

12-2017

Examining the Role of Orthographic Coding Ability in Elementary Students With Previously Identified Reading Disability, Speech or Language Impairment, or Comorbid Language and Learning Disabilities

Erin K. Haugh

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EXAMINING THE ROLE OF ORTHOGRAPHIC CODING ABILITY IN ELEMENTARY STUDENTS
WITH PREVIOUSLY IDENTIFIED READING DISABILITY, SPEECH OR LANGUAGE
IMPAIRMENT, OR COMORBID LANGUAGE AND LEARNING DISABILITIES

A Dissertation

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Doctor of Education

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December 2017

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Title: Examining the Role of Orthographic Coding Ability in Elementary Students with Previously Identified Reading Disability, Speech or Language Impairment, or Comorbid Language and Learning Disabilities

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The purpose of this study was to examine the role orthographic coding might play in distinguishing between membership in groups of language-based disability types. The sample consisted of 36 second and third-grade subjects who were administered the PAL-II Receptive Coding and Word Choice Accuracy subtest as a measure of orthographic coding ability. Disability groups included No Disability, Reading SLD, and Speech or Language Impairment. Results showed that orthographic coding ability was correlated with measures of early literacy skills in both the second and third grade samples. With both functions included, results of the Wilks-Lambda reveal a significant relationship between predictors and groups. Results show that Orthographic Coding Ability adds to the ability to differentiate between the groups. Results revealed that 89.5% percent of membership in the No Disability group was correctly predicted by the model.

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank my committee members: Dr. Black, Dr. Runge, and Dr. Staszkievicz. Dr. Black, your thoughtful comments reminded me that my work is important and relevant. Your encouragement helped me to keep things in perspective during challenging times. Dr. Runge, the time and attention you spent reviewing my manuscript helped make this product far greater than it would have been otherwise. Thank you for challenging me to find the answers on my own. Dr. Staszkievicz, thank you for offering me compliments and encouragement just when I needed them the most. You helped me to understand difficult statistical concepts, without which this project would not have been possible.

Above all, I would like to thank my committee chair, Dr. Mark McGowan, for his endless patience and guidance. There are many times throughout this process when I felt overwhelmed. You patiently handled my emails, phone calls, and many, many drafts. Thank you for constantly pushing me to the next level. This work would not exist without you.

Finally, I would like to thank my friends and family for their constant support and patience over the past decade. You have my love and gratitude. To my colleagues and fellow educators, your work with children inspires me daily. Thank you Mom and Dad, for your emotional support and for helping me to stuff all those envelopes. Finally, I would like to thank Dr. Stuart Badner, my esteemed colleague and mentor. You helped me to overcome countless professional challenges. I aspire to develop the kind, patient, and knowledgeable approach that you use when working with students and families.

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CHAPTER 1

INTRODUCTION

The ability to read involves a series of language-based skills (Catts, Fey, Tomblin, & Zhang, 2002). Due to the language demands associated with reading, overlap often exists between learning disabilities in reading and speech and language impairments (Lichtenstein, 2008). A robust body of work supports the notion that humans are predisposed to language acquisition (see Everaert, Huybregts, Chomsky, Berwick, & Bolhuis, 2015). Human capacity to acquire language is based on what Everaert et al. (2015) refer to as “shared biological properties” (p. 731). In other words, the development of language is considered by many experts to be innate. According to Chomsky (2013), infants acquire information about properties of language very quickly, even prenatally. Smith (2011) also speaks to the innate nature of language, stating that “language learners come to the language acquisition task with some expectations about the nature of the system they are attempting to learn” (p. 262).

This chapter begins with a discussion of language and reading in elementary students. Research regarding the acquisition of language, language impairment and the development of literacy, and the acquisition of reading skills will be presented. Subsequently, language and learning disabilities will be explored, including the relationship between learning disability, dyslexia, reading, and specific language impairment. This will be followed by a more detailed presentation of the link between language and reading. Next, specific learning disabilities in reading will be examined through the lens of the dual-route model in reading. This discussion will include

information on the educational implications of learning disability and approaches to Specific Learning Disability (SLD) identification. The efficacy of using orthographic processing deficit as a possible *marker* for these disability types will also be discussed. Finally, the chapter will also provide a statement of the problem, problem significance, research questions, and definition of terms.

Language and Reading Development in Elementary Students

Acquisition of Language

Language acquisition is a complex cognitive process that relies on children's experiences, interactions, and interpretation of meaning in the world around them. Toddlers first demonstrate knowledge of this meaning by assigning words to objects in their environment. Subsequently, spoken words are formed when phonemes are combined into a meaningful whole (Sattler & Hoge, 2006). According to Torgesen and Wagner (1998), phonemes are the smallest units of sound in a word that can change its meaning. Language acquisition relies on the successful development of a number of component skills. According to Bloom (2000), children build vocabulary by relying on their learning and memory capacities, their ability to infer the intentions of others, and their ability to acquire concepts. In order for language to develop properly, these factors must work seamlessly together.

Language Impairment and Learning to Read

Language ability establishes the foundation for acquiring reading skills. According to Rathvon (2004), oral language consists of five basic components: phonology (the sound system), semantics (meaning), morphology (word structure),

syntax (sentence structure), and pragmatics (usage; p. 100). When there is a problem in a child's acquisition or use of language, this deficit can also translate into impairment in a child's ability to read. According to Freed, Adams, and Lockton (2011), children with specific language impairment often have difficulty acquiring language despite normal levels of intelligence. Cohen, Morgan, Vaughn, Riccio, and Hall (1999) found that children with certain types of reading impairment performed poorly on verbal fluency. Tambyraja, Farquharson, Logan, and Justice (2015) added that deficits in phonological processing are a key contributor in students identified with language impairment who also subsequently develop poor reading skills.

Unlike language, the ability to read is not innate. Children must be taught how to read. According to the work of the SEDL (2001), a child's ability to comprehend what they are reading is equally dependent on language comprehension and decoding skills. The model proposed by SEDL contains two legs; one consists of decoding skills and the other of language comprehension skills. Reading comprehension cannot develop appropriately if skills from either leg are missing.

Acquisition of Literacy Skills

Reading is a skill that people use in order to decipher the code of written language. Word recognition, fluency, and automaticity are all important components of literacy acquisition (Aaron, Joshi, & Williams, 1999). Learning how to read also requires developing the ability to segment spoken language into phonemes, or smaller pieces. In order to become effective readers, children must learn to identify letters, develop vocabulary, recognize the relationship between print and corresponding sounds, extract

meaning from words, and rapidly recognize whole words (Shaywitz & Shaywitz, 2008). According to Shaywitz and Shaywitz (2008), when first learning to read, children must also be taught how to map letters (i.e., orthographic processing) to sound (i.e., the phonemic processing).

The progression of early reading skills can be broken down into a number of developmental phases, as discussed by Moats (1998). In the first phase, known as logographic reading, children can identify words by a visual cue, but have not yet acquired the notion that letters correspond to speech sounds. The second phase, known as novice or early alphabetic reading, involves learning that letters represent phonemes. In the third phase, the mature alphabetic phase, children begin to learn how to use sound-spelling to decode simple words. Sound-spelling occurs when children are familiar with letter-sound correspondences for basic words and can use them when decoding simple words. In the fourth and final phase, the orthographic stage, children further solidify sound-symbol associations in order to enhance fluency (Moats, 1998).

Comorbid Language and Learning Disabilities

The work of Catts et al. (2002) demonstrated that students with language impairments in Kindergarten were at higher risk for developing reading impairments later in school. Comorbid language and learning disabilities can have a significant negative impact on learning. For instance, Sattler and Hoge (2006) indicate that children with co-occurring disorders tend to have more complex and persistent problems than children with only a single disorder. McArthur, Hogben, Edwards, Heath and Mengler (2000) found that 55% percent of children with a reading disability also

exhibited impaired oral language, and 51% of children with language impairment also demonstrated impaired reading skills. Of even greater concern, the work of McArthur et al. (2000) revealed that half of the population with a reading disability may not be receiving the appropriate interventions in their schools or clinics.

Catts et al. (2002) found that 52.9% of students initially diagnosed with a language impairment also later met the criteria for a reading disability in second grade. In fourth grade, 48.1% of students with language impairment also later met the criteria for reading disability. In both grade levels, approximately half of the sample of students identified with language impairments would also subsequently meet the criteria for a reading disability. Conversely, only 8.6% of second grade and 8.2% of fourth graders without language impairment later met the criteria for a reading disability. Based upon these findings, estimates suggest that students with language impairments were six times more likely than non language-impaired peers to show later reading disabilities. These disabilities might impact a child's ability to decipher written code, read words, or comprehend text.

Exploring the Constructs of SLD and Dyslexia: Distinct or Interchangeable Terms?

According to Hale and Fiorello (2004), a specific learning disability (SLD) refers to a processing disorder that results in academic deficits that cannot be better explained by another disadvantage. Lichtenstein (2008) notes that half of all students who receive special education are identified with a specific learning disability. According to the Individuals with Disabilities Education Act (IDEA 2004) regulations, "the term 'specific learning disability' means a disorder in one or more of the basic psychological processes

involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations” (Individuals with Disabilities Education Act, 2004 Sec. 602(30)(A-C)). Furthermore, IDEA regulations allow for identification of learning disabilities in three areas of reading: basic reading, reading fluency, and reading comprehension. According to Lichtenstein (2008), a specific learning disability must impact a specific feature of learning, while other cognitive functions remain unaffected. In other words, SLD are unique from general cognitive deficits in that they negatively impact a specific aspect of learning. Furthermore, 80% or more of students with SLD identification have the SLD in the area of reading (Lichtenstein, 2008).

A wealth of research examining dyslexia and its subtypes exists in the literature today. Lyon, Shaywitz, and Shaywitz (2003) describe dyslexia as difficulty with accurate or fluent word recognition, as well as by poor spelling and decoding abilities. Most relevant to the current research are the subtypes of phonological dyslexia and orthographic dyslexia. According to Miller (2007), phonological dyslexia is characterized by over reliance on memorizing a whole word “as seen in space” (p. 280) rather than decoding it phonetically. Phonological dyslexia is characterized by strong whole word reading and poor phonetic reading. Wang, Yang, Tasi, and Chan (2013) indicate that orthographic dyslexia is characterized specifically by deficits in the area of orthography, i.e., performing worse in aspects of reading involving visual information.

The terms reading disability, specific learning disability, and dyslexia are very commonly utilized in education today. In fact, Lichtenstein (2008) notes that the terms

dyslexia and reading disability are used interchangeably. According to Flanagan, Ortiz, Alfonso, and Dynda (2006), however, failure to use a common language and clearly communicate across disciplines has resulted in confusion when defining reading disabilities. Furthermore, this ambiguity has made it difficult to ascertain whether debates in SLD are substantive or simply semantic in nature. Educators and consumers should apply caution when supposing that the terms SLD and dyslexia are interchangeable. While SLD is an educational definition used by school psychologists and educators within the framework of IDEA, dyslexia is a term used to characterize performance deficits in reading.

Thus, it is important to clarify meaningful distinctions between Reading SLD and dyslexia. Dickman (2008) speculates on the hesitation of school districts to utilize the term dyslexia, which he refers to as “the ‘D’ word,” (p. 5). Furthermore, Dickman postulates that SLD is essentially a level of classification. Not all children with SLD have the same needs, nor will they benefit from uniform intervention types. In order to best meet the needs of children with reading disabilities, educators must analyze specific skill deficits to understand the root cause of the reading problem. As Dickman eloquently notes, “SLD is the zip code, dyslexia is the street; research is just beginning to distinguish one house from the next” (p. 5).

Relationship Between SLD in Reading and Specific Language Impairment

Some research has examined whether specific language impairment (SLI) and dyslexia can truly be defined as distinct disorders (Catts, Adlof, Hogan, & Weismer, 2005). Lichtenstein states that because learning disabilities are primarily language-

based, there is a commonality between learning disability and speech and language impairment (2008). According to Catts et al. (2005), “at first glance, it would seem that SLI and dyslexia are two distinct developmental language disorders; SLI primarily represented by difficulties in semantics, syntax, and discourse, and dyslexia characterized by problems in phonological processing and word reading” (p. 1378).

Catts et al. (2005) propose the use of three models to distinguish the relationship between Learning Disability (LD) in reading and Specific Language Impairment (SLI). The first model takes into account the severity of a child’s phonological processing deficit when examining the differences between dyslexia and SLI, which it considers to be one cognitive deficit that manifests in different ways. For instance, phonological processing deficits might include deficits in phonological awareness and phonological memory. The second model considers dyslexia and SLI as distinct disorders, with phonological processing contributing to both the SLI and dyslexia but with other cognitive deficits contributing to only the SLI. The third model indicates that phonological processing deficit contributes to dyslexia only and that the SLI is better construed as the result of other distinct cognitive deficits (Catts et al., 2005).

Lexical and Non-Lexical Routes: An Introduction to the Dual Route Model of Reading

The work of Coltheart, Rastle, Perry, & Langdon (2001) has shown that children learn to read using both lexical and non-lexical routes. According to Castles (2006), the lexical route involves reading by using a pre-existing store of “previously seen written words (p. 50),” more commonly known as a lexicon. The non-lexical route, on the other

hand, utilizes a set of rules to convert graphemes (the written form of words) to phonemes (the spoken form of words).

Romani, Di Betta, and Tsouknida (2008) report that children present with different reading and spelling difficulties depending on the route in which their deficit lies. Romani et al. (2008) add that it is helpful to postulate that difficulties with different capacities of reading result in differential dyslexic profiles. However, though an examination of the subtypes of dyslexia is an important step in characterizing and conceptualizing reading deficits, an understanding of these deficits alone is not sufficient in identifying a child with an SLD in a school setting. Though both SLD and dyslexia involve deficits in psychological processes, the constructs of SLD and dyslexia should not be used interchangeably, as the term dyslexia is used to characterize a type of performance deficit and SLD refers to an eligibility area under IDEA. When determining if a child meets eligibility criteria for SLD, school personnel should consider not only how a child's dyslexia, or processing impairment, impacts reading ability, but also how the impairment manifests itself in a way that impedes academic functioning in the school setting.

Castles (2006) cautions that heavy reliance on one route versus the other might result in a series of potential issues. Readers who rely heavily on the lexical route, for instance, might have trouble adequately decoding unfamiliar words or non-words. Readers who rely primarily on the non-lexical route, on the other hand, might make errors decoding irregular words that do not follow typical language rules. According to

Romani et al. (2008), when grapheme-phoneme connections are not appropriately developed, children will struggle to convert written words into spoken ones.

The dual-route model proposes that subtypes of dyslexia should be identifiable within the reading-impaired population (Castles, 2006). Reading is a complex skill that involves many processes. Orthography is a single process, one piece of the larger puzzle of literacy. As posited by Castles (2006), impairment in either the lexical or non-lexical routes might result in differential impairment profiles. Orthography can be defined as “a system of printed symbols for representing the speech sounds in a written language,” (Rathvon, 2004, p. 92). Therefore, a primary goal of the current study is to establish the role of orthography, as a process, in the development of second and third grade students’ reading and language abilities.

Educational Implications of Reading Impairment

According to a publication from the National Center for Learning Disabilities (2014), specific learning disability represents the largest category of students who receive special education services. In 2014, there were nearly two and a half million students in American public schools who met criteria for SLD under the Individuals with Disabilities Education Act (IDEA). However, the report also states that the number of students identified with SLD has decreased by 18% between the years of 2002 and 2011. The National Center for Learning Disabilities (2014) attributes this decrease to improved reading instruction and changes in the way that educators identify SLD.

According to Munro (1995), successful readers process text at a word, sentence, and conceptual/topic level. Children who have difficulty with reading may display this

difficulty at one or more of these levels. Munro (1995) indicated that struggling readers have not yet developed knowledge of more complex letter patterns. Munro's (1995) work also suggests that orthographic knowledge is lower in readers with dyslexia than with non-dyslexic peers. He found that dyslexic readers were able to read shorter words more quickly than longer words. Orthographic structure of a word influenced dyslexic readers' ability to read it. Dyslexic readers were also more likely to attempt to identify words by using a single letter. Finally, dyslexic readers were more likely than non-dyslexic readers to make errors as a result of focusing on individual letters rather than groups of letters. In addition, the likelihood of this type of error increased as word length increased (Munro, 1995).

There are a number of long-term implications for students with Reading SLD as they enter secondary school. According to the National Center for Learning Disabilities, "between 7 percent to 23 percent of secondary students with LD received very below-average scores on academic performance, compared with only 2 percent of students in the general population" (2014, p. 16). Also, the National Center for Learning Disabilities reports that one-third of students with learning disabilities have been held back at least one time (2014).

Approaches to SLD Identification

A review of the literature reveals that there are a number of ways in which educators might determine if a child meets criteria for SLD. However, Hale and Fiorello (2004) discuss current confusion in the field regarding reading deficits, reading delays, and resulting learning problems. The authors question how children with learning

delays and true learning deficits should be distinguished from each other. Hale and Fiorello (2004) propose that children with learning disabilities are a heterogeneous group. According to Castles (2006), it is unlikely that only one type of reading disability exists. Reading is a complex process. As a result, there are many ways in which children might fail to acquire adequate reading skills. Additionally, though Castles acknowledges the importance of describing subtypes of reading disability, she cautions that descriptive-only models fail to provide understanding as to why or how children read in a particular way. Flanagan et al. (2006) highlight the following commonalities in SLD definitions: history of academic difficulty, identified academic deficit, use of pre-referral interventions, identifiable cognitive or processing deficits, underachievement, intact cognitive ability in areas that are not directly related to the academic deficit, functional impairment, and an evaluation of exclusionary factors.

Shaywitz, Fletcher, Holahan, and Shaywitz (1992) examined whether children who met the criteria for SLD under the discrepancy approach differ cognitively and behaviorally than students who have met criteria for a disability diagnosis based on commensurately low ability and reading achievement. In order to examine differences, Shaywitz et al. (1992) compared three groups of second grade students comprising one who met criteria for learning disability utilizing a discrepancy approach, another who met criteria based on low achievement, and a third group of contrast students who were not reading disabled. Four hundred forty-five students met criteria for participation. The sample was followed longitudinally from Kindergarten through ninth grade.

