012). Nonsense words follow English spelling patterns but do not carry meaning (e.g. Lowell, Felton, & Hook, 2014; Mather & Wendling, 2012). They are used to assess whether an individual has mastered phonics skills and how automatically he or she can decode (e.g. Christo, Davis, & Brock, 2010; Lowell, Felton, & Hook, 2014; Mather & Wendling, 2012). The timed reading of real words assesses how automatically an individual can retrieve orthographic knowledge (Christo, Davis, & Brock, 2010). Untimed real word reading measures the individual's lexicon, or vocabulary (Christo, Davis, & Brock, 2010).

To measure fluency of word recognition, lists of words or nonsense words are read aloud within a specific time limit, and the number of words read correctly within the time limit is calculated (Lowell, Felton, & Hook, 2014). This score is converted into a standard score, percentile rank, and age or grade equivalents for standardized assessments (Lowell, Felton, & Hook, 2014).

**Methods of assessment.** The IQ-Achievement discrepancy model is one of the methods that was used to diagnose specific learning disabilities in public schools before IDEIA 2004 (Mather & Wendling, 2012). With this model, the individual's IQ score was compared to their scores on various achievement measures. If a 15-point or more discrepancy was found between, for example, the child's IQ and Basic Reading scores, the child could be diagnosed with dyslexia (Gabrieli, 2009). Research has shown this model to be inadequate in identifying students who are struggling with reading (e.g. Aaron, Joshi, Gooden, & Bentum, 2008; Pennington, 2009).

The more scientifically sound option for diagnosing SLD is the Response to Instruction and Intervention (RtI<sup>2</sup>) method (e.g. Christo, Davis, & Brock, 2010; TNCore, 2013). As of July 1, 2014, public schools in Tennessee are required by law to use RtI<sup>2</sup> instead of IQ-Achievement discrepancy when diagnosing learning disabilities (TNCore, 2013). During the RtI<sup>2</sup> process, an evidence-based intervention is implemented based on the child's pattern of strengths and weaknesses identified through triannual universal screening (TNCore, 2013). Data are collected (e.g., words correct per minute, nonsense word fluency, etc.) while the intervention is in place, and a decision is made about whether the child is making adequate progress based on a rate of improvement formula. If multiple interventions do not improve the child's skills, a referral for a SLD evaluation may be made (Christo, Davis, & Brock, 2010). The RtI<sup>2</sup> process ensures that the reason the child isn't making progress is not due to lack of practice or inadequate instruction

(Vellutino & Fletcher, 2005). The RtI<sup>2</sup> model ensures that children receive intervention sooner than they would with the discrepancy model (Kamhi & Catts, 2012).

The dyslexia evaluation process in public schools or private clinics includes multiple methods of gathering data about the child's current functioning (Christo, David, & Brock, 2010). While information from an RtI<sup>2</sup> intervention and triannual benchmark data can contribute to the evaluation process, many other sources must be included, such as parent and teacher reports, background history, and standardized test results (Mather & Wendling, 2012). These standardized tests can include IQ tests to rule out intellectual disability, achievement tests such as the Wechsler Individual Achievement Test, third edition (WIAT-III), and tests of specific skills such as the Test of Word Reading Efficiency, second edition (TOWRE-2) and Comprehensive Test of Phonological Processing (CTOPP-2) (Mather & Wendling, 2012).