For the purposes of their study, Shaywitz et al. (1992) assessed children with a variety of cognitive, academic, and behavioral domains. At the beginning of the study, participants' parents completed the Yale Children's Inventory (YCI) to gather information on family, developmental, medical, and social history. In addition, parents completed a follow-up of the YCI at the end of second and fourth grades. Kindergarten performance was assessed utilizing the Kindergarten Early Learning Profile. Likewise, classroom performance was assessed using the Multigrade Inventory for Teachers. At the end of the school year, the End of the Year Evaluation was used to gather information about placement meetings, special services, and various educational recommendations. Finally, ability and achievement were assessed using the Wechsler Intelligence Scale for Children-Revised (WISC-R) and the reading and math subtest of the Woodcock Johnson Psychoeducational Battery-Part II, respectively. Self-concept, self-esteem, and perceived competence were measured with Harter's Perceived Competence Scales (Shaywitz et al., 1992).

Shaywitz et al. (1992) found that children identified via a discrepancy approach and via a low achievement approach exhibited a number of similarities. More specifically, similarities were observed in the areas of medical history, motor functioning, visual perception, and teacher assessment of learning and behavior. However, some differences were noted as well. For instance, the discrepancy group exhibited higher full scale, verbal, and performance IQ scores and higher reading performance in second grade. Children who met disability criteria with a discrepancy

approach also showed better prognosis than did students identified with both low ability and achievement.

Shaywitz et al. (1992) point out important factors to consider when utilizing the discrepancy approach. If only a simple difference is utilized, children with above average IQs will tend to be over identified and children with low average IQs will be under identified. The researchers proposed that children with dyslexia also exhibit language deficits, particularly in the area of phonological processing. Furthermore, the researchers hypothesize that phonological processing is integral to reading and reading disability, regardless of how disability is defined.

Subsequent to the development of the Individuals with Disabilities Education Act (IDEA), 58 Expert Panel participants initiated the White Paper project to address concerns with IDEA legislation brought forth by the Learning Disabilities Association (LDA) of America. The White Paper was designed to provide guidance and information to not only the federal government, but also to practitioners, the general public, and professional organizations (Hale et al., 2010). The panel revealed five key points with regard to the treatment of SLD in the IDEA legislation. These key points are summarized as follows:

1. Maintain the SLD definition and strengthen requirements in the SLD identification process;
2. Neither Response to Intervention (RtI) nor an ability-achievement discrepancy are alone sufficient in identification of SLD;

3. In order to meet identification criteria, students must also exhibit a pattern of strengths and weaknesses and achievement consistent with these processing deficits;
4. RtI can be utilized in order to help prevent learning problems; however, children must undergo a comprehensive evaluation in order to be identified for SLD;
5. Cognitive and neuropsychological assessment can be used not only for SLD identification, but also to identify possible interventions.

In summary, the White Paper concluded that: “Both RTI and comprehensive evaluation of psychological processes that take into account ability and achievement are needed to optimize service delivery for children with and without SLD” (Hale et al., 2010, p. 231).

Orthographic Processing Deficit as a Possible Marker for Disability

The goal of the current research was to evaluate the possible link between orthographic coding skills and language and learning disabilities. The definition of orthography itself infers a relationship between specific language impairment and specific learning disability. Rathvon (2004) indicated that orthographic awareness involves knowledge of the written symbols, which represent speech sounds. Therefore, orthographic coding can be defined as “the use of word-specific patterns to aid in word recognition and pronunciation” (Pennington & Bishop, 2009, p. 292). According to Breznitz (2003), “the orthographic system operates via the visual route and processes information in a more holistic manner” (p. 184). When a child develops the ability to fluently associate a word’s visual appearance (i.e., its unique word specific pattern) to its pronunciation, they lay the groundwork for enhancing sight word recognition by

improving memory for spelling patterns. Rathvon (2004) refers to this concept as “unitized orthographic representation” (p. 92).

Munro (1995) indicates that readers who can only represent graphic information at a “single letter level” will recognize words less efficiently than those who are able to recognize “multi-letter clusters,” (p. 3). Munro (1995) elaborates that readers typically acquire orthographic knowledge in the following sequence: “The 3-letter consonant-vowel-consonant form; initial consonant blends and final vowel-consonant blends (and the relevance of the vowel for letter string segmentation); syllables; and longer word forms” (Munro, 1995, p. 3). How children process orthography is evident in how they spell and read words. Munro’s (1995) research revealed that recognizing orthographic patterns between words by analogy and phonemic segmentation are both key processes in orthographic learning.

When examining readers’ ability to process orthographic and phonological features of words, Slowiaczek and Kahan (2014) found that participants were able to respond faster when a cue was presented 750 milliseconds before the target, rather than presented with the target simultaneously. Participants were also able to respond more quickly to a clearly presented target, as opposed to a degraded target. Thirdly, the study established that orthographic processing occurs more automatically than phonological processing. During orthographic processing tasks, the researchers found that pre-lexical processing took place more automatically than in the phonological task. Thus, Slowiaczek and Kahan (2014) concluded that processing can occur simultaneously in both a visual and an auditory manner when orthographic processing is required.

Statement of the Problem

The primary goal of the current research was to examine the role of orthographic coding in distinguishing between membership in groups of language-based disability types. The study first attempted to determine if there is an association between performance on orthographic coding measures and performance on previously obtained curriculum based assessments. According to Pennington and Bishop (2009), a fundamental question for psychologists to address is how atypical development relates to typical development. In their review, the authors focused specifically on speech, language, and literacy disorders. In the past, the authors indicated that research has focused on explaining individual disorders but have indicated that the co-occurrence of disorders is a peripheral issue. Pennington and Bishop (2009) urge readers to consider that “comorbidity is of interest in its own right” (p. 284).

Another issue is related to the notion that there are many subtypes of reading disabilities. According to Aaron, Joshi, and Williams (1999), reading speed and orthographic skill are important factors that contribute to the reading process. Deficits in orthographic processing might contribute uniquely to reading disability. Additionally, processing speed and orthography might play an increasingly important role as children get older, even up until students are in sixth grade. Furthermore, Aaron et al. (1999) note that different types of reading disability require different types of remediation.

As a result, the most important goal of the current research was to determine if disability group membership can be reliably predicted by orthographic coding ability. According to a review of speech and reading development, Pennington and Bishop

(2009) indicate that “connectionist models”(p. 288) provide a framework for considering how language impairments and reading disabilities relate at the cognitive level.

According to Pennington and Bishop (2009), connectionist figures of both reading development and speech development involve semantics and phonology. In contrast, only the reading model includes an orthographic component, while the speech model includes both acoustic features and articulatory features (Pennington & Bishop, 2009). However, Pennington and Bishop (2009) discuss the components and precursors involved in extracting meaning from written text, with reading comprehension being the ultimate goal. Some of the precursors Pennington and Bishop (2009) highlight include phoneme awareness, rapid serial naming, phonological memory, oral vocabulary, and syntax. Some of the later components include phonological coding and orthographic coding, which result in fluent printed word recognition skills (Pennington & Bishop, 2009).

Problem Significance

There appears to be a dearth of literature that focuses on orthographic processing deficits in dyslexia (Boros, Anton, Pech-Georgel, Grainger, Szwed, & Siegler, 2016). Rathvon (2004) cites a consensus regarding the role of phonological processing in reading development. However, she states that there is far less agreement on the degree to which orthographic processing contributes to the acquisition of reading skills (Rathvon, 2004). Therefore, the current study attempted to determine if orthographic coding ability accurately predicts membership in disability group.

This research was important because it allowed for further analysis of the role of orthographic coding in students with disabilities. Once the relationship between orthographic coding and disability is better understood, educators will be better able to link assessment and intervention. In addition, administrators will have a framework for evaluating the success of special education programming. Thirdly, research will allow for increased understanding of the etiology of various disability types, which will lay groundwork for enhanced cross-disciplinary service provision.

Research Questions and Hypotheses

Research Question One

Research Question One was as follows: Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy, correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in second grade students?

It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores would correlate positively with DORF-Words Correct, DORF-Retell, and DORF-Retell Quality, but negatively with DORF-Errors. In second grade, skills assessed at the middle of the year include DORF-Words Correct, DORF-Errors, DORF-Accuracy, DORF-Retell, and DORF-Retell Quality. In addition, the assessment produces a DIBELS Next Composite Score. Not all of the DIBELS probes were included in the correlation analysis. DORF-Accuracy was excluded, because it is a percentage. The Composite score was also excluded, as it is based in part of DORF-Accuracy. Probes obtained at the

middle of the year were chosen because that time frame aligns most closely with the PAL-II administration time. In order to address this question, a correlation analysis was conducted.

Research Question Two

Research question two was as follows: Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy correlate with reading performance as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in third grade students?

It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores will correlate positively with performance on the MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted, and negatively in the area of DORF-Errors and Daze-Incorrect. In third grade, skills assessed at the middle of the year include DORF-Words Correct, DORF-Errors, DORF-Accuracy, DORF-Retell, and DORF-Retell Quality. In addition, the assessment produces a DIBELS Next Composite Score. In third grade, the DIBELS Next assessment also produces three measures of comprehension: Daze-Correct, Daze-Incorrect, and Daze-Adjusted. It is important to note that not all of the DIBELS probes were included in the correlation analysis. DORF-Accuracy was excluded, because it is a percentage. The Composite score was also excluded, as it is based in part on DORF-Accuracy score. In order to address this question, a correlation analysis was conducted.

Research Question Three

Research Question Three was as follows: Does orthographic processing, as measured by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II, distinguish between children with No Disability, a language impairment, and learning disability in reading? It was hypothesized that orthographic coding ability, as measured by performance on the Receptive Coding (RC) and Word Choice Accuracy (WCA) subtests of the Process Assessment of the Learner-Second Edition (PAL-II) will differentiate between disability group membership.

Catts et al. (2002) found that 67% of second graders and 61% of fourth graders with previously identified language impairment would have met criteria for a reading disability based on their word recognition ability (i.e., orthographic coding ability) alone. However, there are missing links in the literature between components of the model that Pennington and Bishop (2009) reference, such as between orthographic coding and listening comprehension (both precursors to reading comprehension) that need to be further examined empirically. As discussed earlier, the connectionist model involving reading development and speech development, discussed by Pennington and Bishop (2009), involve semantics and phonology. In contrast, only the reading model includes an orthographic piece, while the speech model includes both acoustic features and articulatory features (Pennington & Bishop, 2009).

Limitations

This study had a number of limitations. Primarily, the sample under review was a convenience sample. It consisted of previously identified 2nd and 3rd grade students at

the study site, as well as a regular education control group also consisting of 2nd and 3rd grade students. Due to the convenience nature of the study, results may not be applicable to the general population, students in other grade levels, or students in other education settings. Additionally, this study was limited by historical and maturational factors; i.e., how the initial special education identification was made, how many months of special education support a child received prior to the study, demographics and family history, and types of interventions received in special education.

Definition of Terms

Orthographic Coding - For the purpose of the current study, orthographic coding is defined as “the use of word-specific patterns to aid in word recognition and pronunciation” (Pennington & Bishop, 2009, p. 292). In addition to the WCA scaled score, information about participants’ orthographic coding ability will be obtained via the Receptive Coding (RC) subtest of the PAL-II.

Orthography - Orthography can be defined as “a system of printed symbols for representing the speech sounds in a written language” (Rathvon, 2004, p. 92)

Oral Reading Fluency - According to Rasplika and Cummings (2013), “Oral reading fluency is the ability to read connected text quickly, accurately, and with expression” (p. 1). For the purposes of the current study, information about participants’ oral reading fluency will be gathered from their performance on the DIBELS DORF-Words Correct probe, administered at the middle of their second or third grade years. According to the developers of the DIBELS system, DIBELS Oral Reading Fluency (DORF) “is a standardized, individually administered test of accuracy and fluency with connected

text,” (University of Oregon Center on Teaching and Learning, 2016). In addition, scores on the DORF-Errors, which provides information about the number of errors made while reading, will also be collected via file review.

Retell Fluency - According to DIBELS publishers, DORF-Retell is designed to provide a comprehension check for the Oral Reading Fluency measure (University of Oregon Center on Teaching and Learning, 2016). DIBELS Retell Fluency also allows educators to provide a rating of the quality of the child’s retell.

Word Choice - The Word Choice subtest of the PAL-II is a measure of a child’s orthographic spelling ability. The subtest evaluates the participants’ knowledge and recognition of correct spelling but does not require them to actually physically spell or write words (Berninger, 2007). The Word Choice subtest of the PAL-II required participants to examine a set of three words presented visually and chose the one that is spelled correctly. The Word Choice subtest on the PAL-II produces two scaled scores: Word Choice Accuracy (WCA) and Word Choice Fluency (WCF).

Phonological Dyslexia - According to Miller (2007), phonological dyslexia is characterized by strong whole word reading but poor phonetic reading.

Orthographic Dyslexia - Wang, Yang, Tasi, and Chan (2013) indicate that orthographic dyslexia is characterized specifically by deficits in the area of orthography, i.e., performing worse in aspects of reading involving visual information.

Reading Disability - According to the eligibility guidelines for the participating district, the criteria for a specific learning disability in reading are met when a 15-point discrepancy between a child’s cognitive ability and academic achievement is revealed.

This deficit must also impact academic functioning. In other words, students must present with academic need, such as poor grades, inability to meet curriculum based assessment benchmarks, or other inability to demonstrate skills expected at their grade level. Cognitive ability and academic achievement scores are assessed by certified school psychologists. Ability and achievement assessments are standardized, norm referenced, and individually administered.

Specific Learning Disability - According to Hale and Fiorello (2004), a specific learning disability (SLD) is a processing disorder that results in academic deficits that cannot be better explained by another disadvantage.

Speech or Language Impairment - According to the eligibility guidelines for the participating district, the criteria for a disability in speech or language impairment are met when a child's performance in any area assessed as part of the speech and language evaluation is at least one standard deviation below the mean. This deficit must also impact a child's academic functioning in the school setting. Speech and language skills are assessed by certified speech language therapists.

Comorbid Language and Reading Disability - For the purposes of the study, participants are considered to have comorbid language and reading disability when they meet district criteria and receive special education support for both a learning disability in reading and a speech or language impairment.

Eligibility Guidelines - This term refers to the criteria with which educators determine if a child meets the criteria for a student with a disability in need of specially designed instruction, or special education. A reading disability is identified by a child's

educational team, which must include a certified school psychologist who has evaluated a child with measures of cognitive ability and academic achievement. A speech or language impairment is also identified by a child's educational team, with assessments conducted by certified speech and language therapists. The identification of comorbid language and reading disability is determined by a child's team, which must consider evaluation information from both certified school psychologists and certified speech and language therapists. For the purposes of the current study, disability type, magnitude of discrepancy, and special education program will be noted in the file review.

Summary

This chapter began with a discussion on the development of language and reading in elementary students. Research has shown that children are biologically predisposed to acquiring language, while reading requires that children learn a series of language-based skills. Information regarding acquisition of language, language impairment and the development of literacy, and the acquisition of reading skills was also presented. Next, comorbidity between language and learning disabilities, including the relationships between learning disability, dyslexia, reading, and specific language impairment were discussed. Research has shown that both language comprehension and decoding skills are equally important in the development of reading comprehension (SEDL, 2001). Information on specific learning disability in reading through the lens of the dual-route model in reading was presented. This model proposes that readers utilize both lexical and non-lexical routes when processing text. The chapter also

discussed alternative methods of identifying learning disabilities, including a brief discussion of RtI versus the discrepancy model. Next, orthographic processing deficit as a possible marker for disability was introduced. Finally, the problem statement, the significance of the problem, research questions, limitations, and definition of terms were presented.

The primary goal of the current research was to examine the relationship between orthographic coding and various disability types. As such, the researcher examined whether orthographic coding ability, as measured with the PAL-II Receptive Coding and Word Choice Accuracy subtests, reliably differentiated between children who do not have a disability and those with either a speech or language impairment or reading disability. The researcher also examined if performance on the PAL-II Receptive Coding and Word Choice subtests correlated with reading performance, as assessed by performance on the MOY DIBELS in second and third grade students. This research allowed for further analysis of the role of orthographic coding in students with disabilities. Once the relationship between orthographic coding and disability is better understood, educators will be better able to link assessment and intervention, evaluate the effectiveness of special education programming, and enhance cross-disciplinary service provision.

CHAPTER 2

LITERATURE REVIEW

This chapter will begin with a review of language and reading development in elementary students. To supplement this discussion, a model illustrating the cognitive foundations of learning to read will be discussed. Next, the construct of orthography will be introduced. This introduction will be presented within the lens of the dual-route model, which is used as a theoretical framework for the current research. This section will conclude with a discussion on the utility of orthographic coding deficit as a possibly marker for reading disability. Subsequently, the chapter will examine work establishing the link between language and reading, including an overview of language and learning disabilities, specific learning disabilities, reading disabilities, and dyslexia. As part of this discussion, various methodologies for identifying learning disabilities will be presented.

Language and Reading Development in Elementary Students

Acquisition of Language

Children are biologically predisposed to acquire language (e.g. Chomsky, 2013; Everaert et al., 2015; Smith, 2011). Language is a complex ability that requires mastery of many component parts. With regard to spoken language, Bloom (2000) stated that learning a new word requires a child to establish a connection between the word's visual appearance and meaning. According to Bloom (2000), research indicates that children first learn words by simple association. By about 17 months, children acquire about five new words a week. Syntactic understanding increases with age, as children are exposed to new environmental experiences. True word learning begins around 12

months. Rate of word learning can also be impacted by factors such as parental linguistic ability, sex of the child, and parental education (Bloom, 2000).

While research clearly indicates that children are biologically predisposed to language learning, the developmental age at which children acquire language is also important to consider. Newport (1990) proposes that language acquisition occurs best at an early age. According to Newport (1990), “language learning operates under a set of internal constraints” (p. 11). She adds that maturational constraints dictate and shape language development. Newport proposes that language learning occurs very early in life because children are more apt to acquire language than adults. Some evidence exists for this phenomenon. For instance, early language learners make very different types of errors in language acquisition than do late language learners (Newport, 1990).

The Cognitive Foundations of Learning to Read

The SEDL Framework

Reading is a complex cognitive skill that requires mastery of many component parts. Though there is a heavy focus on basic reading skills and reading fluency in elementary education, the primary function of reading is to comprehend text by extracting meaning from print (Lichtenstein, 2008). In order to achieve this primary function, however, children must also demonstrate mastery in the various component areas.

The SEDL (2001) developed a framework to illustrate how the components of reading fit together to help students achieve the ultimate goal of reading

comprehension. According to this framework, Language Comprehension and Decoding contribute equally to the development of reading comprehension. Each of these factors is represented via a *leg* in the SEDL model. The Language Comprehension leg is comprised of Linguistic knowledge and Background Knowledge. Linguistic knowledge refers to knowledge of the formal structure of language, while Background Knowledge refers to knowledge that is obtained through interaction with one's environment (SEDL, 2001).

Most relevant to the current research; however, are the components of the Decoding leg. According to the SEDL (2001), "Alphabetic languages are those whose writing systems relate the written and spoken form of words systematically" (p. 15). Therefore, decoding refers to a child's ability to recognize relationships between written and spoken words. The Decoding leg consists of two primary components: Cipher Knowledge and Lexical Knowledge. According to SEDL (2001), Cipher Knowledge is defined as the ability to relate units of written words (letters) to units of spoken words (phonemes). If a child develops the ability to successfully apply Cipher Knowledge, he or she will be able to recognize words not previously encountered in print. Sometimes, however, there are exceptions to the typical rules of language, where spoken or written units of words do not follow the conventional rules of a language. Knowledge of such exceptions is referred to as Lexical Knowledge (SEDL, 2001).

The SEDL framework (2001) further underscores that Cipher Knowledge and Lexical Knowledge depend additionally on four other components: Letter Knowledge, Phoneme Awareness, Knowledge of the Alphabetic Principal, and Concepts About Print.

According to SEDL (2001) Letter Knowledge refers to a child's ability to recognize units of the written system. Being able to recognize individual letters is an important skill. For instance, Catts et al. (2002) found that strong letter identification ability in young students made them less likely to develop later reading deficits.

According to the SEDL (2001), Phoneme Awareness refers to a child's ability to recognize and manipulate units of spoken words, or phonemes. The SEDL emphasizes the importance of this knowledge being explicit. In other words, "knowing explicitly that this distinction in meaning is carried by a particular unit in a particular location (i.e., by the last unit in the preceding example) does not come automatically with learning the language. It is something that in most cases must be taught in order to be learned," (SEDL, 2001, p. 17).

The SEDL postulates that in order to master decoding, a reader must be able to decipher the relationship between Cipher and Lexical Knowledge (2001). As such, "knowing that a systematic relationship exists between the internal structure of written and spoken words, and that the task of learning to recognize individual words requires discovering this relationship," (p. 17). The SEDL refers to this concept as Knowledge of the Alphabetic Principle.

According to the SEDL (2001), Concepts about Print refer to the knowledge regarding mechanics of the printed word. For instance, children must understand that print carries linguistic meaning. Concepts about Print also requires understanding that there is an association between spoken and written words as well as that print is read from left to right.

The SEDL framework is a helpful guide when conceptualizing how children develop reading skills, or what the model developers refer to as “the cognitive foundations of learning to read” (2001, p. 3). Of particularly relevance to the current research are the factors presented in the decoding leg of the model: Letter Knowledge, Phoneme Awareness, Knowledge of the Alphabetic Principal, and Concepts About Print. However, other factors not specifically addressed in the SEDL model are also critical in understanding the acquisition of literacy skills. These factors include a child’s ability to recognize words, understanding of the morphemic structure of words, phonological processing skills, and fluency and automaticity. These additional cognitive capacities will be discussed in the following section.

Additional Cognitive Capacities Involved in Reading

Word recognition. An extension of a child’s ability to recognize letters is word recognition. Catts et al. (2002) found that measures of word recognition in second grade accounted for 75% of the variance in similar measures in fourth grade. The work of Pennington and Bishop (2001) established a relationship between word recognition and orthographic coding ability.

Aaron, et al. (1999) assessed general education students’ performance on reading speed, orthographic memory, non-word reading, listening comprehension, and reading comprehension tasks in relation to their ability to recognize words. All of these skills were assessed individually by preexisting standardized assessments or more informal assessments designed for the study. For the purposes of their study, Aaron et al. (1999) operationally defined word recognition as a child’s ability to read nonwords as

well as irregular words, which the researchers considered a measure of orthographic processing skill. Aaron et al. (1999) assessed orthographic processing by presenting participants with a target word and subsequently presenting a trio of stimuli including the test word, a homophone of the target word, and a homophonic nonword (i.e., a nonword that would sound the same as the target word but is spelled in such a way that it is not a real word).

Aaron et al. (1999) determined that word recognition and comprehension accounted for 65% of the variance in comprehension. Furthermore, participants' word recognition ability accounted for 50% of the total variance in reading comprehension, while the comprehension factor only accounted for 15%. Later on in their review, Aaron et al. (1999) added that becoming a proficient reader depends at least in part on the acquisition of orthographic processing skill, which will allow children to be sight-word readers.

Morphemic structure. According to Bybee (1985), identifying morphemes involves dividing words into parts and subsequently assigning meaning to the parts. Carlisle and Stone (2005) posited that the English language is morphophonemic. This means that spelling of words in the English language is based on both morphemes, or the units of meaning, as well as phonemes, or representations of sounds. The development of word reading skill requires an understanding of the connection between sounds (phonology) and letters (orthography) in words. Grainger and Zeigler (2011) reported that up to 85% of words in the English language are morphologically complex. Grainger and Zeigler (2011) added, "there is growing evidence that part of the

process of reading morphologically complex words involves the sublexical segmentation of the word into its constituent morphemes” (p. 6).

In order to gather more information on the importance of morphemic structure, Carlisle and Stone (2005) examined phonological and orthographic transparency. According to the Carlisle and Stone, “orthographic transparency means that the spelling of the base word is intact (or mostly so) in the derived word” (2005, p. 432). By this definition, the word *quickly* would be transparent, but the word *decision* would not, as the spelling of the base word *decide* is not present in the derived word. Carlisle and Stone (2005) defined phonological transparency as “the pronunciation of the base word is intact in the derived word” (p. 432). For instance, the word *growth* is phonologically transparent, whereas the word *health* is not (because the pronunciation of the root word *heal* changes in the derived word *health*).

Carlisle and Stone (2005) conducted a study in two parts, both of which aimed to examine the role of morphemic awareness in word recognition. The first study was designed to determine whether morphemes play a role in the accuracy and speed of reading derived words. Performance of lower (grades 2 and 3) and upper (grades 5 and 6) elementary students was compared. In the first study, all words were both phonologically and orthographically transparent. The word reading task was administered on a computer. Students were asked to read the words aloud. Stimuli consisted of either low frequency derived words, such as *queendom*, or high frequency derived or pseudoderived words, such as *winner* or *windy*. According to Carlisle and Stone (2005), “the results showed that both lower and upper elementary readers were

more accurate at reading transparent derived words (e.g., *shady*) than pseudoderived words (e.g., *lady*), matched on spelling, word length, and word frequency” (p. 438).

In the second study, Carlisle and Stone (2005) compared middle and high school students’ ability to read words that were phonologically transparent and words that were not phonologically transparent. According to Carlisle and Stone (2005), “the results showed that for middle and high school students, derived words with transparent phonological structure (e.g., *classical*) were read more accurately than words with phonological shifts between the base and derived forms (e.g., *colonial*)” (p. 442). In summary, Carlisle and Stone (2005) determined that morphemic structure is an important factor in reading different types of words, particularly those with transparent structure.

Phonological processing. Catts (1993) found phonological awareness to be an important factor related to reading ability. According to Breznitz (2003), the “phonological processing system operates via an auditory, speech-based route and is sequential” (p. 184). According to Vesay and Gischlar (2013), “*balanced*” literacy instruction accounts for both basic skills such as sound/letter correspondence, awareness of sound units, and learning the alphabet, as well as more advanced skills such as vocabulary, reading comprehension, and semantic skills. Vesay and Gischlar (2013) added that phonological awareness is an important skill that ultimately leads to literacy, and that a teacher’s own awareness of sound-symbol knowledge is imperative for effective phonics instruction.

Fluency and automaticity. The National Reading Panel (2000) cited fluency as one of its Five Big Ideas in Reading. When a process becomes automatic, or fluent, children are able to complete it more quickly and efficiently. Munro (1995) indicated that words that can be read very rapidly, i.e., under one second, are likely to be read orthographically. If a child can read a word correctly but more slowly, other attentional resources are likely also being utilized.

In order to examine differences in automaticity between orthographic and phonological tasks, Slowiaczek and Kahan (2014) recruited 64 college students. Each participant was exposed to both orthographic and phonological trials. Participants were presented with a series of words that fit into one of four possible conditions. In the phonological task, participants had to determine whether a stimulus letter *a* should be pronounced /e/ as in *face*, or /æ/ as in *cast*. In the orthographic task, participants had to determine whether the sound /s/ would be spelled with an *s* (as in *waste*) or a *c* (as in *trace*). Participants responded by indicating their response on a keyboard.

Before each trial, Slowiaczek and Kahan (2014) cued participants as to whether the task would be phonological or orthographic in nature. Cues were task dependent: a green or red square was presented on the screen for auditory tasks, and a high or low pitched tone was presented to indicate a visual task. The researchers also created conditions in which the cue was sometimes presented simultaneously with the target and was sometimes presented 750 milliseconds (ms) prior to the target. The researchers created an additional condition in which stimuli were presented clearly or degraded. In the auditory task, stimuli were either presented without noise in the clear

condition or mixed with brown noise in the degraded condition. For the visual task, stimuli were presented in white on a black background in the clear condition or dark gray on a black background in the degraded condition (Slowiaczek & Kahan, 2014).

Slowiaczek and Kahan (2014) found that participants were able to respond more quickly when the cue was presented both clearly and prior to the presentation of the target, as opposed to simultaneously or under degraded conditions. Furthermore, the researchers found that participants responded differently on phonological and orthographic tasks when clarity of the cue and stimulus onset asynchronies (SOA) were considered. In the orthographic task, response times were quicker when a clear cue was presented at 750 milliseconds SOA, but not at a 0 millisecond SOA. The researchers concluded that participants process phonological and orthographic tasks differently. This discrepancy might possibly be because orthographic processing is a priority. Orthographic processing was determined to be more automatic than phonological processing. In summary, the researchers concluded that concurrent processing can occur in both visual and auditory modalities when participants are required to extract orthographic information.

In summary, to achieve the ultimate goal of comprehending text, children must first master a series of lower level cognitive skills. The cognitive foundations in learning to read have been conceptualized and presented through the 2001 work of the SEDL. This organization postulates that reading comprehension depends equally on Language Comprehension and Decoding, both of which form a leg in the model. Most relevant to the current research are the facets of the Decoding leg. The Decoding leg consists

primarily of Cipher Knowledge and Lexical Knowledge, and these factors further depend on four even smaller components: Letter Knowledge, Phoneme Awareness, Knowledge of the Alphabetic Principal, and Concepts About Print.

However, research has revealed other important factors of reading that are not discussed in the SEDL model but are also important in the development of literacy. Some of these other factors include word recognition, morphemic structure, phonological processing, and fluency and automaticity. Orthographic processing is another important cognitive capacity that enables children to read. The current research aims to build upon the current literature in order to evaluate the possible link between orthographic coding skills and learning disabilities. The primary goal of the current research was to examine the role orthographic coding plays in learning to read. The construct of orthography will be presented in the following section.

An Introduction to Orthography

Munro (1995) discusses the processes involved in orthographic learning. The first process, phonemic segmentation, allows children to link groups of letters that they are reading to words that they use in speech. The second process involves a child's ability to recognize patterns between words. If children are not able to adequately develop these skills, they might rely on less efficient strategies which place too high of a demand on attention resources. Likewise, they might not be able to use information they know about some words and apply the skills to reading newer words. Like the broader task of reading, orthography also has its own set of prerequisites. First, Munro indicates that children must have phonemic knowledge; in addition, they need

orthographic knowledge of less complexity. Third, successful orthographic knowledge depends on sufficient vocabulary and oral language skills. Finally, readers require an awareness of how to employ orthographic skills.

The Dual-Route Model of Reading and the Processing of Text

According to Castles (2006), the dual-route model proposes that each route functions somewhat independently. The lexical route involves reading by using a pre-existing store of “previously seen written words,” more commonly known as a lexicon (2006, p. 50). Recall that Lexical Knowledge also refers to knowledge of exceptions to the typical rules of language (SEDL, 2001). Grainger and Ziegler (2011) referred to the lexical route as the *direct* route, as “sublexical orthographic information makes direct contact with whole-word orthographic representations, which then provide access to whole word phonology on the one hand, and higher-level semantic information on the other” (p. 1). The non-lexical route, on the other hand, utilizes a set of rules to convert graphemes (the written form of words) to phonemes (the spoken form of words). Grainger and Ziegler (2011) referred to the non-lexical route as *indirect*, stating that “sublexical orthographic information is first transformed into a sublexical phonological code before making contact with phonological output units, whole word phonological representations, and semantics” (p. 1).

In summary, struggling readers may have difficulty accessing one route versus the other. Difficulty with accessing the two routes results in different manifestations of dyslexia. According to Romani et al. (2008), difficulty with lexical processing will result

in an inability to read irregular words. Deficiencies in non-lexical processing, on the other hand, result in a diminished ability to read non-words.

How Readers Process Text

According to Munro (1995), readers process text at a number of different levels. Examples of these levels include the word level and the sentence level, an issue of cognitive complexity. Munro also discusses the notion that the efficiency at which readers process information at each level will impact overall fluency. Children who have difficulty with reading struggle in part because they have processing difficulties at one or more levels. When a processing difficulty is present, a struggling reader will expend too much attention trying to access print at one level and, as a result, have limited resources remaining to attend to higher levels of text comprehension, such as the conceptual or topical level (Munro, 1995).

Munro (1995) discussed how competent readers process text. Readers who are able to recognize what Munro termed “multi-letter clusters,” are more efficient readers than those who are only able to process graphic information at the “single letter level” (p. 3). He further elaborates on this efficiency by describing two additional levels: three letter consonant vowel consonant words or words with one syllable that consists of both vowel and consonant blends. Factors such as length of word and its orthographic-phonemic mapping profile can impact how readers process the word. Munro found that readers with dyslexia had less orthographic knowledge than did their peers.

Orthographic Processing Deficit as a Possible Marker for Disability

In his research, Munro (1995) attempted to determine how orthographic knowledge is processed by dyslexic readers and how orthographic knowledge can be effectively enhanced. According to Munro, orthography is demonstrated by a child's ability to read and spell words. In order to examine orthography, Munro examined a child's ability to read single syllable words that varied in both the number of letters in the word and also in orthographic-phonemic complexity. In some words, each letter maps to a sound. In other words, two letters map to a sound. Orthographic-phonemic complexity in which two letters mapped into a sound varied further in three ways: vowel-vowel clusters, vowel consonant clusters, or consonant clusters. Information was collected on how long it took for a child to read a word correctly and the reading strategies that the child used. Each child's response was recorded. Errors were also recorded for analysis. The following types of errors were analyzed: whether letters were added or deleted to the target word, whether an error was made after part of the stimulus word was read correctly, when the word was familiar to the reader and shared letters with the target word, and whether the word was read correctly but had no similarity to the target word.

Munro (1995) also found that readers with dyslexia had lower orthographic knowledge than did their nondyslexic peers. Readers with dyslexia were also more likely to identify words by single letters, both systematically and nonsystematically, and they focused more on single letters than on letter groups. His study produced four major findings relevant to the current review. First, Munro found that readers with

higher phonemic awareness skills are also more able to establish orthographic analogies between words. Secondly, Munro established that when readers with dyslexia are taught to link letter clusters with sounds, rather than simply linking individual letters with sounds, they are more likely to be able to not only enhance orthographic knowledge, but are also able to transfer skills to unknown words. Third, Munro found that incorporating long-term memory strategies to word recognition instruction can enhance word knowledge transfer and retrieval. Finally, Munro established that encouraging students to reflect on how they learn orthography and allowing them to focus on what they know about certain words will allow them to better utilize attention when reading new words. This process might involve requiring children to describe how they read a word or helping children to establish similarities between words.

Cohen et al. (1999) examined trends in verbal fluency with a variety of populations, including normally developing children, children diagnosed with developmental dyslexia, and children diagnosed with Attention Deficit Hyperactivity Disorder. In order to do so, the researchers pooled a “normal” sample of 130 regular education students who ranged in age for 6-12 years. The clinical portion of the sample included 42 children with developmental dyslexia and 23 children who met the criteria for ADHD. The developmental dyslexia group was further divided into Language Disorder/Dysphonetic ($n = 35$) and Visual Spatial/Dyseidetic ($n = 7$). Each participant was assessed with a verbal fluency task either in their school (in the case of the normal sample), or at the Child Neuropsychology Laboratory at the Medical College of Georgia (in the case of the clinical sample). The verbal fluency task required participants to

provide as many words as possible starting with a specified letter in 30 seconds. Credit was not given for plurals of previously given response, nor for proper nouns (Cohen et al, 1999).

Results of the Cohen et al. (1999) study indicated that verbal fluency improves with age in the normal sample. Results also indicated that the Language Disorder/Dysphonetic Dyslexic subgroup performed more poorly on the verbal fluency task than did either the ADHD group or the Visual Spatial/Dyseidetic Dyslexic subgroup. Overall, Cohen et al. (1999) concluded that verbal fluency is not a weak area for all dyslexic students. Results support the notion that students with dyslexia are a heterogeneous group.

The findings of Cohen et al. (1999) are important because understanding the manifestations of dyslexia and processing problem subtypes is an important first step in establishing links between various processing problems and SLD. For instance, Cohen et al. (1999) found that children with developmental dyslexia also met the criteria for a learning disability per the Georgia State Department of Special Education regulations. More specifically, they exhibited normal intelligence and a >20 point discrepancy in reading comprehension or recognition. The current research attempted to further establish links between orthographic processing and previously identified disability types.

Understanding the Link Between Language and Reading

According to Everaert et al. (2015), “language is so deeply embedded in human social interaction, facilitating the communicative and social needs of a community of

speakers to share information” (p. 740). Chomsky (2013) first presented the notion of the genetic component of language, which he referred to as Universal Grammar or UG.