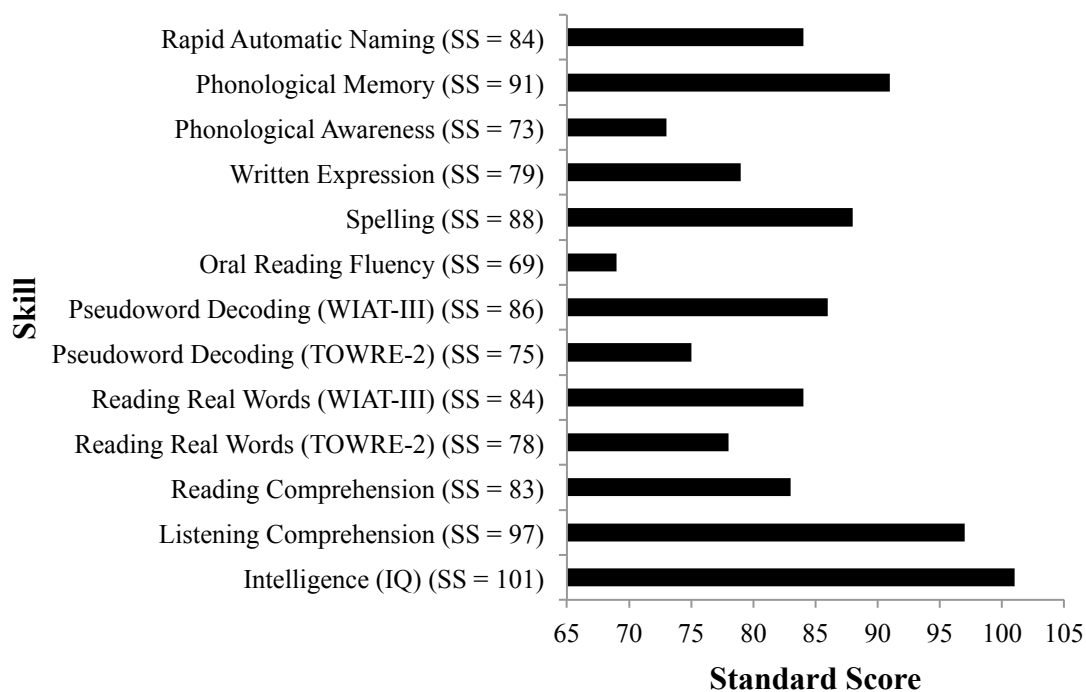
Another method that can be used to diagnose dyslexia is a pattern of strengths and weaknesses. This method compares an individual's scores to a normative group as well as the individual's other scores (Christo, Davis, & Brock, 2010). This method is used by Middle Tennessee State University's Tennessee Center for the Study and Treatment of Dyslexia (also referred to as the Center for Dyslexia) when diagnosing children. By analyzing achievement test scores in areas relevant to dyslexia, it can be decided whether or not an individual meets the profile of a child with dyslexia.

The process for assessing a child at the Tennessee Center for the Study and Treatment of Dyslexia begins with requests for existing information. This information

includes medical and academic background information, family history, previous test scores, and progress monitoring information. Using these sources, a plan for testing is chosen. Staff are currently trained by Erin Alexander, Assistant Director for Clinical Services, before they begin evaluating children. Mrs. Alexander provided most of the information about the center included in this study. The majority of the children tested at the center receive the same battery of tests. Tests used most often include the Wechsler Individual Achievement Test, Third Edition (WIAT-III), Developmental Spelling Analysis (DSA), Test of Word Reading Efficiency, Second Edition (TOWRE-2), Comprehensive Test of Phonological Processing, Second Edition (CTOPP-2), Phonological Awareness Test, Second Edition (PAT-2), Decoding Skills Test (DST), Woodcock-Johnson Tests of Achievement III NU (WJ-III NU), and DIBELS*Next* or a grade level fluency passage for older students. The Wechsler Individual Achievement Test, Third Edition (WIAT-III) measures academic skills including reading, math, listening comprehension, oral expression, and writing. The Developmental Spelling Analysis (DSA) is a measure of spelling that breaks down words into features (e.g., short vowels, consonant blends and digraphs, etc.) to indicate where the child is having difficulty. The Test of Word Reading Efficiency, Second Edition (TOWRE-2) measures accuracy and fluency of word reading and pseudoword decoding. The Comprehensive Test of Phonological Processing, Second Edition (CTOPP-2) measures phonological awareness, phonological memory, and rapid automatic naming skills. The Phonological Awareness Test, Second Edition (PAT-2) measures phonological awareness skills, such

as segmenting, deleting, and blending. The Decoding Skills Test (DST) assesses word reading and decoding skills and provides information related to stage of spelling (i.e., letter name stage, within word stage, etc.). The Woodcock-Johnson Tests of Achievement III NU (WJ-III NU) and its update, the Woodcock-Johnson Tests of Achievement IV (WJ-IV) assess academic skills similar to the WIAT-III, and the DIBELS*Next* assesses reading fluency and basic reading skills in young children. An interview with the parent also is conducted to determine the specific problems seen in reading, performance in other subject areas, and the child's strengths and interests. After all tests have been administered and scored, an individual's standard scores ( $M = 100$ ,  $SD = 15$ ) are placed on a bar graph (see Figure 1). Information provided by the various sources and the test scores are considered in making a diagnosis. Information from previous assessments and RtI data is considered, but not necessary in determining if the child has characteristics of dyslexia. If a child's personal and academic history are indicative of a struggling reader and scores on those areas associated with dyslexia (e.g., word reading and decoding, spelling, or phonological awareness) are one or more standard deviations below the mean (i.e., standard score of 85 or lower), and their IQ and listening comprehension scores are in the average range, the child may be diagnosed with dyslexia. All diagnostic decisions are made by trained and licensed professionals.

The bar graph in Figure 1 is an example of the information used by the Center for Dyslexia when determining whether a child meets the profile of a person with dyslexia.



*Figure 1. Student Profile Graph.* This graph is representative of the profile graph used by the Tennessee Center for Dyslexia when assessing children for dyslexia.  $M = 100$ ,  $SD = 15$ .

The child in the example illustrated in Figure 1 has an IQ score in the Average range. Most of his academic skills are in the Low to Low Average range (i.e., phonological awareness  $SS = 73$ ; reading comprehension  $SS = 83$ ; and oral reading fluency  $SS = 69$ ), except for Spelling. The TOWRE-2 scores (i.e., 75 and 78) and WIAT-III scores (i.e., 86 and 84) indicate that the child's word reading and decoding skills are in the deficit range, especially when taking speed into account which is reflected in the TOWRE-2 scores. His difficulty reading real and pseudowords is likely due to a deficit in Phonological Awareness (i.e., standard score of 73). He also has a deficit in Rapid Automatic Naming,



which, as discussed previously, would contribute to fluency problems. After ruling out lack of instruction and other outside factors, a graph with a pattern seen in Figure 1 and a history of reading difficulty given adequate instruction, regular school attendance and intervention would be indicative of the presence of dyslexia.

### **Study Purpose**

The purpose of the current study was to determine whether the basic word reading skills measured by the Test of Word Reading Efficiency, 2<sup>nd</sup> Edition (TOWRE-2) alone provides sufficient information to diagnose dyslexia instead of using both the TOWRE-2 and Wechsler Individual Achievement Test, 3<sup>rd</sup> Edition (WIAT-III) as is current practice at the Tennessee Center for the Study and Treatment of Dyslexia. The TOWRE-2 assesses both fluency and accuracy, and both areas represent core deficits mentioned in the IDA definition of dyslexia. For this reason, it seems a reasonable hypothesis that using only the TOWRE-2 would be comprehensive and efficient. A reduced amount of testing time could benefit both examiners and examinees. In current practice, sometimes the two tests provide discrepant scores and this clouds the decision making process.

### **Study Hypotheses**

**Hypothesis 1:** Mean scores from the TOWRE-2 Total Word Reading Efficiency (TWRE) composite and WIAT-III Basic Reading Composite (BRC) for participants with and without dyslexia will be significantly lower than the published test mean ( $M = 100$ ).

**Hypothesis 2:** The mean scores for the TOWRE-2 TWRE and the WIAT-III BRC will be significantly different between participants with and without characteristics of dyslexia.

**Hypothesis 3:** The TOWRE-2 TWRE mean will be significantly different from the WIAT-III BRC for participants with and without characteristics of dyslexia.

## CHAPTER II

### METHOD

#### **Participants**

The participants in the current study were 53 male and 47 females ages 6-17 for a total of 100 participants. Test data from 50 participants diagnosed with dyslexia and 50 participants without a diagnosis of dyslexia were included in this study. All participants at the time of data collection were residents of Tennessee. Participants were administered a battery of tests that assessed reading, spelling and language ability at the Tennessee Center for the Study and Treatment of Dyslexia, located in Murfreesboro, TN, between September 2013 and May 2016. The purpose of the Center for Dyslexia is to spread awareness and provide resources for families and schools to help children with dyslexia. An evaluation at the center ends with recommendations for how to improve the child's specific reading deficits. Evaluation procedures include administration of both the Test of Word Reading Efficiency, Second Edition (TOWRE-2) and Wechsler Individual Achievement Test, Third Edition (WIAT-III) Prior to evaluation, a parent or guardian is asked to sign a consent form to allow their child's deidentified test results to be used for research purposes. All participants in this study have a signed consent form on file at the Center for Dyslexia. Permission to conduct this study using deidentified, existing data was approved by the Middle Tennessee State University Institutional Review Board. See Appendix B for written IRB approval.

### **Assessment Instruments**

The WIAT-III and the TOWRE-2, are described in detail in the following section. Both instruments are individually administered skill assessments that include reading real words and pseudowords. The WIAT-III also includes various subtests of reading, math, and writing, while the TOWRE-2 exclusively assesses fluency of word reading and decoding. Both assessments produce a composite score that reflects word reading and pseudoword decoding accuracy. These composite scores were used to test study hypotheses.