Everaert et al. (2015) further elaborate on UG, which their work defines as:

The theory of the genetic component of the faculty of language, the human capacity for language that makes it possible for human infants to acquire and use any internalized language without instruction and on the basis of limited, fragmentary, and often poor linguistic input. UG is the general theory of internalized languages and determines the class of generative procedures that satisfy the basic property, besides the atomic elements that enter into these computations. (p. 733)

According to Everaert et al. (2015), children acquire most of the necessary language skills prior to entering school.

The relationship between language and reading is further illustrated by how children acquire literacy skills. Tambyraja et al. (2015) indicate that decoding unfamiliar words requires readers to identify graphemes (letters) with phonemes (speech sounds) and subsequently blend sounds to read words. In other words, phonological and phonemic awareness focus on the sound element of spoken words, whereas phonics focus on letter sound relationships within written words. The purpose of phonics instruction is to teach children the relationship between written symbols and sounds of spoken language. According to Everaert et al. (2015), reading in English also involves the ability to understand an alphabetic symbol system, in which individual characters represented individual sounds in a word.

Attempts have been made to further examine the developmental link between language and reading. Catts (1993) focused on why some students with speech language impairment develop reading disability and others do not. The findings of this research support the idea that students with speech language impairment are at increased risk for reading disability. However, Catts (1993) found that language impairment is not the only contributing factor, as about 50% of language impaired participants were normal readers in first and second grade.

The current research is important because, as stated by Pennington and Bishop (2009), viewing multiple disorders through the lens of comorbidity can provide new information and perspective. Pennington and Bishop (2009) also cite the importance of focusing on underlying deficits, such as phonological processing, when examining comorbidity among disorders. Many of the studies that were reviewed in this current chapter have attempted to identify markers for later reading disabilities. In some studies, research on these markers has helped to explain the relationship between language and learning (Catts, 1993; Catts et al., 2002; Catts et al., 2005; Freed, Adams, & Lockton, 2011; Hoover & Gough, 1990; McArthur et al., 2000).

Reading is a complex process. As a result, there are many ways in which children might fail to acquire adequate reading skills. Orthographic coding deficits are one such way that reading acquisition might be impeded. The current research attempts to establish orthographic coding as a unique marker for language and learning disability. The following section will review the literature on language and learning disabilities, laying the groundwork for establishing orthographic coding as a unique marker for

disability. Recall that SLD is an educational concept, based on specific identification parameters set forth by the IDEA. Dyslexia, on the other hand, is a specific term found throughout the research literature that can help characterize and conceptualize performance deficits in reading. As both are important concepts in understanding how some children might have difficulty in learning to read, the following section focuses specifically on processing deficits affiliated with dyslexia and also how educators in school settings identify SLD, as dictated by the IDEA framework.

Language and Learning Disabilities

In order to examine the concept that Specific Language Impairment (SLI) and dyslexia are distinct, Catts et al. (2005) gathered data on language, intelligence, and word recognition in Kindergarten, second grade, fourth grade, and eighth grade. Children in this study had originally participated in an epidemiologic study of language and reading development. For the purposes of their study, definitions of dyslexia ranged from: 1) simple low achievement in word recognition (the most liberal definition); 2) low achievement in conjunction with average intelligence, and; 3) an IQ-achievement discrepancy approach, which allows for identification of children with dyslexia when their achievement level is lower than would be predicted by intelligence. Results indicated that one-third of children identified with an SLI later met the most liberal definition of dyslexia in second, fourth, and eighth grade. When criteria were considered with reference to IQ, 17% to 29% of children with SLI in kindergarten subsequently met criteria for dyslexia in later grades. When the results were considered

in reverse, Catts et al. (2005) found that 15-20% of students who met criteria for dyslexia as school aged students also met the criteria for SLI in Kindergarten.

Identification of Specific Learning Disabilities

Currently, there are a number of ways in which specific learning disabilities can be identified (Lichtenstein, 2008). One way is the ability-achievement discrepancy approach, which requires an element of underachievement in one of the aforementioned areas when compared with a child's intellectual ability. A second approach involves the use of a Response to Intervention (RtI) model, which examines a child's ability to respond to implementation of research-based interventions. Lichtenstein also cited psychoeducational testing as a means by which a child might be identified with a specific learning disability. With regard to the latter, Lichtenstein elaborated that the use of norm-referenced, standardized psychoeducational assessment is a leading approach to the identification of specific learning disability. Lichtenstein (2008) also stated that, when designing an evaluation, psychologists should consider assessments that will answer not only the question of eligibility, but also address the educational needs of the specific child.

Integrating RtI and cognitive assessment. Hale, Kaufman, Naglieri, and Kavale (2006) advocated an integration of RtI and traditional cognitive assessment approaches. Rather than take a divisive approach of RtI versus evaluation of psychological processes, Hale et al. (2006) advocate a procedure that evaluates and incorporates the merits of each approach. The researchers posit that any psychological process evaluation is incomplete until balanced with RtI practices. Response to Intervention requires that

observable and measureable outcomes are utilized to make data-based educational decisions. However, when used alone, the RtI approach has a number of shortcomings. These shortcomings include, but are not limited to, questions about how RtI meets unique student learning needs, how it differentiates between students with SLD and other impairments such as Attention Deficit Hyperactivity Disorder (ADHD) or low achievement, and how curricula will be standardized across classrooms.

Conversely, Hale et al. (2006) indicate that the use of a comprehensive evaluation of cognitive processes allows psychologists to concretely identify various cognitive impairments and link them to academic deficits. However, as with RtI, the researchers cite a number of problems with the use of the evaluation process alone. First, a comprehensive evaluation generally requires the use of IQ-type measures, which many consider irrelevant when determining SLD. For instance, McGrew and Knopik (1996) found that a large number of strengths and weaknesses revealed through a test profile are unrelated to the presence of academic problems in math, reading, or writing. Therefore, this process alone might have minimal diagnostic utility. Steubing, Fletcher, Branum-Martin, and Francis (2012) also evaluated the technical adequacy of identifying SLD based on cognitive discrepancies. According to this research, only 1-2% of the study population met criteria for specific learning disability. Thus, Steubing et al. (2006) concluded that certain discrepancy approaches have very low positive predictive values.

The integrated model proposed by Hale et al. (2006) utilizes a three-tier process that includes use of a standardized RtI protocol at Tier I, a problem solving approach at Tier II, and a comprehensive evaluation model at Tier III. The researchers indicated that

this approach is efficacious because many children can be appropriately served through an RtI model (i.e., early intervention, problem solving, and progress monitoring).

However, Hale et al. (2006) discouraged the use of RtI alone for SLD identification, as children can fail to respond to interventions for many reasons, only one of which is true SLD. In order to meet IDEA requirements that an evaluation of basic psychological processes take place, cognitive assessment processes must also occur. Hale et al. (2006) argue that use of an integrated approach will provide more accurate identification of students with SLD and will also better inform individualized instruction practices.

Third-Method approaches to SLD identification. Flanagan, Fiorello, and Ortiz (2010) posit that there are a number of third-method approaches to SLD identification; i.e., alternative methods to the traditional discrepancy or RtI approaches. Though a full review of third-method approaches is beyond the scope of the current research, all third-method approaches share some commonalities. All require identification of both cognitive and academic deficits, as well as at least average intelligence. Additionally, the third-model approaches require that a meaningful relationship between cognitive deficits and resulting academic impairment be established. The researchers examined the utility of the Cattell-Horn-Carroll (CHC) theory and the identification of learning disabilities. Flanagan et al. (2010) advocated the use of CHC theory for four reasons:

1. CHC theory is supported by large body of research which evidences the validity of the model;
2. Most major intelligence assessments are based in some way on CHC theory;

3. Most test publishers have utilized CHC theory to classify their assessments; i.e., have cited which composites measure broad CHC abilities and which subtests measure narrow CHC abilities;
4. An increasing amount of research has begun to examine the relationship between CHC cognitive abilities and academic outcomes.

Thus, Flanagan et al. (2010) conducted a review to discuss how CHC theory has begun to influence SLD identification and academic outcomes. They advocated a Hypothesis-Testing CHC Approach (HT-CHC). Like RtI, the HT-CHC approach requires the use of a tiered model. The goal at Tier II is to determine if a student is making adequate progress. Within Tier II, students are exposed to a Standard Treatment Protocol (STP) to enhance learning. Efficacy of the STP is evaluated through data collection and progress monitoring. At Tier III, parent consent is obtained to pursue what Flanagan et al. (2010) referred to as a hypothesis testing evaluation, the purpose of which is to guide further assessment and intervention. If a child continues to exhibit learning difficulties, they will move on to the fourth tier. Tier IV involves a more comprehensive evaluation of a child's cognitive and academic strengths and weaknesses, the purpose of which is to determine eligibility for special education.

In summary, recall Dickman's (2008) discussion of dyslexia versus SLD; that SLD might be conceptualized as the "zip code" in which a child's reading impairment might manifest, while dyslexia is the "street" (p. 5). The Dual-Route model further illustrates ways in which children might process reading skills, i.e., the streets through which a processing problem might manifest. However, there is no direct link between dyslexia

subtypes and SLD eligibility. Thus, the current research attempts to establish orthographic processing problems as a unique marker for disability.

Summary

This chapter began by discussing language and reading development in elementary students, including a more detailed review of acquisition of language and the cognitive foundations of learning to read, as presented in the framework from the SEDL (2001). Subsequently, the construct of orthography was introduced. This introduction was supplemented with a presentation of the dual-route model, which is used as a theoretical basis for the current research. Finally, the chapter presented a more detailed discussion of specific learning disability, include SLD identification through Response to Intervention, tiered models, more traditional cognitive assessment approaches, and third-method approaches.

CHAPTER 3

METHODOLOGY

The primary goal of the current research study was to examine the relationship between orthographic coding in children with previous identified Reading SLD or Speech or Language Impairment. In so doing, the research attempted to establish orthographic coding as a unique marker for disability. In addition to the Reading SLD and Speech or Language Treatment groups, the study also utilized a control group of regular education second and third grade students. The study examined the role of orthographic coding in these disability types. This chapter will begin with a presentation on study participants, including a description of the sample, population, and sampling procedures. Next, the chapter will present a description of the setting, including a description of the study site, as well as the curriculum used at the site and supports available for struggling readers. Subsequently, the chapter will discuss the variables under consideration, including the three independent variables and five predictor variables. Next, the chapter will review study procedures, including data collection procedures. Finally, the chapter will conclude with a review of the data analysis.

Participants

Sample

The sample in this study consisted of second and third grade students who had been previously identified with a Reading SLD or a Speech or Language Impairment. The study also included a control group consisting of second and third grade regular education students. For the first research question, the analysis was completed with all

second grade students, i.e., second grade participants both with and without disabilities. For research question two, the analysis was completed with all third grade students, i.e., third grade participants with and without disabilities. For research question three, the entire sample of participants was examined together, regardless of grade or disability group status. Participants were obtained from six elementary schools in a rural and suburban school district in northeastern Pennsylvania. Participants ranged from seven to ten years of age. Both males and females were included in the study; there were no restrictions based on sex. The sample was a convenience sample.

The treatment population contained 86 second and third grade special education students who were identified during the 2015-2016 school year. Out of these 86 students, 22 students met criteria for Reading SLD as their primary disability, 53 met criteria with Speech or Language impairment, and 11 students met the criteria for comorbid Reading SLD and Speech or Language Impairment. Out of the 86 consent forms sent to families of students in special education groups, 29 signed consent forms were received. This resulted in an overall 34% response rate for treatment groups. A total of 10 consent forms were received for students who had been previously identified with a specific learning disability in reading. A total of 14 consent forms were received for students who had been previously identified with a speech or language impairment. A total of five consent forms were received for students who had been previously identified with comorbid reading and speech disability types. Out of the 29 treatment group consent forms received, 19 PAL-II assessment session appointments were scheduled and completed. 11 participants met criteria for a speech or language

impairment, six met criteria for a specific learning disability in reading, and two met the criteria for comorbid reading and speech disability.

Additional information was gathered for participants who met criteria for a Reading SLD. One participant met criteria for all three types of Reading SLD (Basic Reading Skills, Reading Fluency, and Reading Comprehension). Two participants met the criteria for SLD in two areas. One of these participants met criteria in Basic Reading Skills and Reading Fluency. The other participant met criteria for Reading Fluency and Reading Comprehension. Two participants met the criteria for SLD in only one area. One met criteria in Reading Fluency, and the other met criteria in Reading Comprehension.

Information was also collected on the *degree of discrepancy* of Reading SLD. In order to qualify for a Reading SLD at the study site, students must present with a 15-point or greater discrepancy between cognitive ability and academic achievement. One participant was identified with a Reading SLD with a cognitive-achievement discrepancy of less than 15 points in the area of Reading Fluency. However, this participant also met criteria in the area of Basic Reading Skills with a discrepancy between 15-30 points. As a result, the participant was retained in the analysis. The majority of participants identified with a Reading SLD ($n = 5$) met criteria with a discrepancy between 15-30 points. No participant achieved a discrepancy greater than 30 points.

To establish a control group, regular education students were selected from each elementary building using a lottery system. In order to generate a pool from which to recruit participants, a search for all second and third grade students enrolled in all six

elementary schools was conducted using the study site's student management system. This list was compiled and imported into Excel. Each potential participant was assigned a numbered cell. A web-based random number generator was used to choose individual participants. The range of potential participants from each elementary school (based on cell number) was entered into the number generator. The generator was programmed to compute 25 randomly generated numbers from each grade level at each building. Students were solicited for participation if the random number generator produced their corresponding cell number in Excel. In this way, 150 regular education students from each grade level were chosen for participation. However, some of the data produced by the student management system were inaccurate or outdated. For instance, some students populating the search results had previously aged out of second or third grade or were no longer enrolled in the district. As a result, a total of 174 consent forms were sent to solicit participation in the control group. Out of the 174 consent forms sent to families of regular education students, 23 signed consent forms were returned. This resulted in an overall 13% response rate for the control group. Out of the 23 signed control group consent forms received, 19 PAL-II assessment session appointments were successfully scheduled and completed.

Sampling procedures. After obtaining university IRB and study site approval, parent consent and child assent forms were sent to the parents of students who met eligibility criteria (see Appendices A and B). Forms were sent to families via the student, with coordination between the researcher and each student's homeroom teacher. Return envelopes were addressed to the attention of the researcher at her assigned

elementary school. If consent forms were not returned in approximately two weeks, the 14-day follow up post card, along with another copy of the consent forms and another return envelope, was sent home.

Inclusion Criteria

The study site identifies students in need of special education services with primary, and sometimes secondary or tertiary, disabilities. For the purposes of the current study, students met inclusion criteria with a primary eligibility of either a primary disability of Reading SLD or Speech or Language Impairment during the 2015-2016 school year. Students also met inclusion criteria if they had a primary eligibility of Reading SLD and a secondary disability of Speech or Language Impairment during the 2015-2016 school year. Some students initially met eligibility criteria for a Speech or Language Impairment only during the 2015-2016 school year, but were subsequently re-evaluated and then found to meet the criteria of a specific learning disability as well. In this case, the Reading SLD became the child's primary eligibility category, and the Speech or Language Impairment became secondary. In order to participate in the study, students must have been second or third grade students during the 2016-2017 school year.

Exclusion Criteria

Students with primary disabilities other than a Reading SLD or a Speech or Language Impairment were excluded from this study. In other words, students who qualified for special education under the categories of autism, deaf-blindness, deafness, emotional disturbance, hearing impairment, intellectual disability, multiple disabilities,

orthopedic impairment, other health impairment, traumatic brain injury, or visual impairment were excluded from participation if any of the aforementioned diagnoses were listed as their primary disability. The purpose of these exclusion criteria was to allow the researcher to focus on orthographic processing deficit and its ability to differentiate between regular education, Reading SLD, and Speech or Language Impaired populations.

Setting

Description of the Study Site

The study occurred at a moderately sized, rural-suburban district in Northeastern Pennsylvania. Figure 1 illustrates percent enrollment by ethnicity as of 2017. According to the school district's school performance profile, most recent data from 2016-2017 school year indicated that total district enrollment is approximately 6,900 students. The population is 47% female and 53% male. Across the entire district, 18% of students have been identified for special education. Fifty-one percent (51%) are identified as economically disadvantaged. Less than 2% (1.3%) are identified as English Language Learners (Pennsylvania Department of Education, 2017).

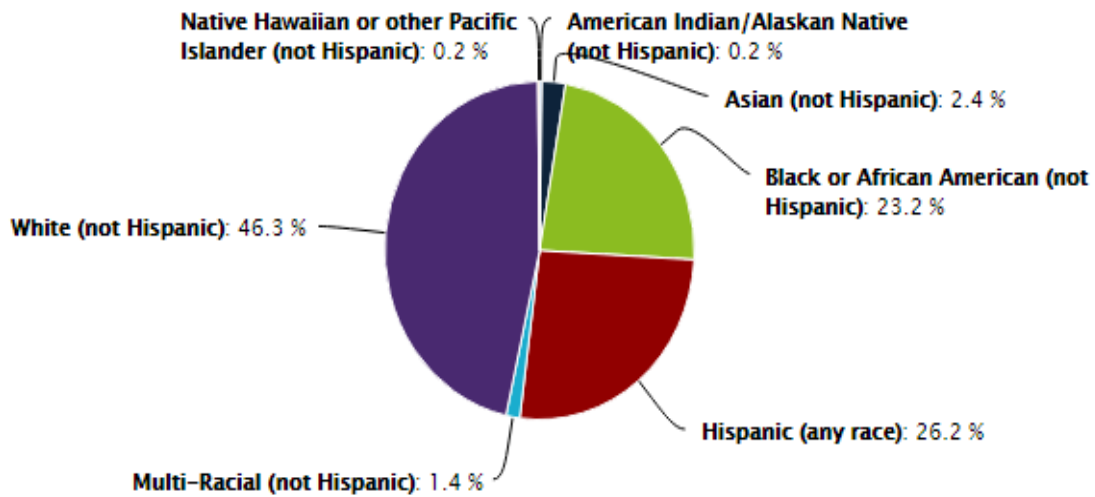


Figure 1. Racial breakdown of the study site.

In recent years, Pennsylvania has begun to transition to a Multi-Tiered System of Supports (MTSS) framework. According to the Pennsylvania Training and Technical Assistance Network (2010) Pennsylvania's MTSS involves a system of supports that include standards-aligned, culturally responsive and high quality core instruction. MTSS also involves the use of data-based decision-making, universal screening procedures, and tiered services and supports. Though the study site is not yet fully immersed in the MTSS process, they utilize high quality core instruction, universal screening, data-based decision making, and tiered services and supports at the elementary level. The following section will provide more information in the setting in which the study occurred.