**Wechsler Individual Achievement Test, Third Edition.** The Wechsler Individual Achievement Test, Third Edition (WIAT-III) examiner's manual describes the test as an individually administered clinical instrument designed to measure the academic achievement of students in Prekindergarten through 12<sup>th</sup> grade, or ages 4-19. It consists of 16 subtests that evaluate skills such as listening, reading, writing, speaking, and mathematics. The WIAT-III as compared to the WIAT-II contains updated norms, new and revised subtests, and modifications to the administration and scoring (Psychological Corporation, 2009).

An independent validity study shows that items in each domain on the WIAT-III accurately measure the concepts intended (McCrimmon & Climie, 2011). Also, regarding internal structure validity, correlations within subtests were moderate to high, and correlations between related domains were also high (McCrimmon & Climie, 2011).

Reliability and validity for individual subtests and composites were not reported. Test-retest reliability was adequate for subtests and composites (McCrimmon & Climie, 2011).

The subtest scores of the WIAT-III included in this study are the Word Reading (WR) and Pseudoword Decoding (PD) subtests. Administration of each subtest can take one minute to 10 minutes, as speed of word reading is not emphasized. Both subtests present items in increasing difficulty. The manual explains that the Word Reading subtest is designed to measure speed and accuracy of word recognition in isolation. Although speed is not emphasized, the item reached at 30 seconds is marked and a percentile is given. The directions written on the test booklet for the Word Reading subtest are as follows: “I want you to read these words out loud. Start here and read across *this* way. If you finish this page, turn to the next page. Go ahead,” (Psychological Corporation, 2009)

The Pseudoword Decoding subtest present items in increasing difficulty and includes pseudowords. This subtest measures a person’s ability to decode nonwords, which are words that are not real words and have no meaning, but they do follow English spelling patterns. The directions written on the test booklet for this subtest are as follows: “I want you to read some words that are nor real words, but say them as if they were.” The student is given two sample items with teaching directions, and then “Start here and read across *this* way. If you finish this page, turn to the next page. Go ahead,” (Psychological Corporation, 2009).

Each subtests yields a standard score and fluency percentile, when combined, these subtest scores produce a Basic Reading composite score. This composite score is a broad indication of an individual's skills in basic reading. The subtests measure both fluency and accuracy of isolated word reading. The score for accuracy, or words read correctly in an untimed situation, is given as a standard score with a mean of 100 and standard deviation of 15. The fluency score, or number of words read in 30 seconds regardless of accuracy, is given as a percentile rank. The Basic Reading composite score is given as a standard score with a mean of 100 and standard deviation of 15.

**Test of Word Reading Efficiency, Second Edition.** The examiner's manual of the Test of Word Reading Efficiency- Second Edition (TOWRE-2) describes the test as a measure of ability to pronounce words accurately and fluently. The examiner's manual boasts the ability for administration to be completed very quickly, as each subtest only takes 45 seconds, making it very efficient. The TOWRE-2 can be used both as an assessment measure and a progress monitoring tool. The TOWRE-2 can be used with children ages 6-24 (Torgesen, Wagner, & Rashotte, 2012). Criterion validity among the subtests and composite score are strong with the average correlation coefficients ranging from .89-.96 (Tarar, Meisinger, & Dickens, 2015). The test review by Tarar, Meisinger, and Dickens (2015) states that the fluency aspect of the TOWRE-2 may be more sensitive in distinguishing reading disabilities than measures that only assess accuracy. Test-retest reliability ranges between .89-.93, and interrater reliability is .99 (Tarar et al., 2015).

Two subtests, Sight Word Efficiency (SWE) and Phonemic Decoding Efficiency (PDE), as well as a composite score (Total Word Reading Efficiency (TWRE)) are scores that can be obtained. The SWE subtest includes real words and the PDE subtest is composed of pseudowords. Administration of each subtest takes approximately 2-4 minutes. Both subtests include a practice list of words with separate directions that emphasize speed of reading. The directions for the SWE subtest are written on the test booklet and read, "I want you to read some lists of words as fast as you can. Let's start with this practice list. Begin at the top and read the down the list as fast as you can. If you come to a word you cannot read, just skip it and go to the next word. Use your finger to help keep your place if you want to," (Torgesen, Wagner, & Rashotte, 2012). The student completes the list of practice words and then receives instructions for the subtest.