District Reading Programs

Curriculum. The study site utilizes the *Reading Wonders* reading series.

According to its publishers, *Reading Wonders* contains differentiated levels of curriculum, all of which focus on the same vocabulary, strategies, and skill development (McGraw Hill Education, 2017, p. 2). All elementary students at the study site receive 90 minutes of ELA instruction per day. More specifically, every student receives the core *Reading Wonders* program.

At the second and third grade levels, *Reading Wonders* contains six units of lessons with six weeks of instruction in each unit. The sixth week is a review. Curriculum materials provide a unit overview. Each unit has a suggested lesson plan, as well as plans for the approaching level, on level, and beyond level readers. The focus of each unit includes comprehension, vocabulary, oral vocabulary, sight words, writing, grammar, spelling, and other related tasks. If the leveled readers do not provide enough support to struggling readers, students are moved to Tier II or Tier III levels of support.

While *Reading Wonders* is the reading series, it is only one component of a comprehensive literacy program. This literacy program has been devised by school district reading staff and was designed to align with PA common core. According to the Pennsylvania Department of Education (2013), Common Core standards were adopted in 2010 in order to develop a set of standards that would meet specific instructional needs in the areas of English Language Arts, Mathematics, history, social studies, and

science. The study site also has a comprehensive literacy plan, which addresses educating children from birth through grade twelve. The comprehensive literacy plan includes instruction in the Headstart programs, as well as participation from other preschool programs. These programs actively participated in the development of the comprehensive literacy plan. The literacy plan also includes strategies to involve parents and families in teaching children to read.

Response to Instruction and Intervention at the Study Site

According to Lichtenstein (2008), Response to Intervention (RtI) examines a child's ability to respond to implementation of research-based interventions. Response to Instruction and Intervention (RtII) at the study site varies across buildings due to staffing and student need. Tier II is limited to six students who meet daily for a minimum of 20 but more typically at least 40-45 minutes. Groups at Tier II are comprised of both regular and special education students. Tier II instruction is delivered in the classroom or via pull out sessions. The method of instruction depends on student need, grade level, and teacher preference. Tier III averages from groups of three to six but groups at Tier III cannot exceed six students. Similar to Tier II, Tier III groups can consist of students in both regular and special education. Tier III meets for approximately 30 minutes in second grade and for about 20 minutes in third grade.

Support for struggling readers. For students who need supplemental assistance via Tier II instruction, pull-out or push-in support is available. This support is available for both students with and without disabilities. According to its publisher, the *Reading Wonders* program has leveled readers, which educators deliver via small group

instruction (McGraw Hill Education, 2017). The leveled readers provide various levels of support, depending on student need. Leveled readers support students who are on grade level, who are approaching grade level, or who are beyond grade level. The leveled readers may differ in vocabulary, but all levels present the same material and skills.

WonderWorks. At the study site, students who need a more intensive level of support also receive supplemental instruction through a differentiated component of the *Reading Wonders* curriculum named *WonderWorks*. According to the publisher, *WonderWorks* provides the same core content but scaffolds content to “accelerate progress” (McGraw Hill Education, 2017, p. 3). *WonderWorks* is available for students in both regular and special education.

At the study site, *WonderWorks* is considered Tier III. Students in grades two through five receive *WonderWorks* as part of the Tier III curriculum. *WonderWorks* is typically delivered by special education teachers, though students do not have to be identified as special education in order to receive it. *WonderWorks* itself has two components. First, it consists of a leveled reader with workbooks. In addition, it includes a kit that with additional resources and supplemental work for extra practice and activities for grades two and three.

Independent Variables

According to Alquraini (2013), the Individuals with Disabilities Education Improvement Act (IDEIA) requires that students with disabilities be educated alongside their general education peers to the greatest extent possible throughout the course of

the school day. At the study site, time spent in a special education placement determines level of support. Level of support is calculated by the educational team and documented in the child's Individual Education Plan (IEP) as a percentage. At the study site, students who spend more than 80% of the day in the regular education classroom are considered *itinerant*. Students who spend between 79-40% of the day in the regular education classroom are considered *supplemental*. Students who spend less than 40% of their day in the regular education classroom are considered *full-time*.

At the study site, educational placement is a team decision. Generally speaking, students identified with a Speech or Language Impairment will receive Speech or Language Support. However, a child might meet criteria for a Reading SLD but receive support in an Emotional Support classroom. This determination might be made due to behavior or emotional needs that impede a child's learning, in addition to the presence of the Reading SLD. In this regard, it is important to note that disability alone does not dictate placement. For the purposes of the study, information regarding program placement was gathered from a review of each participant's educational record.

Specific Learning Disability in Reading

For the purpose of the current study, and in accordance with study site eligibility criteria, Reading SLD was operationally defined as a 15-point or greater discrepancy between cognitive ability and academic achievement. This deficit must also negatively impact academic functioning. In order to make this determination, a child's evaluation team reviews a child's grades, inability to meet curriculum based assessment benchmarks, or inability to demonstrate skills expected at a grade level. The eligibility

determination was made by a child's educational team, in which a certified school psychologist must be a member. Information about a child's Reading SLD status was obtained from a review of educational records.

Eligibility status is defined by the Local Education Agency in accordance with the Individuals with Disabilities Education Act (U.S. Department of Education, 2006). The study site uses a discrepancy model to determine the presence of a specific learning disability. According to Kavale (2001), discrepancy models have been the primary way in which learning disabilities have been identified since 1976. Kavale (2001) further stated: "for LD, the primary operation has been the application of a discrepancy criterion" (p.5). Kavale (2001) added that discrepancy generally refers to a difference between ability and achievement, though the model allows for a choice between any number of ability and achievement measures. Lichtenstein (2008) posited that use of a discrepancy can help to operationalize underachievement.

At the study site, a certified school psychologist completes a comprehensive psychoeducational assessment. As part of the evaluation process, the school psychologist administers ability and achievement testing to a student. Ability and achievement assessments are standardized, norm referenced, and individually administered. The most commonly administered assessments at the study site include the Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) and the Wechsler Individual Achievement Test-Third Edition (WIAT-III). However, in certain situations, and with preliminary consultation with district administrators, other assessment instruments were utilized. For instance, the Stanford-Binet Intelligence Scales-5th Edition (SB-5)

might be administered to a child with inconsistent language development or a multilingual background. In other cases, supplemental academic assessment might occur with the Kaufman Test of Educational Achievement-Third Edition (KTEA-3) or the Woodcock Johnson Tests of Achievement-Fourth Edition (WJ-IV Ach).

Speech or Language Impairment

For the purpose of the current study, and in accordance with study site eligibility criteria, Speech or Language Impairment was operationally defined as performance at least one standard deviation below the mean in any language area assessed. This deficit must also impact a child's academic functioning in the school setting. This determination was made by a child's educational team, in which a certified speech language therapist must be a member.

At the study site, a comprehensive speech and language evaluation is completed by a certified speech language therapist, who administers a battery of standardized, norm referenced, and individually administered assessments to a child, as per the referral question. Though assessments administered were dependent on the referral question, the most commonly used speech and language evaluation materials included the Arizona Articulation Proficiency Scale-Third Edition (Arizona-3), Peabody Picture Vocabulary Test-Fourth Edition (PPVT-4), Language Processing Test-3 (LPT-3), Boehm Test of Basic Concepts, Third Edition (Boehm-3), or the Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5). Other speech and language evaluation materials used included the Test for Examining Expressive Morphology (TEEM), Expressive Vocabulary Test, Second Edition (EVT-2), Goldman Fristoe Test of Articulation 2, and the

Expressive One-Word Picture Vocabulary Test (EOWPVT). Eligibility status is defined by the Local Education Agency in accordance with the Individuals with Disabilities Education Act (U.S. Department of Education, 2006). Information about a child's Speech or Language Impairment status was obtained from a review of educational records.

No Disability

For the purposes of the current study, membership in the No Disability (control) group was operationally defined as being a part of the regular education, non-identified second or third grade population at the study site. Students in the regular education group had not received any form of special education services at the time of their selection to participate in the study. Students in the regular education group were selected via a lottery system. Information about a child's regular education status was obtained through a review of records.

Predictor Variables

The predictor variables were orthographic coding ability and early literacy skills. Orthographic coding ability was measured with the Receptive Coding (RC) and Word Choice Accuracy (WCA) Scaled Scores, obtained from a partial administration of the Process Assessment of the Learner-Second Edition (PAL-II). Information regarding participant's early literacy skills was obtained from performance on the Middle of the Year Dynamic Indicators of Basic Early Literacy Skills (MOY DIBELS), including DIBELS-DORF Words Read Correct, DORF-Errors, DORF-Retell, and DORF-Retell Quality. In the third grade sample, MOY DIBELS information also include scores on the three Daze

comprehension measures. Information regarding the predictor variables and the way in which they were measured is presented in the following section.

Instrumentation

Process Assessment of the Learner-Second Edition (PAL-II). In order to directly assess orthographic skills, participants completed the Word Choice and Receptive Coding subtests from the Process Assessment of the Learner-Second Edition (PAL-II). According to Berninger (2007), the Receptive Coding subtest evaluates a child's ability to code written words into memory and segment the word into different sized units by requiring a child to read a written word from a stimulus book and decide whether whole words, single letters, or letter groups correspond to a word that has been coded in memory. The Word Choice subtest is designed to measure a child's knowledge of orthographic spelling ability by requiring the child to identify a correctly spelled real word that is presented with two incorrectly spelled distractors that would have the same pronunciation as the correctly spelled word (Berninger, 2007).

The administration of these two subtests took approximately 20-25 minutes for each participant. Subtests were hand-scored by the researcher, utilizing scoring procedures and tables provided by the publisher in the administration manual. The Receptive Coding subtest yields a scaled score and a percentile rank. The Word Choice subtest yields two scaled scores and percentile ranks: one set for Word Choice Accuracy and another for Word Choice Fluency. Only the scaled score for Receptive Coding and the scaled score for Word Choice Accuracy were utilized for the analysis.

The PAL-II is a standardized, norm-referenced, individually administered assessment. Test developers utilized split-half and alpha, test-retest, and inter-rater agreement methods to assess the reliability of the PAL-II subtests. According to the publishers, reliability coefficients for the Receptive Coding subtest are acceptable for both second and third grade (second grade $\alpha = .72$; third grade $\alpha = .73$). Word Choice Accuracy is considered good for second grade ($\alpha = .88$), but poor for third grade ($\alpha = .58$; NCS Pearson, 2007).

Test publishers also reported information on the content, construct, and concurrent validity of the PAL-II. The technical manual states, “the goal of content validation is to ensure that the items and subtests composing a test adequately sample the domain of behaviors included in the constructs that the test intends to measure” (NCS Pearson, 2007, p. 1074). Evidence of content validity was collected based on response processes.

The purpose of construct validity is to establish a degree of relationship between subtests that are designed to measure the same construct (NCS Pearson, 2007). For the purposes of the current review, the highest and lowest construct validity coefficients for both second and third grade students on the Receptive Coding and the Word Choice subtests are reported. On Receptive Coding for second grade students, the highest coefficient was .5, with the Sentence Sense Accuracy (SSA) subtest. Sentence Sense is a measure of the child’s silent reading fluency. The lowest coefficient for Receptive Coding was .28, with the Rimes subtest. The Rimes subtest assesses the child’s ability to understand rimes in syllables. In third grade, the highest coefficient for Receptive

Coding was .53, with the Morphological Decoding Fluency (MDF) subtest. The MDF subtest is designed to measure a child's ability to pronounce words when various suffixes are added to a base word. The lowest coefficient was .05, with the Sentence Structures subtest. The Sentence Structures subtest evaluates understanding of morphemes and syntax. On the Word Choice subtest for second grade students, the highest coefficient was .68, with the Morphological Decoding Fluency subtest. The lowest coefficient was .09, with the Rimes subtest. For third grade students, the highest coefficient was .33, also with the Morphological Decoding Fluency subtest. The lowest coefficient was .08, with the Sentence Structure subtest (NCS Pearson, 2007).

The purpose of concurrent validity is to examine the relationship between a score on the test in question with external variables, such as performance on other tests designed to measure the same construct. In order to establish concurrent validity, the PAL-II was correlated with the Differential Ability Scales-Second Edition (DAS-II), the Wechsler Nonverbal Scale of Ability (WNV), and the NEPSY-II. Select validity information for the DAS-II and WNV is reported in the current review, as both the DAS-II and WNV are measures of general cognitive ability and are therefore more relevant to this research. According to the publishers, the PAL-II is designed to measure different constructs than the DAS-II, the WNV, and the NEPSY-II. Thus, correlations were predicted to be low and were therefore expected to demonstrate discriminant validity. With regards to the DAS-II, the highest correlation of .39 was observed between the PAL-II Receptive Coding subset and the DAS-II Verbal Cluster. Word Choice Accuracy, on the other hand, was mostly highly correlated with the Working Memory Cluster of the

DAS-II, with a coefficient of .48. With regards to the WNV, the highest correlation with Receptive Coding was on the Recognition (RG) subtest, with a coefficient of .32. Word Choice Accuracy was most highly correlated with the Picture Arrangement (PA) subtest of the WNV, with a coefficient of .37 (NCS Pearson, 2007).

For the purpose of the current study, Orthographic Coding Ability was operationally defined as performance on the PAL-II Receptive Coding and Word Choice Accuracy scaled scores. Both of these scaled scores were chosen to represent the construct of Orthographic Coding Ability. Higher scaled scores represent better performance on a subtest; therefore, higher scaled scores represent higher Orthographic Coding Ability.

Dynamic Indicators of Basic Early Literacy Skills (DIBELS). According to Good, Kaminski, Simmons, and Kame'enui (2001), reading assessment should accomplish the following:

- (a) measure growth on foundational reading skills on a frequent and ongoing basis, (b) predict success or failure on criterion measures of performance (i.e., high-stakes tests), and (c) provide an instructional goal that, if met, will prevent reading failure and promote reading success. (p. 6)

According to Rathvon (2004), the DIBELS system allows educators to monitor the development of early reading skills in children. DIBELS Next is the most recent edition of the DIBELS assessment system. According to Munger, LaFaro, Kawryga, Sovocool, and Medina (2014), assessments included in the DIBELS Next system are designed to

measure early literacy skills such as letter-sound knowledge and phonemic awareness, as well as higher-level skills such as fluency and comprehension.

According to Munger et al. (2014), the DIBELS probes require students to read three brief passages for one minute. At the second grade level, probes administered include Nonsense Word Fluency-Correct Letter Sounds (NWF-CLS), Nonsense Word Fluency-Whole Words Read (NWF-WWR), DORF-Words Correct, DORF-Errors, DORF-Accuracy, DORF-Retell, DORF-Retell Quality. The DIBELS system also produces a composite score for second grade students. At the third grade level, probes administered include DORF-Words Correct, DORF-Errors, DORF-Accuracy, DORF-Retell, DORF-Retell Quality. Additionally, third grade students were assessed with three measures of comprehension: Daze-Correct, Daze-Incorrect, and Daze-Adjusted. The third grade level DIBELS assessment produces a composite score as well.

Kaminski and Good (1996) report that DIBELS NWF is a measure of alphabetic principle, letter-sound correspondence, and the ability to blend letters into words. According to the UO DIBELS Data System (2015a), DORF-Words Correct is a measure of text fluency and accuracy. Munger (2014) notes that a median score is taken to provide information on number of words read correctly. DORF also includes two related scores obtained from probe administration: DORF-Errors, which is a record of the number of errors a student makes, and DORF-Accuracy, which is a percentage. The DIBELS system also includes a measure of how well a child is able to retell information about what they have read. According to the UO DIBELS Data System (2015a), DORF-Retell is designed to provide a comprehension check for passages read. Munger (2014) reports that DORF-

Retell requires students to retell what they had read on the fluency passage. Students receive a score based on how much they are able to retell. The purpose of DORF-Retell is to emphasize the importance of reading to gain meaning from text, rather than just to read for speed. DORF-Retell also includes a measure of the quality of the child's ability to retell information, called DORF-Retell Quality. This assessment is scored by the administrator on a Likert-type 1-4 scale. According to its publishers, DIBELS Daze is a measure of comprehension (UO DIBELS Data System, 2017). It contains three additional measures for students in third grade: Daze-Correct, Daze-Incorrect, and Daze-Adjusted. In order to complete this task, students read a passage where every seventh word is represented by a blank space. The probe presents three possible options with which the blank could be filled. One option is correct, and the other two options are incorrect. Students choose one of the three words as they read through the passage.

At the study site, all second and third grade students were assessed using the DIBELS-Next system throughout the course of the school year. These assessments are conducted by the reading team at each elementary school. The Beginning of the Year (BOY) assessment occurs in September. The Middle of the Year (MOY) assessment occurs in January. The End of the Year (EOY) assessment occurs in May. For the second grade sample, only DORF-Words Correct, DORF-Errors, DORF-Retell, and DORF-Retell Quality were used in the analysis. The NWF probes were not considered in the second grade analysis because letter sound correspondence and sound blending are not of primary interest in the current study. The DORF-Accuracy score was excluded in the analysis because it is a percentage. The second grade DIBELS Composite score was

excluded because it is based in part on DORF-Accuracy and NWF. In the third grade sample, DORF-Words Correct, DORF-Errors, DORF-Retell, and DORF-Retell Quality were used in the analysis. Daze measures were also included in the analysis for the third grade sample. DORF-Accuracy and the Composite scores were also excluded for the third grade sample. MOY probes were chosen because the January time frame aligned most closely with the PAL-II administration time.

According to Tindal, Marston, and Deno (1983), test-retest reliability for the DORF and Retell probes ranges from .92 to .97. Good and Jefferson (1998) report that criterion related validity for DORF and Retell probes ranged from .52 to .91. According to Good, Kaminski, Dewey, Wallin, Powell-Smith, and Latimer (2011), reliability for the Daze measures range from .66 to .99. Good et al. (2011) also report that for the Daze measure, concurrent validity with DORF ranges from .73 to .78 and predictive validity with DORF ranges from .76 to .78.