"Ok, now you will read some longer lists of words. The words start out pretty easy but they get harder as you go along. Read as many words as fast as you can until I tell you to stop. Begin here and read down the list before you start on the next list. Read the words in order, but if you come to one you can't read, skip it and go to the next one. Use your finger to help keep your place if you want to, and if you skip more than one word, point to the word you are reading next. Do you understand? Ok, you will begin as soon as I turn over the card," (Torgesen, Wagner, & Rashotte, 2012).

Words increase in difficulty and there is no ceiling rule to discontinue either subtest; however, if the individual cannot name any more words, the test is discontinued.

The directions for the PDE subtest are written on the test booklet, and are the same, except the words are called made-up words. The individual's raw score is the total number of words read correctly within 45 seconds for SWE, PDE, and TWRE, represented by a single standard score for each with a mean of 100 and standard deviation of 15.

### **Procedures**

Two graduate assistants and Erin Alexander, the Assistant Director for Clinical Services, collected archival data for this study from existing files at the Tennessee Center for the Study and Treatment of Dyslexia. The staff gathered files for 100 participants who were assessed at the center between September 2013 and May 2015 when the current battery of tests was first implemented. All participants had been administered the TOWRE-2 and WIAT-III on the same day. Fifty files were chosen at random that met the time frame criterion from those diagnosed with dyslexia, as well as 50 files chosen at random from those without dyslexia.

Since the data was de-identified, the staff assigned an identification number for each participant to keep track of which children were included in the study and to allow for an accuracy check. Accuracy of data was determined by a fourth staff member checking every fifth entry. Information collected included the relevant results from the WIAT-III and TOWRE-2, whether the child was diagnosed with dyslexia or not and age and gender. Demographic descriptive statistics are provided in Table 1.



Table 1

*Participant Demographics*

	<i>Variable</i>	<i>N</i>
Gender	Male	53
	Female	47
Age Group (years)	6-9	44
	10-13	46
	14-17	10
Dyslexic	Yes	50
	No	50

---

*N* = 100

## CHAPTER III

### RESULTS

#### Inter-Rater Reliability

A fourth staff member at the center checked every fifth entry for discrepancies between the scores listed in the file and the scores that were included on the de-identified list of data. Inter-rater reliability was found to be 90%. Two errors were found, and I corrected them in my data set before I tested the hypotheses.

#### Hypothesis Testing

**Hypothesis 1.** I predicted that the mean scores from the TOWRE-2 Total Word Reading Efficiency (TWRE) composite and WIAT-III Basic Reading Composite (BRC) for participants with and without a diagnosis of dyslexia would be significantly lower than the test mean ( $M = 100$ ). Four one-sample  $t$  tests were used to compare group means to the test mean for both the dyslexic and non-dyslexic groups for measures on both tests. Table 2 provides descriptive statistics for each measure.

Table 2

<i>Measure Descriptive Statistics</i>			
<i>Variable</i>	<i>M</i>	<i>SD</i>	<i>SE</i>
TOWRE-2 TWRE			
Dyslexic*	74.04	9.48	1.34
Not Dyslexic**	91.22	10.25	1.45
WIAT-III BRC			
Dyslexic*	79.76	8.35	1.18
Not Dyslexic**	94.64	8.73	1.23

\* $N = 50$

\*\* $N = 50$

The mean score for the TOWRE-2 TWRE diagnosed ( $M = 74.04$ ,  $SD = 9.48$ ) was significantly different from the published test mean,  $t(49) = -19.36$ ,  $p < .01$ . The mean score also was significantly different for those in the non-dyslexic group ( $M = 91.22$ ,  $SD = 10.25$ ),  $t(49) = -6.05$ ,  $p < .01$ . The mean score for the WIAT-III diagnosed ( $M = 79.76$ ,  $SD = 8.35$ ) group was significantly different from the published test mean,  $t(49) = -17.14$ ,  $p < .01$ . The mean score for the non-dyslexic group ( $M = 94.64$ ,  $SD = 8.73$ ) was also significantly different,  $t(49) = -4.34$ ,  $p < .01$ . The data supports Hypothesis 1. The study means for the dyslexic and non-dyslexic groups for both the TOWRE-2 TWRE and WIAT-III BRC were significantly different from the published test mean ( $M = 100$ ). This indicates that in this sample, participants' performance was different from average. Thus, both dyslexic and non-dyslexic group scores reflect some degree of reading difficulty.