MOY DIBELS scores served as predictor variables in the current research. They were included to represent the construct of Early Literacy Skills. Thus, early literacy skills are operationally defined as performance on the DORF-Words Correct, DORF-Errors, DORF-Retell, and DORF-Retell Quality for the second grade sample and by performance on the DORF-Words Correct, DORF-Errors, DORF-Retell, DORF-Retell Quality, and Daze comprehension measures for the third grade sample.

Research Design

This study utilized a quasi-experimental design in order to examine the role of orthographic coding ability in students previously identified with a reading disability or

speech or language impairment, as well as with a non-disabled control group. The research design was considered quasi-experimental because disability groups existed, but there was no random assignment to groups. Participants were grouped according to special education eligibility status. There was no random selection of participants in disability groups. However, participants in the regular education control group were selected via a lottery system. Every regular education second and third grade student enrolled at the study site had an equal opportunity for participation.

Procedure

Conversations With Stakeholders

In the fall of the 2016-2017 school year, the researcher met with administrative stakeholders, including her direct supervisor, the study site superintendent, and the study site special education director. Next, the researcher emailed building administrators and school counselors in each of the six elementary schools. The purpose of this email communication was to inform district stakeholders to the purpose of the study, as well as to alert them to study related communications that would be disseminated through their second and third grade classrooms. The researcher made an effort to speak with each building administrator personally before sending out research packets. These conversations occurred prior to November 24, 2016. In order to facilitate the discussion, the researcher provided building administrators, guidance counselors, and second and third grade teachers with a brief informational summary entitled *Orthographic Coding-What Families and Schools Should Know*. School teams

were encouraged to share this informational summary if they were approached by parents with questions regarding the study.

Research Packet

For all participants in both treatment and control groups, the researcher assembled research packets that contained combined informational letters and parent consent describing the study and its purpose, child assent forms, and a return envelope with the researcher's name and assigned building to the parents of each student on the list (see Appendices A and B). All study-related communication was sent home via the student and facilitated by the participant's homeroom teacher, with advanced notice from the researcher.

The parent consent form explained the purpose of the study, why their child was selected for participation, and what data would be collected. The form also reinforced that participation was voluntary and that all data collected would be maintained in a confidential manner. The consent form also contained a separate page designed to collect demographic information such as free and reduced lunch status, whether the child was retained, and if so, in what grade the retention occurred.

In addition, the research packet contained a child assent form. This form was designed to educate potential participants about the study and why their participation was being solicited. Similar to the parent consent form, the child assent form emphasized that participation is voluntary and ensured the child, in age-appropriate terms, that they would not have to participate if they did not want to. Though the child assent form was written in child-friendly language, it was designed to be discussed by

parents with the child. Similarly, in the parent consent form, parents were encouraged to discuss the study with their children and answer any questions their children might have. The researcher's contact information was included on both the parent consent and child assent forms, and parents were encouraged to contact the researcher if they or their child had any question or concerns about participation. If consent was not received after the first attempt, the follow-up post card was mailed to non-respondents 14 days after the packet was mailed). Those who had not yet responded were reminded that although their participation was solicited, it was strictly voluntary.

Data Collection Procedures

Once consent forms were returned, data collection began. Study data were collected in two phases: Phase one involved direct assessment of orthographic skills with the PAL-II. Phase two involved a file review, through which demographic information and curriculum based information (as discussed previously) were collected by the researcher utilizing the file review form (please refer to Appendix B). The data collection process began after the study was approved by the University Institutional Review Board (IRB).

Phase One: Prospective Data Collection via Additional Assessment of Orthographic Skills

As parent consent forms were received, the researcher contacted parents to set up a time to administer the PAL-II to the child. Each assessment was conducted individually and occurred in an approved school setting (i.e., the central administration office, the child's elementary school, or in the office of the researcher's assigned

building). Specific school setting varied depending on the most convenient location for the family. All sessions were scheduled after school, so that participants did not miss any instructional/intervention time during the school day. Administration of the Receptive Coding and Word Choice subtests took approximately 20-25 minutes for each participant. Latency between administration of the PAL-II and administration of MOY DIBELS was minimized to the greatest extent possible. No PAL-II assessment session was conducted more than two months before or two months after MOY DIBELS information was collected by a child's educational team.

Phase Two: Data Collected via File Review

Upon receipt of consent and completion of the PAL-II assessment, file review confirmed that each participant was appropriately assigned to the correct treatment group. This confirmation process consisted of a review of the child's evaluation or re-evaluation report, assessment scores, and conclusions and recommendations of the assigned building. For each participant, disability type, as well as degree of discrepancy (when applicable), were noted in the file review. In addition, type of service received (regular education, learning support, speech and language support, or other) was also noted in the file review.

In order to collect relevant data for the purpose of the current study, a File Review Form and Data Collection Sheet was developed (please refer to Appendix B). File review was conducted by the researcher upon receipt of parent consent and after the administration of the PAL-II. The purpose of the File Review Form was to assist the

researcher in collecting relevant information regarding the participants' demographics, disability type, and curriculum based assessment scores.

Demographic information. Demographic information collected included information on participants' sex (male/female), age, grade (second or third), family income (free lunch, reduced lunch, or none), and whether or not a student was retained. If retention occurred, information was also collected on the grade in which the child was retained. This information was collected to describe the sample and to check to make sure assumptions were met. Information on disability type and subtype were also collected to address the research questions.

Completion of parent information sheet. After the completion of Phase One and Phase Two, parents received a summary of their child's performance on the PAL-II. This form was completed by the researcher and sent home with each student in May of 2017. This form was designed as a summary report only, and was not intended to provide a thorough interpretation of the child's reading ability. Parents were reminded that this summary report is confidential in nature. Individual data were not disclosed to the child's educational team by the researcher. However, parents were encouraged to share results with their child's educators if they felt that the information would be useful to the school team.

Confidentiality and Use of Data

The data will be stored along with other confidential data in a locked filing cabinet at the researcher's office. This data will not become a part of a child's educational record. According to data management protocol, the data will be

maintained and secured by the researcher for at least three years. All individual scores will be held in strict confidence. At this time, the school district does not use the PAL-II to inform educational decisions. Ultimately, the decision to utilize this assessment in any way will be a local education agency (LEA) decision. The data gathered through this study will help to assist the district in making this decision. For instance, if the LEA feels that information gathered is relevant and beneficial to the educational decision making process, they might decide to train personnel in the administration of the assessment.

Data Analysis

Data for each participant was coded and entered into the Statistical Package for the Social Sciences (SPSS) program. Demographic statistics were calculated and a visual inspection of graphic data identified any possible outliers or errors in data entry. Information regarding a student's disability status was also entered into the SPSS. Likewise, curriculum based assessment scores were entered into the SPSS as raw numerical scores. Finally, results of the PAL-II Receptive Coding and Word Choice Accuracy subtests were entered into the SPSS as standardized age-based scaled score and percentile. However, only the scaled scores were used in the analysis.

The first research question asked: does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy, correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in second grade students? It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores will correlate positively with performance on the MOY

DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, and DORF-Retell Quality, and negatively in the area of DORF-Errors. Probes obtained at the middle of the year were chosen because that January time frame aligned most closely with the PAL-II administration time. In order to address this question, a Spearman's rank-order correlation matrix was generated for the six variables under review in the second grade sample. This analysis was chosen because a Spearman's rank-order correlation does not require data to be normally distributed. According to Faherty (2008), this analysis allows a researcher to determine if there is a relationship between variables that are at least ordinal in nature. In other words, Spearman's rank-order correlation does not require data to be at least interval, ratio, or scale.

The second research question asked: does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy correlate with reading performance as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in third grade students? It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores will correlate positively with performance on the MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted, and negatively in the area of DORF-Errors and Daze-Incorrect. In order to address this question, a second Spearman's rank-order correlation matrix was generated to examine relationships between the nine variables under consideration for the third grade sample.

The third research question asked: does orthographic coding, as measured by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II, distinguish between children with no disability, a language impairment, and learning disability in reading? It was hypothesized that orthographic coding ability, as measured by performance on the Receptive Coding (RC) and Word Choice Accuracy subtests of the Process Assessment of the Learner-Second Edition (PAL-II) would accurately predict disability group membership. In order to address this question, a Discriminate Function Analysis was conducted to determine if Receptive Coding and Word Choice Accuracy scaled scores on the PAL-II accurately predict disability group membership. In order to address this question, a Discriminant Function Analysis (DFA) was calculated. According to Field (2009), DFA provides information about how dependent variables discriminate between groups. It does this by identifying significant variates and how each dependent variable contributes to each variate.

Table 1 provides a description of the research questions, along with corresponding variables and statistical analyses used to answer each question. In order to answer the first two questions, a series of correlations were calculated. This analysis was chosen in order to explore the relationship between all the of the variables under consideration in the second and third research questions. The correlations allowed the researcher to explore relationships between orthography and performance on commonly used academic assessments.

Table 1

Research Question, Variables, and Statistical Analyses

Research Question	Variables	Statistical Analyses
Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy, correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in second grade students?	PAL-II Receptive Coding Scaled Score PAL-II Word Choice Accuracy Scaled Score Second Grade DORF-Words Correct, DORF-Errors, DORF-Retell, and DORF-Retell Quality	Spearman's Rank-Order Correlation
Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy, correlate with reading performance as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in third grade students?	PAL-II Receptive Coding Scaled Score PAL-II Word Choice Accuracy Scaled Score Third Grade DORF-Words Correct, DORF-Errors, DORF-Retell, DORF-Retell Quality, Daze-Correct, Daze-Incorrect, and Daze-Adjusted scores	Spearman's Rank-Order Correlation

Does orthographic processing, as measured by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II, distinguish between children with no disability, a language impairment, and learning disability in reading?	PAL-II Receptive Coding Scaled Score PAL-II Word Choice Accuracy Scaled Score DORF-Words Correct, DORF-Errors, and DORF-Retell scores	Discriminate Function Analysis
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Note. PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score; DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; DORF-Retell Quality = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell Quality.

Summary

This chapter outlined the methodology of the study, including the research design, study site, population, sample size, inclusion criteria, and exclusion criteria. It also discussed threats to internal and external validity. The chapter began with a presentation on study participants, including a description of the sample, population, and sampling procedures. Next, the chapter provided a description of the setting, including a description of the study site, as well as the curriculum used at the site and supports available for struggling readers. Subsequently, the chapter discussed the variables under consideration, including three independent variables and five predictor variables. Next, the chapter reviewed study procedures, including data collection procedures. Finally, the chapter concluded with a review of the data analysis.

CHAPTER 4

RESULTS

The primary purpose of this study was to determine if there was a relationship between early literacy skills and orthographic coding ability in second and third grade students. The first research question was as follows: does orthographic processing, as measured by performance on Process Assessment of the Learner-Second Edition (PAL-II) Receptive Coding (RC) and Word Choice Accuracy (WCA), correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) in second grade students? The second research question was: does orthographic processing, as measured by performance on PAL-II RC and WCA correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the DIBELS in third grade students? In order to address these questions, two correlational analyses were conducted.

After these preliminary relationships were established, the study examined the role of orthographic coding in distinguishing between membership in three disability groups by examining links between orthographic coding skills and language and learning disabilities. The third question was: does orthographic processing, as measured by the PAL-II RC and WCA, distinguish between children with no disability, a language impairment, and learning disability in reading? This question attempted to determine if orthographic coding ability would reliably predict disability group membership. In order to address this question, a discriminate function analysis (DFA) was completed.

This chapter will begin with a description of the sample, including participant characteristics and demographics. Next, results of the two correlational analyses will be presented. Subsequently, the chapter will address the third and most critical question: whether orthographic coding ability can accurately predict disability group membership. Statistical assumptions will be addressed alongside the presentation of research question results. Results for all three analyses will be summarized at the conclusion of the chapter.

Characteristics of the Sample

The study sample was obtained in part from 86 second and third grade special education students who were recruited for participation. An additional group, comprised of students who had no history of special education involvement, was included as a nondisabled control group. One hundred seventy four consent forms were sent to regular education students to populate this control group. Thirty-eight participants in all were administered the PAL-II assessment. Only two participants met the criteria for comorbid reading and speech disabilities. Due to an insufficient number of participants in the comorbid group, these two participants, and the comorbid group as a whole, were excluded from further analysis.

The remaining sample of 36 participants included 18 males and 18 females. Participants ranged in age from seven to ten years old, with the majority of participants ($n = 16$) being 8 years of age. Fifteen participants were in second grade and 21 were in third grade. Thirteen participants received free lunch, 4 received reduced lunch, and 19

did not participate in the free and reduced lunch program. Table 2 lists the number of participants in each disability group.

Table 2

Number of Participants Per Disability Group

Disability Group	<i>N</i>
Reading SLD	6
Speech or Language Impairment	11
No Disability (Control)	19
Total	36

Note. SLD = Specific Learning Disability

Table 3 illustrates the type of educational program received by each of the 36 participants during the 2015-2016 school year, when they met study criteria and were therefore solicited for participation. Nineteen of the participants were in the No Disability control group. Eleven participants received Speech or Language support at the time of identification. Five participants received Learning Support, and one received Emotional Support.

Table 3

Number of Participants by Type of Program Received (per 2015-2016 Evaluation)

Program Type	<i>N</i>
No Disability (Control Group)	19
Speech or Language Support	11
Learning Support	5
Emotional Support	1 ^a

^aThis participant spent 79-40% of the day in the regular education classroom. As a student in emotional support, he also received access to behavioral and emotional support either through goals and supports from school personnel to address behavioral needs.

For students in the Speech or Language Impairment group, a review of educational records revealed that all 11 of the students who met criteria for this disability group received itinerant speech and language support during the 2015-2016 school year. Four participants in the Learning Support group received itinerant learning support during the 2015-2016 school year, and one participant received supplemental learning support during the 2015-2016 school year. The four students who received itinerant learning support spent 80% or more of their day with regular education peers. The remainder of their day would occur in a small group targeted to support development of deficit skills in the areas of reading. These deficits were determined based on data taken by learning support teachers at the time of identification. For these students, a special educational teacher or an alternative approved educator would deliver special education support in the regular education classroom. For the participant receiving supplemental learning support, 79-40% of the day was spent in the regular education classroom. As with the itinerant students, the remainder of his day might occur in a small group focused on targeted academic intervention, depending on individual student need. At the study site, special education support decisions were made during the child's Individualized Education Plan (IEP) meeting.

Finally, one participant received itinerant emotional support during the 2015-2016 school year. At the study site, itinerant emotional support incorporates *push-in* or *pull-out* academic support and access to a social skills group. Push-in support involves support staff delivering instruction to small groups of students within the regular education classroom. Pull-out support means that students are taken from the regular

education room to receive their intervention in another setting, such as a learning support classroom or resource room. Students in an emotional support placement also receive behavior and emotional support either through specially designed instruction (i.e., supports that school personnel put in place to assist the child in meeting goals) or via specific goals designed to address behavioral needs.

Data Screening

Prior to conducting any statistical analyses, univariate and multivariate screening was conducted to ensure accuracy of data entry and that statistical assumptions were met. First, the data were visually checked for missing or unusual data. To further ensure accuracy of data, descriptive statistics and frequencies were calculated. Next, data were checked for outliers.

Complications

Not all participants had Daze scores entered into the DIBELS system. All DIBELS data is recorded by a child's teacher or by their reading team. If Daze scores were not entered into the DIBELS system, they were not included in the analysis. In addition, only two participants met criteria for comorbid language and learning disabilities. Therefore, this group was excluded from the analysis. Finally, DORF-Retell and DORF-Retell Quality scores were not available for one second grade participant.

Data Analysis

The first two research questions proposed in this study were designed to determine if there is a relationship between previously obtained curriculum based assessment scores, collected via Middle of the Year Dynamic Indicators of Basic Early

Literacy Skills (MOY DIBELS) and newly obtained scores on PAL-II subtests. Research question one addresses this issue for the second grade sample, and research question two addresses the same issue for the third grade sample. These questions are important because they will provide more information concerning the relationship between previously obtained curriculum-based measures of reading performance commonly used in elementary school settings and orthographic coding performance. The third question was designed to explore the utility of PAL-II scores in predicting disability group membership.

Research Question One

The first research question was: Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in second grade students? Based upon theoretical and empirical evidence (see Aaron et al., 1999; Moats, 1998; Munro, 1995), it was hypothesized that there would be a significant positive correlation between PAL-II Receptive Coding and Word Choice Accuracy scaled scores and MOY DIBELS probes in the areas of DIBELS Oral Reading Fluency (DORF)-Words Correct, DORF-Retell, and DORF-Retell Quality. In addition, there would be a significant negative correlation between PAL-II scores and DORF-Errors. Typically, the MOY assessments occur in early January, upon returning from the holiday break.

Assumptions of the statistical analysis. Prior to analyses, the data were reviewed to determine if assumptions for correlational research were met. Scores on DORF-Words Correct, DORF-Errors, and DORF-Retell are considered interval data. However, DORF-Retell Quality is evaluated on a Likert-type scale, which makes scores on this assessment ordinal data. Results of the Shapiro-Wilk statistic examining normality of each variable for the second grade sample are presented in Table 4. A Shapiro-Wilk statistic with a significance level $<.05$ indicates that data are not normally distributed. Since the data set contained ordinal data and because the data were not normally distributed for a number of variables, a Spearman's rank-order correlation was chosen to answer this question.

Table 4

Results of the Shapiro-Wilk Test for Normality in MOY DIBELS and PAL-II Subtests for the Second Grade Sample

Measure	Shapiro-Wilk Statistic	<i>p</i>
DORF-Words Correct ^a	.889	.079
DORF-Errors ^b	.845	.019*
DORF-Retell ^c	.924	.248
DORF-Retell Quality ^d	.862	.033*
PAL-II RC Scaled Score ^e	.954	.629
PAL-II WCA Scaled Score ^f	.718	.001*

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; DORF-Retell Quality = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell Quality; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 15. ^b*n* = 15. ^c*n* = 14. ^d*n* = 14. ^e*n* = 15. ^f*n* = 15.

**p* < .05 level

Finally, the data must be linear. A visual inspection of a scatterplot matrix confirmed that this assumption was met.

Results of the statistical analysis for Research Question One. A series of Spearman's rank-order correlations were conducted in order to examine relationships between the MOY DIBELS and PAL-II scores for the second grade sample. This analysis was conducted to establish relationships between orthographic coding and early literacy skills for the second grade sample. The first question was designed to provide additional information regarding relationships between these two constructs to supplement previous research, which has established a connection between fluency and orthography (see Moats, 1998). Second grade students from both the special education groups and the control group were included in the analysis. Refer to Table 4 for more information regarding sample size.

The magnitude of each correlation coefficient was determined by utilizing criteria established by Cohen (1988). According to Cohen (1988), coefficients in the range of .10 are considered small, coefficients in the range of .30 are considered medium, and those exceeding .50 are considered large. Table 5 presents the correlations between the MOY DIBELS scores and the PAL-II scores for the second grade sample. Results indicated a number of statistically significant positive correlations between MOY DIBELS and PAL-II scores. The relationship between DORF-Words Correct and PAL-II RC was statistically significant and positive, $r_s = .676$, $n = 15$, $p < .01$. The relationship between DORF-Words Correct and PAL-II WCA was also statistically significant and positive, $r_s = .830$, $n = 15$, $p < .01$. Statistically significant positive

correlations were observed between DORF-Retell and PAL-II RC Scaled Score, $r_s = .656$, $n = 14$, $p < .05$, as well as between DORF-Retell and PAL-II WCA Scaled Score, $r_s = .734$, $n = 14$, $p < .01$. Additionally, the correlation between PAL-II WCA and DORF Retell Quality was statistically significant and positive, $r_s = .610$, $n = 14$, $p < .05$. Only one non-statistically significant relationship was revealed between MOY DIBELS and PAL-II scores; the correlation between PAL-II RC and DORF-Retell Quality, $r_s = .384$, $n = 14$, $p = .176$.

As expected, DORF-Errors revealed statistically significant negative correlations when compared with both PAL-II subtests. These negative correlations were anticipated because DORF-Errors was entered as number of errors that a child makes when reading. Therefore, it was anticipated that a higher number of errors would have an inverse relationship with all other measures because all other measures are entered as a numerical value with the higher value being associated with a more positive score. The correlation between DORF-Errors and the PAL-II RC scaled score was statistically significant and negative, $r_s = -.622$, $n = 15$, $p < .05$, while the relationship between DORF-Errors and the PAL-II WCA scaled score was also statistically significant and negative, $r_s = -.730$, $n = 15$, $p < .01$. These results indicate that the more errors participants exhibited on DORF-Errors, the lower their PAL-II RC and WCA scores.

Overall, results partially confirm the hypothesis that there would be significant positive correlations between MOY DIBELS and PAL-II scores in the areas of DORF-Words Correct, DORF-Retell, and DORF-Retell Quality and statistically significant negative correlations between DORF-Errors and all other measures. All correlations between the DIBELS and PAL-II scores were significant with the exception of the correlation between

PAL-II RC and DORF-Retell Quality. Thus, the better second grade participants performed on the MOY DIBELS probes (with the exception of DORF-Retell Quality), the better their performance on PAL-II subtests. Conversely, the more errors participants received on DORF-Errors, the lower their performance on both PAL-II subtests would be.

Other statistically significant correlations of note were revealed between various scores on the DIBELS, as well as between the two PAL-II subtests. DORF-Words Correct and DORF-Retell revealed a large positive correlation, $r_s = .824, n = 14, p < .01$. The correlation between DORF-Words Correct and DORF-Retell Quality revealed a large positive correlation, $r_s = .714, n = 14, p < .01$, while the correlation between DORF-Retell and DORF-Retell Quality was also large, $r_s = .782, n = 14, p < .01$. Correlations between PAL-II RC and PAL-II WCA also demonstrated a large positive correlation, $r_s = .643, n = 15, p < .01$. These results indicate that DIBELS and PAL-II subtests were largely positively correlated with each other.

As expected, DORF-Words Correct and DORF-Errors revealed a statistically significant negative correlation, $r_s = -.782, n = 15, p < .01$. The correlation between DORF-Retell and DORF-Errors was also large and negative, $r_s = -.763, n = 14, p < .01$. The correlation between DORF-Retell Quality and DORF-Errors was large and negative as well, $r_s = -.588, n = 14, p < .05$. The correlation between DORF-Errors and the PAL-II RC scaled score was large and negative, $r_s = -.622, n = 15, p < .05$, and the relationship between DORF-Errors and the PAL-II WCA scaled score was also large and negative, $r_s = -.730, n = 15, p < .01$. All correlations were statistically significant. These results reveal

that the more errors participants made on DORF-Errors, the lower their performance in other areas of the MOY DIBELS assessments.

Table 5

Correlation Matrix of MOY DIBELS Scores and PAL-II Scores for the Second Grade Sample

Measure	1	2	3	4	5	6
1. DORF Words Correct ^a	--					
2. DORF-Errors ^b	-.782**	--				
3. DORF-Retell ^c	.824**	-.763**	--			
4. DORF-Retell Quality ^d	.714**	-.588**	.782**	--		
5. PAL-II RC Scaled Score ^e	.676**	-.622**	.656*	.384	--	
6. PAL-II WCA Scaled Score ^f	.830**	-.730**	.734**	.610*	.643**	--

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; DORF-Retell Quality = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell Quality; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 15. ^b*n* = 15. ^c*n* = 14. ^d*n* = 14. ^e*n* = 15. ^f*n* = 15.

p* < .05 level (2-tailed). *p* < .01 (2-tailed).

Research Question Two

The second research question was: Does orthographic processing, as measured by performance on PAL-II Receptive Coding and Word Choice Accuracy correlate with reading performance, as measured by performance on the middle of the year (MOY) Oral Reading Fluency probes of the Dynamic Indicators of Basic Early Literacy Skills in third grade students? It was hypothesized that there would be a significant positive correlation between PAL-II Receptive Coding and Word Choice Accuracy scaled scores and MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted. In addition, there would be a significant negative correlation between PAL-II scores, DORF-Errors, and Daze-Incorrect. Daze-Correct, Daze-Incorrect, and Daze-Adjusted are measures of comprehension that are also administered to third grade students. Probes obtained at the middle of the year were chosen because that time frame aligns most closely with the PAL-II administration time.

Assumption of the statistical analysis. Prior to analyses, the data were reviewed to determine if assumptions for correlational research were met. Scores on DORF-Words Correct, DORF-Errors, DORF-Retell, and all three Daze measures are considered interval data. However, DORF-Retell Quality is evaluated on a Likert-type scale, which makes scores on this assessment ordinal data. Results of the Shapiro-Wilk statistic, examining normality of variables for third grade participants are presented in Table 6. A Shapiro-Wilk statistic with a significance level $<.05$ indicates that data are not normally distributed. Since the data set contained ordinal data and because the data were not

normally distributed for a number of variables, a Spearman's rank-order correlation was chosen to address this question.

Table 6

Results of the Shapiro-Wilk Test for Normality in MOY DIBELS and PAL-II Subtests for the Third Grade Sample

Measure	Shapiro-Wilk Statistic	<i>p</i>
DORF-Words Correct ^a	.952	.367
DORF-Errors ^b	.914	.066
DORF-Retell ^c	.922	.094
DORF-Retell Quality ^d	.633	.000*
Daze-Correct ^e	.938	.290
Daze-Incorrect ^f	.823	.004*
Daze-Adjusted ^g	.911	.106
PAL-II RC Scaled Score ^h	.973	.796
PAL-II WCA Scaled Score ⁱ	.788	.000*

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; DORF-Retell Quality = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell Quality; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 21. ^b*n* = 21. ^c*n* = 21. ^d*n* = 21. ^e*n* = 17. ^f*n* = 17. ^g*n* = 17. ^h*n* = 21. ⁱ*n* = 21.

**p* < .05 level

Finally, the data must be linear. A visual inspection of a scatterplot matrix confirmed that this assumption was met.

Results of the statistical analysis for Research Question Two. A series of Spearman's rank-order correlations were conducted in order to examine the relationship between MOY DIBELS and PAL-II scores for the third grade sample. This analysis was conducted to establish relationships between orthographic coding and early literacy skills for the third grade sample. The second question was designed to

provide additional information regarding relationships between the constructs of orthography, fluency, and comprehension. Previous research has established a connection between orthography and comprehension (see Pennington & Bishop, 2009). Third grade students from both the special education groups and the control group were included in the analysis. Refer to Table 6 for more information regarding sample size.

Once again, the magnitudes established by Cohen (1988) were used for descriptive purposes. Table 7 presents the correlation matrix between MOY DIBELS Scores and PAL-II scores for the third grade sample. Results revealed a number of statistically significant positive correlations. A large positive correlation existed between DORF-Words Correct and the PAL-II RC scaled score, $r_s = .750, n = 21, p < .01$. A large positive correlation was revealed between the DORF-Words Correct and the PAL-II WCA scaled score, $r_s = .699, n = 21, p < .01$. Similarly, statistically significant positive correlations were revealed between the DORF-Retell and PAL-II RC Scaled Score, $r_s = .551, n = 21, p < .01$, as well as between DORF-Retell and PAL-II WCA Scaled Score, $r_s = .490, n = 21, p < .05$. These results reveal that the better participants performed on DORF-Words Correct and DORF-Retell assessments, the better their performance on both PAL-II subtests.

Statistically significant positive correlations were also revealed between MOY DIBELS measures of comprehension and PAL-II scores. Daze-Adjusted and PAL-II RC Scaled Score exhibited a large positive correlation, $r_s = .797, n = 17, p < .01$. Daze-Adjusted and PAL-II WCA Scaled Score were largely correlated, $r_s = .514, n = 17, p < .05$.

Additionally, the correlation between Daze-Correct and PAL-II RC Scaled Score was large and positive, $r_s = .723$, $n = 17$, $p < .01$. Daze-Correct and PAL-II WCA Scaled Score were still positive, but medium, $r_s = .490$, $n = 17$, $p < .05$. These results confirmed that the better participants performed on measures of comprehension, as assessed by DIBELS Daze, the higher their performance on both PAL-II subtests.

As predicted, correlations between DORF-Errors and PAL-II measures were statistically significant. The correlation between DORF-Errors and the PAL-II RC scaled score was large and negative, $r_s = -.597$, $n = 21$, $p < .01$, as was the relationship between DORF-Errors and the PAL-II WCA scaled score, $r_s = -.678$, $n = 21$, $p < .01$. These relationships reveal that the more errors participants exhibited on DORF-Errors, the lower their performance on both PAL-II subtests.

However, a number of non-statistically significant relationships were also revealed between MOY DIBELS and PAL-II scores for the third grade sample. DORF-Retell Quality and PAL-II RC Scaled Score were positively correlated, but the correlation was not statistically significant, $r_s = .016$, $n = 21$, $p = .945$. DORF-Retell Quality and PAL-II WCA Scaled Score were also positively correlated, but the relationship was not statistically significant, $r_s = .216$, $n = 21$, $p = .347$. Daze-Incorrect and PAL-II RC Scaled Score revealed a medium negative correlation, $r_s = -.410$, $n = 17$, $p = .102$; however, this correlation was not statistically significant. The correlation between Daze-Incorrect and PAL-II WCA Scaled Score was negative and small, $r_s = -.145$, $n = 17$, $p = .579$.

Overall, results of the analyses partially confirmed the hypothesis that there would be significant positive correlations between PAL-II Receptive Coding and Word

Choice Accuracy scaled scores and MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted and significant negative correlations between PAL-II scores and DORF-Errors and Daze-Incorrect in the third grade sample. Significant positive correlations were revealed between DORF-Words Correct, DORF-Retell, Daze-Correct, and Daze Adjusted and both PAL-II subtests. These results revealed that the better participants performed on these MOY DIBELS assessments, the better they would perform on PAL-II subtests. Likewise, significant negative correlations were revealed between DORF-Errors and both PAL-II subtests. Therefore, the higher the number of errors participants obtained on DORF-Errors, the lower their performance would be on PAL-II subtests. However, the relationships between DORF-Retell Quality and both PAL-II subtests was not statistically significant. The negative relationship between Daze-Incorrect and both PAL-II subtests were also not statistically significant.

Large correlations were revealed between various scores on the DIBELS, as well as between the two PAL-II subtests. All of these relationships were statistically significant. DORF-Words Correct and DORF-Retell revealed a large positive correlation, $r_s = .743, n = 21, p < .01$, while PAL-II RC and PAL-II WCA also demonstrated a large positive correlation, $r_s = .546, n = 21, p < .05$. Daze-Correct exhibited a large positive correlation with DIBELS-Words Correct, $r_s = .828, n = 18, p < .01$. The correlation between DIBELS-Retell and DORF-Retell Quality was large and positive, $r_s = .597, n = 21, p < .01$. Finally, large correlations were revealed between the DAZE probes. For

instance, Daze-Correct and Daze-Adjusted exhibited a large positive correlation, $r_s = .946$, $n = 17$, $p < .01$.

As predicted, DORF-Errors and Daze-Incorrect were also negatively correlated with other MOY DIBELS measures. The correlation between DORF-Words Correct and DORF-Errors revealed a large negative correlation, $r_s = -.726$, $n = 21$, $p < .01$. The correlation between DORF-Retell and DORF-Errors was medium and negative, $r_s = -.499$, $n = 21$, $p < .05$. DIBELS Retell and Daze-Incorrect were negatively correlated, $r_s = -.507$, $n = 17$, $p < .05$. All three of these relationships were also statistically significant.

Table 7

Correlation Matrix of MOY DIBELS Scores and PAL-II Scores for the Third Grade Sample

Measure	1	2	3	4	5	6	7	8	9
1. DORF Words Correct ^a	--								
2. DORF-Errors ^b	-.726**	--							
3. DORF-Retell ^c	.743**	-.499*	--						
4. DORF-Retell Quality ^d	.453*	-.065	.597**	--					
5. Daze-Correct ^e	.828**	-.596*	.721**	.350	--				
6. Daze-Incorrect ^f	-.258	.018	-.507*	-.245	-.359	--			
7. Daze-Adjusted ^g	.782**	-.536*	.729**	.254	.946**	-.587*	--		
8. PAL-II RC Scaled Score ^h	.750**	-.597**	.551**	.016	.732**	-.410	.797**	--	
9. PAL-II WCA Scaled Score ⁱ	.699**	-.678**	.490**	.216	.490*	-.145	.514*	.546*	--

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; DORF-Retell Quality = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell Quality; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 21. ^b*n* = 21. ^c*n* = 21. ^d*n* = 21. ^e*n* = 17. ^f*n* = 17. ^g*n* = 17. ^h*n* = 21. ⁱ*n* = 21.

p* < .05 level (2-tailed). *p* < .01 (2-tailed).

Research Question Three

The third research question was: Does orthographic processing, as measured by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II, distinguish between children with no disability, a language impairment, and learning disability in reading? It was hypothesized that orthographic coding ability, as measured by performance on the Receptive Coding (RC) and Word Choice Accuracy subtests of the Process Assessment of the Learner-Second Edition (PAL-II) would accurately predict disability group membership. In order to address this question, a Discriminant Function Analysis (DFA) was conducted.

Assumptions of the statistical analysis. Prior to the analysis, the data were reviewed to determine if the assumptions for the DFA were met. According to Tabachnick and Fidell (2013), assumptions for a DFA are as follows: a) equal sample sizes and missing data b) normality of sampling distributions c) no outliers d) linearity e) homogeneity of variance-covariance matrices f) absence of multicollinearity and singularity. The research design contains five continuous predictors; DORF-Words Correct, DORF-Retell, DORF-Errors, PAL-II Receptive Coding Scaled Score, and PAL-II Word Choice Accuracy Scaled Score, and one categorical independent variable, disability group. The categorical Independent Variable (IV) consisted of three levels: No Disability, Speech or Language Impairment, or Reading SLD. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS), Version 24.

In order to check the assumption of equal samples and missing data, frequencies and descriptive statistics were calculated for all five predictor variables in all three

disability groups, using SPSS. Predictor variables included DORF-Words Correct, DORF-Retell, DORF-Errors, PAL-II Receptive Coding Scaled Score, and PAL-II Word Choice Accuracy Scaled Score. Disability groups include No Disability, Speech or Language Impairment, and Reading SLD. No missing cases existed for any of the five predictor variables in the No Disability or Speech or Language Impairment groups. A DIBELS-Retell score was missing for one participant in the Reading SLD group. According to Tabachnick and Fidell (2013), “the sample size of the smallest group should exceed the number of predictor variables” (p. 383). In the current study, the Reading SLD group consists of 6 cases, which exceeds the number of predictor variables by one. Thus, the data met the criteria for this assumption.

Univariate normality was assessed by calculating skewness and kurtosis values for each predictor variable in SPSS. Results of the skewness analysis are presented in Table 8. According to Tabachnick and Fidell (2013), skewness refers to the symmetry of the distribution. A variable that is skewed indicates a mean that is not centrally distributed. In order to determine if the level of skewness is significant enough to warrant concern (i.e., the assumption of univariate normality was not met), Z scores were calculated using a standard error value of .398.

Resulting Z Scores are presented in Table 8. With a significance level of .01, Z score = ± 2.58 . Results reveal that the level of skewness for the predictor variable PAL-II WCA scaled score is significant. However, according to Tabachnick and Fidell (2013), DFA is “robust to failures of normality if violation is caused by skewness rather than outliers” (p. 384).

Table 8

Results of the Skewness Calculation for the Predictor Variables of MOY DIBELS and PAL-II Subtests

Predictor Variable ^a	Skewness	Z-Score
DORF-Words Correct	.193	.484
DORF-Errors	.853	2.143
DORF-Retell	.774	1.944
PAL-II RC Scaled Score	.000	0
PAL-II WCA Scaled Score	-1.204	3.025

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 35

According to Tabachnick and Fidell (2013), kurtosis refers to the level of peakedness in a distribution. Results of the kurtosis analysis are presented in Table 9. The same formula was utilized to determine a corresponding Z-score for each kurtosis value, with the standard error value = .778. Results indicate that none exceed the critical value of ± 2.58 . All kurtosis values were considered to be within acceptable levels.