**Hypothesis 2.** I predicted that the mean scores for the TOWRE-2 TWRE and the WIAT-III BRC would be significantly different between participants with and without dyslexia. The means were analyzed using two independent samples  $t$  tests. Results indicated that there was a significant difference between the dyslexic and non-dyslexic groups for the TOWRE-2 TWRE,  $t(98) = -8.70$ ,  $p < .01$ . There was also a significant difference between the dyslexic and non-dyslexic groups for the WIAT-III BRC,  $t(98) = -8.71$ ,  $p < .01$ . The data supports Hypothesis 2. The significant difference between these groups indicates that both tests can adequately discriminate between those with skill deficits characteristic of dyslexia and those without.

**Hypothesis 3.** I predicted that the TOWRE-2 TWRE mean would be significantly different from the WIAT-III BRC for participants with and without a diagnosis of dyslexia. Upon visual inspection, it appeared that the TOWRE-2 scores were consistently lower than WIAT-III scores. To test this hypothesis, data was analyzed in 2 paired sample *t* tests.

The first paired samples *t* test compared the mean scores for children with dyslexia ( $N = 50$ ) on the TOWRE-2 TWRE ( $M = 74.04, SD = 9.48$ ) and WIAT-III BRC ( $M = 79.76, SD = 8.35$ ). The results of this *t* test indicated a significant difference between the means of these two assessments for children with dyslexia,  $t(49) = -4.23, p < .01$ . There is a moderate positive correlation between TOWRE-2 TWRE and WIAT-III BRC mean scores for children diagnosed with dyslexia ( $r = .433, p < .01$ ).

The second paired samples *t* test compared the mean scores for children without dyslexia ( $N = 50$ ) on the TOWRE-2 TWRE ( $M = 91.22, SD = 10.25$ ) and WIAT-III BRC ( $M = 94.64, SD = 8.72$ ). The results of this *t* test indicated a significant difference between the means of these two assessments for non-dyslexic children,  $t(49) = -2.88, p < .01$ . There is a significant positive correlation between TOWRE-2 and WIAT-III mean scores for non-dyslexic children ( $r = .619, p < .001$ ). The assessment scores are correlated; however, there is still a significant difference between scores for each group.

## CHAPTER IV

### DISCUSSION

I worked as a graduate assistant at the Tennessee Center for the Study and Treatment of Dyslexia for 2 years. One full evaluation at the center takes approximately 4 hours and includes between 6 and 8 assessments that target specific skill deficits associated with dyslexia. This testing is in addition to a battery of tests (e.g., IQ, reading achievement, language) that most students receive at school prior to being referred to and assessed at the center. Many students experience fatigue from these intensive evaluation procedures and I have seen first hand the adverse effects of fatigue on the assessment process. Some children comment that they are tired during the afternoon portion of testing and ask how much they have left repeatedly. It was also my observation that for many of our clients, their TOWRE-2 Total Word Reading Efficiency (TWRE) scores were lower than their WIAT-III Basic Reading Composite (BRC) scores no matter whether both were given in the morning session or one in the morning and one in the afternoon session. Additionally, the word reading and pseudoword decoding skills subtests on the WIAT-III take significantly more time to administer than the TOWRE-2 subtests. Therefore, instead of using two assessments that investigate word reading and decoding, why not administer a single assessment (i.e., TOWRE-2 TWRE) that incorporates both accuracy and fluency? These observations in combination with my understanding that accurate and fluent word decoding are core characteristics of dyslexia (International Dyslexia Association, 2002) prompted me to test my ideas in the current

study that the TOWRE-2 subtests alone would be a sufficient component in the assessment battery. The results of the current study provide some support for my ideas that have practical implications for assessment of dyslexia.

This pattern I had observed held true for many of the participants in the current study. Out of all 100 participants, there were 29 instances where the TOWRE-2 score was 10 or more points lower than the WIAT-III score, and only 4 instances where the WIAT-III score was 10 or more points lower than the TOWRE-2 score. I predicted that the means between the dyslexic and non-dyslexic groups for the TOWRE-2 and the WIAT-III would be significantly different. The results show that this was true, as there was a significant difference between mean scores on both assessments for the dyslexic and non-dyslexic groups. This suggests that these measures are valid indicators of decoding differences seen in the two groups. I predicted that both groups scores would be lower than the test published mean and this hypothesis also was supported suggesting that the referral process is valid and students with reading difficulties are the ones served at the Center for Dyslexia.

I also predicted that the mean scores on the TOWRE-2 would be significantly different than the mean scores on the WIAT-III and data supported this hypothesis. The average TOWRE-2 score of 74.04 was significantly lower than the average WIAT-III score of 79.76 for the diagnosed group. The average TOWRE-2 score of 91.22 was significantly lower than the average WIAT-III score of 94.64 for the non-dyslexic group. The WIAT-III scores may overestimate the decoding abilities of a child by not including

the fluency component. This inflation may lead to a false negative (i.e., dyslexia not being diagnosed when characteristics are present), particularly if there is a discrepancy between the WIAT-III and TOWRE-2 scores. Discrepancies can cause confusion (i.e., results are not pointing in a consistent direction) and may even lead to more testing. By using only one assessment that is a reliable test of a specific skill, this discrepancy and further testing may be avoided. An added benefit is that testing time would be reduced, lessening the negative impact of fatigue on the child, limit redundancy and save staff time in administration, interpretation and report writing. Further, because the TOWRE-2 scores were lower for both the diagnosed and non-diagnosed groups, use of this score would provide the lowest estimate of decoding ability and possibly limit false negatives. Keep in mind that TOWRE-2 scores are only one piece of assessment information considered when making a diagnostic determination so low scores alone would not sway a diagnostic decision. My recommendation would be to use *only* the TOWRE-2 because it is more time efficient and assesses both fluency and accuracy, core deficits associated with dyslexia.

Finally, although it would be more efficient to use only the TOWRE-2, using both could provide different information. When considering the WIAT-III, children have ample time to decode and read words without time pressure. The child has time to use their decoding skills and read as many words as possible, no matter how long it takes them. An argument could be made that using both measures provides different information, although only the TOWRE-2 includes fluency.

### **Limitations of the Study**

The implications of this study are primarily relevant to the Center for Dyslexia; however, school districts and dyslexia assessment specialists with parallel diagnostic procedures in place may find these results applicable. The decisions about diagnoses are made by trained center staff including background history, teacher and parent information, progress monitoring data, and assessment results. There are no clear-cut score cut-offs for diagnosing dyslexia. Much of the diagnostic decision-making is based on clinical judgment in regards to how low scores need to be to warrant a diagnosis. Further, there is no inter-rater reliability check for diagnoses at the Center for Dyslexia so the integrity of the diagnosis may be disputed by other experts. Additionally, some of the diagnoses may have been different if only the information from the TOWRE-2 had been used. Finally, sometimes word reading and decoding scores can be higher while phonological awareness is low as a result of high quality intervention. This study did not control for previous interventions or other possible comorbid diagnoses, such as Attention Deficit Hyperactivity Disorder (ADHD) or Language Impairment (LI).

### **Future Research**

The fluency percentiles on the WIAT-III were not included in this study. It is possible that the WIAT-III fluency percentiles in combination with the composite score can predict dyslexia as accurately as the singular TOWRE-2 composite score. Another option for comparing these assessments is by separating the composite scores into subtest scores. For instance, comparing the TOWRE-2 Sight Word Efficiency score to the



WIAT-III Word Reading score, and the TOWRE-2 Pseudoword Decoding Efficiency score to the WIAT-III Pseudoword Decoding score. Comparing the means of the subtests, instead of the composite means in this study, may produce different results.

Finally, although it would be more efficient to use only the TOWRE-2, using both could provide different information. When considering the WIAT-III, children have ample time to decode and read words without time pressure. The child has time to use their decoding skills and read as many words as possible, no matter how long it takes them. This could provide a realistic picture of what reading is like for the child. An argument could be made that using both measures provides different information, although only the TOWRE-2 includes fluency within the standard score.

A next step for researchers would be to investigate whether using either the TOWRE-2 alone would yield the same diagnostic decision as using both tests. This would involve reviewing all assessment data and not just scores from the 2 subtests. It would also be important to test the validity of the current diagnosis by having a different trained assessor to confirm that a correct decision was made. If diagnostic decisions held, this would provide more conclusive evidence that the TOWRE-2 alone is not only adequate but a more efficient testing practice that can save an examiner time, reduce student fatigue and possibly support more accurate diagnoses.

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**APPENDICES**

APPENDIX A: Consent Form

Tennessee Center for the Study and Treatment of Dyslexia  
MTSU P.O. Box 397  
Murfreesboro, Tennessee 37132  
Office: (615) 494 8880 • Fax: (615) 494-8881  
E-mail: dyslexia@mtsu.edu • www.mtsu.edu/dyslexia



Parent’s Commitment to Assessment

Assessment involves an evaluation of a student’s reading and spelling skills. To provide this service most efficiently, we will need your commitment to the process that will enable the Center to serve the maximum number of children:

1. **Assessment appointments must be kept** unless a request for change in appointment is made in advance, or in an emergency. The Center must be notified of any requested change a week in advance (or immediately should an emergency occur).
2. The Center is engaged in research and continuous study of dyslexia. Your child’s test scores may be used for research. At no time will a child’s name be used publicly without an additional release in writing.
3. The Center is a training facility. Therefore, your child’s assessment could be conducted by a graduate student. Our graduate assistants have received thorough training in procedures for identifying dyslexia, and if your child is tested by a graduate student, the evaluation process will be supervised by the Center’s Assistant Director for Clinical Services. This supervisor will carefully review your child’s case before testing, will consult on interpretation of test results, and will review the written report of findings before the report is prepared for mailing.

If you understand and accept these conditions for assessment, kindly sign the statement below and return it to the Center.

Re: \_\_\_\_\_  
(Student’s Name)

I understand and agree with the above commitment to assessment.

\_\_\_\_\_  
Parent’s / Legal Guardian’s Signature

\_\_\_\_\_  
Date

APPENDIX B: IRB Approval

**IRB**  
**INSTITUTIONAL REVIEW BOARD**  
 Office of Research Compliance,  
 010A Sam Ingram Building,  
 2269 Middle Tennessee Blvd  
 Murfreesboro, TN 37129



IRBN007 – EXEMPTION DETERMINATION NOTICE

Thursday, September 29, 2016

Investigator(s): Morgan Griffith; Dr. Monica Wallace  
 Investigator(s) Email(s): meg5r@mtmail.mtsu.edu; monica.wallace@mtsu.edu  
 Department: Psychology

Study Title: DEGREE OF PREDICTION OF DYSLEXIA USING THE TEST OF WORD READING EFFICIENCY- SECOND EDITION (TOWRE-2) AND THE WECHSLER INDIVIDUAL ACHIEVEMENT TEST- THIRD EDITION (WIAT-III)  
 Protocol ID: 17-1037

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category (4) *Study involving existing data*. A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	EXEMPT from further IRB review***	
Date of expiration	<b>NOT APPLICABLE</b>	
Participant Size	100	
Participant Pool	<b>Existing data</b>	
Mandatory Restrictions	Only existing de-identified data covered by the approved permission letter may be used	
Additional Restrictions	<b>No new data will be collected on minors &lt;18 years of age.</b>	
Comments		
Amendments	<b>Date</b>	<b>Post-Approval Amendments</b>

\*\*\*This exemption determination only allows above defined protocol from further IRB review such as continuing review. However, the following post-approval requirements still apply:

- Addition/removal of subject population should not be implemented without IRB approval
- Change in investigators must be notified and approved
- Modifications to procedures must be clearly articulated in an addendum request and the proposed changes must not be incorporated without an approval
- Be advised that the proposed change must comply within the requirements for exemption
- Changes to the research location must be approved – appropriate permission letter(s) from external institutions must accompany the addendum request form

- Changes to funding source must be notified via email ([irb\\_submissions@mtsu.edu](mailto:irb_submissions@mtsu.edu))
- The exemption does not expire as long as the protocol is in good standing
- Project completion must be reported via email ([irb\\_submissions@mtsu.edu](mailto:irb_submissions@mtsu.edu))
- Research-related injuries to the participants and other events must be reported within 48 hours of such events to [compliance@mtsu.edu](mailto:compliance@mtsu.edu)

The current MTSU IRB policies allow the investigators to make the following types of changes to this protocol without the need to report to the Office of Compliance, as long as the proposed changes do not result in the cancellation of the protocols eligibility for exemption:

- Editorial and minor administrative revisions to the consent form or other study documents
- Increasing/decreasing the participant size

The investigator(s) indicated in this notification should read and abide by all applicable post-approval conditions imposed with this approval. [Refer to the post-approval guidelines posted in the MTSU IRB's website.](#) Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident.

All of the research-related records, which include signed consent forms, current & past investigator information, training certificates, survey instruments and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board  
Middle Tennessee State University

Quick Links:

[Click here](#) for a detailed list of the post-approval responsibilities.  
More information on exempt procedures can be found [here](#).