Table 9

Results of the Kurtosis Calculation for the Predictor Variables of MOY DIBELS and PAL-II Subtests

Predictor Variable ^a	Kurtosis	Z-Score
DORF-Words Correct	-.645	-.829
DORF-Errors	.283	.363
DORF-Retell	.200	.257
PAL-II RC Scaled Score	-.430	.553
PAL-II WCA Scaled Score	.589	.757

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 35

In order to check for multivariate normality, the Shapiro-Wilk test for Normality was conducted in SPSS. Multivariate normality assumes “that the sampling distribution of any linear combination of predictors is normally distributed” (Tabachnick & Fidell, 2013, p. 384). Results of the Shapiro-Wilk statistic are presented in Table 10. Values for the predictor variables DORF-Errors and PAL-II WCA Scaled Score were statistically significant, indicating that data for these variables were not normally distributed. However, according to Tabachnick and Fidell (2013), “classification makes fewer statistical demands than does inference” (p. 383). Thus, violation of this assumption is more serious in statistical analysis designed to establish group differences, such as an Analysis of Variance (ANOVA), than in a DFA. As a result, multivariate normality was considered sufficient for the purposes of the current study.

Table 10

Results of the Shapiro-Wilk Statistic for Normality for Five Predictor Variables

Predictor Variable ^a	Shapiro-Wilk Statistic	<i>p</i>
DORF-Words Correct	.979	.710
DORF-Errors	.893	.003*
DORF-Retell	.941	.060
PAL-II RC Scaled Score	.979	.728
PAL-II WCA Scaled Score	.828	.000*

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 35

**p* < .05 level

In order to check for univariate outliers, a series of boxplots were created in SPSS. A boxplot was created for all five of the predictor variables, and each boxplot contained results for each of the three disability groups. No univariate outliers were revealed for DORF-Words Correct, DORF-Errors, or Receptive Coding Scaled Score, as assessed by inspection of the box plot. One outlier was revealed on DORF-Retell in the Reading SLD group. This outlier reveals significantly higher performance on DORF-Retell than would be expected for a participant in the Reading SLD group. In a small sample size, however, some outliers are to be expected. Further review revealed that the participant met criteria for a SLD in Reading Comprehension only, and did not meet criteria for Reading SLD in any other area. As proposed by Hale and Fiorello (2004) children with learning disabilities are a heterogeneous group. Similarly, Castles (2006), stated that it is unlikely that only one type of reading disability exists. This outlier

represents known heterogeneity in the SLD population. Therefore, this case was retained in the analysis.

One additional outlier was revealed in PAL-II WCA Scaled Score in the No Disability group. This outlier revealed lower PAL-II WCA performance than would be expected for a participant in the No Disability group. However, file review revealed that this participant had been previously evaluated for SLD but did not meet district criteria for identification. The lower performance of this participant is consistent with past performance on standardized assessments, despite evidence that the student does not meet district criteria for Reading SLD. This case was also retained in the analysis. In order to determine the presence of multivariate outliers in any of the five predictor variables, SPSS was utilized to calculate a Mahalanobis Distance. There were no multivariate outliers in the data, as assessed by the Mahalanobis distance ($p > .001$).

Linearity was evaluated by conducting a visual inspection of a series of scatterplot matrices generated for all five predictor variables in each of the three disability groups. There was a sufficient linear relationship between all predictor variables in all three disability groups, as assessed by scatterplot. For more information regarding the linearity of the predictor variables, refer to Tables 4, 5, 6 and 7, which illustrate Shapiro-Wilk statistics and Spearman Rank-Order correlations for the second and third grade samples.

In order to determine whether the assumption of homogeneity of variance-covariance across groups was met, Box's Test of Equality of Covariance Matrices was conducted. Results were statistically significant, Box's $M = 52.964$, $p < .001$. In order to

further determine if the DFA was robust despite this violation, scatterplot matrices were created for all three of the disability groups. A visual inspection revealed no obvious differences between the groups. As a result, it was determined that this assumption was sufficiently met.

In order to check for the absence of multicollinearity and singularity between the predictor variables, a Pearson product-moment correlation was conducted in SPSS. According to Tabachnick and Fidell, “multicollinearity and singularity are problems with a correlation matrix that occur when variables are too highly correlated” (2013, p. 88). Multicollinearity is usually considered when $r^2 \geq .90$ (Tabachnick & Fidell, 2013). A review of the correlation matrix between all five predictor variables do not reveal any coefficients $>.90$. Therefore, this assumption was met.

To further evaluate the assumption of multicollinearity, a variance inflation factor (VIF) was calculated for each of the predictor variables. Results of this statistic are presented in Table 11. According to Field (2009), the VIF statistic reveals whether a predictor has a strong linear relationship with other predictors. Although there is no concrete cutoff rule for VIF, Myers (1990), suggests that VIF values greater than 10 are indicative of multicollinearity. All of the VIF statistic values for the predictor variables were less than 10; therefore, this assumption was met.

Table 11

VIF and Tolerance Statistics for Predictor Variables

Predictor Variable ^a	Collinearity Statistics	
	Tolerance	VIF
DORF-Words Correct	.229	4.374
DORF-Errors	.385	2.596
DORF-Retell	.312	3.202
PAL-II RC scaled score	.454	2.203
PAL-II WCA scaled score	.398	2.511

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score; VIF = Variance Inflation Factor.

^a*n* = 35

Results of the statistical analysis for Research Question Three. A DFA was performed using five scores on curriculum based or standardized assessments as predictors of membership in three groups. Predictors were DORF-Words Correct, DORF-Errors, DORF-Retell, PAL-II RC scale score, and PAL-II WCA scaled score. Groups were No Disability, Speech or Language Impairment, or Reading SLD. It was hypothesized that orthographic coding ability, as measured by performance on the PAL-II RC and WCA subtests, would accurately predict disability group membership.

Two discriminant functions were calculated. Table 12 illustrates results of the Wilks-Lambda revealed using the discriminant function analysis. The Wilks-Lambda statistic is a measure of a variate's significance. With both functions included, results of the Wilks-Lambda reveal a significant relationship between predictors and groups, $\chi^2(8) = 22.112, p = .015$. When the first discriminant function is removed, the prediction is no

longer significant, $\chi^2(4) = 7.317$, $p = .120$. The first function accounts for 69.8% of between group variability, Canonical $R^2 = .39$, while the second function accounts for 30.2% of between group variability, Canonical $R^2 = .22$.

Table 12

Wilks-Lambda for Discriminant Function Analysis

Step	Λ	Chi-Square	df	p
1 through 2	.479	22.112	10	.015*
2	.784	7.317	4	.120

* $p < .05$

Figure 2 illustrates that the first discriminant function maximally separates Reading SLD from the other two groups. The second discriminant function discriminates the Speech or Language Impairment group from the Reading SLD group, with the No Disability group falling between these two groups.

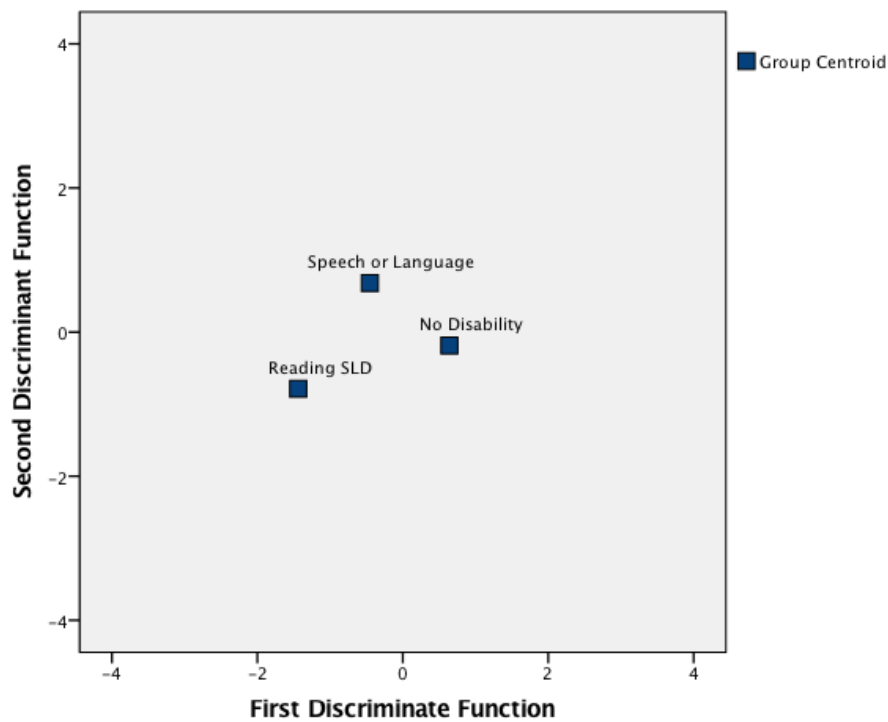


Figure 2. Plots of three group centroids on two discriminant functions derived from five predictor variables.

Table 13 presents the standardized discriminant function coefficients. These values indicate the contribution of each predictor variable to group separation (Field, 2009). Tabachnick and Fidell (2013) suggest that correlations in excess of .33 (10% of variance) should be considered eligible for interpretation. The standardized discriminate function coefficients suggest that the best predictors for distinguishing between Reading SLD and the other two groups is orthographic coding ability, as measured by the PAL-II RC scaled score. The correlations between outcomes and discriminant functions revealed that PAL-II RC scaled score loaded positively and highly on the first function ($r^2 = .718$). Orthographic coding ability (as measured by PAL-II RC scaled score) was higher in the No Disability group (mean = 11.89, SD = 3.21) than in the

Reading SLD group (mean = 6.00, SD = 2.65) and the Speech or Language Impairment group (mean = 9.27, SD = 3.29). These results indicate that students in the Reading SLD group were the most impaired in the area of orthographic coding ability. DORF-Errors exhibited a moderate negative loading on the first function ($r^2 = -.542$), indicating that errors made while reading are also a strong predictor for distinguishing between Reading SLD and the other two groups. Participants in the Reading SLD group exhibited a greater number of errors while reading (mean = 5.00, SD = 2.00), than did their counterparts in the No Disability group (mean = 1.63, SD = 1.86) and the Speech or Language Impairment group (mean = 4.18, SD = 3.19).

Correlations between outcomes and discriminant functions revealed that DORF-Errors loaded more highly (and positively) on the second function ($r^2 = 1.232$). Correlations between outcomes and discriminant functions also revealed that PAL-II WCA scaled score loaded highly and positively on the second function as well ($r^2 = 1.129$). This relationship suggests that reading errors and the ability to choose a correctly spelled word in a field of distractors impacts the second function in a similar way. A moderate positive loading was revealed with DORF-Words Correct ($r^2 = .672$), while a moderately negative loading for DORF-Retell ($r^2 = -.411$) were also noted on the second function. This relationship suggests that reading fluency and reading errors impact this function in a different way. No other correlations were in excess of Tabachnick and Fidell's suggested value of .33; therefore, no additional interpretations were made.

Table 13

Standardized Canonical Discriminant Function Coefficients

Predictor Variable ^a	Function	
	1	2
DORF-Words Correct	.012	.672
DORF-Errors	-.542	1.232
DORF-Retell	-.196	-.411
PAL-II RC Scaled Score	.718	-.215
PAL-II WCA Scaled Score	.075	1.229

Note. DORF Words Correct = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Words Correct; DORF-Errors = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Errors; DORF-Retell = Dynamic Indicators of Basic Early Literacy Skills Oral Reading Fluency-Retell; PAL-II RC Scaled Score = Process Assessment of the Learner-Second Edition Receptive Coding Scaled Score; PAL-II WCA Scaled Score = Process Assessment of the Learner-Second Edition Word Choice Accuracy Scaled Score.

^a*n* = 35

Table 14 illustrates the functions at group centroids for each of the three disability groups. These values represent the mean variate scores for each group (Field, 2009). These values reveal that in function one, the No Disability group presents the highest multivariate mean, while the Reading SLD group presents the lowest multivariate mean. As the first function is best characterized by orthographic coding ability, these multivariate mean values indicate that orthographic coding ability best discriminates between the No Disability and Reading SLD groups. At function two, the Speech or Language Group presents the highest multivariate mean, while the Reading SLD group continues to present the lowest multivariate mean. This indicates that the second function best discriminates between the Speech or Language Impairment group and the Reading SLD group.

Table 14

Functions at Group Centroids

Disability Group	Function	
	1	2
No Disability ^a	.641	-.186
Speech or Language ^b	-.453	.680
Reading SLD ^c	-1.438	-.787

Note. SLD = Specific Learning Disability

^a*n* = 19. ^b*n* = 11. ^c*n* = 5.

Finally, classification results, which were produced in SPSS as part of the DFA, indicated that the model was best at predicting membership in the No Disability group. The prediction was less good for the Reading SLD group, and was least good at predicting group membership in the Speech or Language Impairment group.

Classification results are presented in Table 15.

Table 15

Classification Results of Predicted Group Membership for Three Disability Groups

	Predicted Group Membership		
	No Disability ^a	Speech or Language Impairment ^b	Reading SLD ^c
Original	89.5%	63.6%	66.7%

Note. SLD = Specific Learning Disability

^a*n* = 19. ^b*n* = 11. ^c*n* = 6.

Summary

Thirty-eight participants completed Phase 1 and Phase 2 of data collection. Phase 1 involved administration of the PAL-II, and Phase 2 involved a file review. Nineteen of the participants were in a special education group and 19 were in the No

Disability control group. Only two participants met the criteria for comorbid reading and speech disabilities. Due to an insufficient number of participants in the comorbid group, these two participants, and the comorbid group as a whole, were excluded from further analysis.

The first two questions were designed to determine if there was a correlation between MOY DIBELS assessments and PAL-II subtests. Both of these questions were addressed with Spearman's rank-order correlations. This statistic was chosen because it does not require data to be normally distributed, nor does it require interval, ratio, or scale data. All assumptions for a Spearman's rank-order correlation were met.

The hypothesis for the first research question was partially supported. All correlations between the DIBELS and PAL-II scores were significant with the exception of the correlation between PAL-II RC and DORF-Retell Quality. Thus, the better second grade participants performed on the MOY DIBELS probes (with the exception of DORF-Retell Quality), the better their performance on PAL-II subtests. Conversely, the more errors a second grade participants received on DORF-Errors, the lower their performance on both PAL-II subtests would be. Overall, statistically significant correlations were revealed between various scores on the DIBELS, as well as between the two PAL-II subtests, for the second grade sample.

Results for research question two were also partially supported. Significant positive correlations were revealed between DORF-Words Correct, DORF-Retell, Daze-Correct, and Daze Adjusted and both PAL-II subtests. Thus, the better participants performed on these MOY DIBELS assessments, the better they would perform on PAL-II

subtests. Significant negative correlations were revealed between DORF-Errors and both PAL-II subtests, indicating that the higher the number of errors students obtained on DORF-Errors, the lower their performance would be on PAL-II subtests. However, the relationships between DORF-Retell Quality and both PAL-II subtests was not statistically significant. The negative relationship between Daze-Incorrect and both PAL-II subtests were also not statistically significant.

The third question was designed to determine if orthographic coding performance, as assessed by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II, would contribute to the ability to predict disability group membership. This question was addressed with a DFA. Prior to the analysis, assumptions for conducting a DFA were checked. Results reveal that the hypothesis was supported; orthographic coding ability contributes to the ability to predict disability group membership. Two discriminant functions were calculated. With both functions included, results of the Wilks-Lambda revealed a significant relationship between predictors and groups. When the first discriminant function was removed, the prediction was no longer significant. Results of the factor loadings suggest that the first function is best characterized as orthographic coding ability. Furthermore, review of the multivariate mean values indicated that orthographic coding ability best discriminates between the No Disability and Reading SLD groups. Participants in the No Disability group exhibited higher mean performance on the PAL-II RC subtests than did those in the Speech or Language Impairment or Reading SLD groups. Students in the Reading SLD group exhibited the lowest performance on the PAL-II RC subtest. The model was

best at predicting membership in the No Disability group, with 89.5% of cases correctly classified into the No Disability group.

CHAPTER 5

DISCUSSION

This study adds to the emerging literature base exploring the relationships between early literacy skills and orthographic coding ability. The primary purpose of the study was to determine the role of orthographic processing ability in students who demonstrated difficulties in language or reading based on current theoretical models of reading development (see Castles, 2006; SEDL, 2001). A group comparison was utilized to explore this hypothesis. This chapter will begin by discussing the findings for the three research questions, the results of which were presented in Chapter 4. Next, the chapter will present limitations to the current research, including threats to internal and external validity. Finally, the chapter will present directions for future research and implications for educators and school psychologists.

Research Question One

This first research question examined the relationship between Receptive Coding and Word Choice Accuracy scaled scores on the PAL-II and previously obtained MOY DIBELS scores for second grade students. The purpose of this question was to determine if orthographic coding ability correlates with commonly used and previously administered assessments of early literacy. Thus, constructs under review in this analysis were Early Literacy Skills and Orthographic Coding Ability, as measured by the MOY-DIBELS and PAL-II, respectively. It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores would correlate positively with DORF-Words

Correct, DORF-Retell, and DORF-Retell Quality, but negatively with DORF-Errors. This question was addressed utilizing a Spearman's rank-order correlation.

Overall, results partially confirmed the hypothesis that there would be significant correlations between MOY DIBELS and PAL-II scores. All correlations between the DIBELS and PAL-II scores were statistically significant with the exception of the correlation between PAL-II RC and DORF-Retell Quality. Higher performance on DORF-Words Correct and DORF-Retell equated to higher performance on both PAL-II subtests. Results also revealed that relationships between DIBELS-Retell Quality and PAL-II subtests were positive; however, this relationship was not statistically significant. Conversely, results revealed that the more errors participants received on DORF-Errors, the lower their performance on both PAL-II subtests would be. The correlation between DORF-Errors and both PAL-II subtests revealed statistically significant negative relationships.

Theoretical and empirical evidence (see Castles, 2006; Moats, 1998; Munro, 1995; SEDL, 2001) has established a connection between orthographic coding ability and fluency. Moats (1998) revealed that in the orthographic stage, children further solidify sound-symbol associations in order to enhance fluency. Munro (1995) also established a connection between fluency and orthography, revealing that words that can be read very rapidly (in under one second) are likely to be read orthographically. Thus, it was hypothesized that there would be a relationship between scores on the MOY DIBELS and the PAL-II subtests in the second grade sample. The findings of the current research support this notion. In the second grade sample, scores on the PAL-II RC and WCA

subtests revealed statistically significant positive correlations with DIBELS-DORF and DORF-Retell. These findings provide further evidence that there is a relationship between participants' orthographic coding ability and their ability to read fluently. These findings also support the previous work of Aaron et al. (1999), who found that reading proficiency and efficient sight-word reading depends, in part, on orthographic processing skill.

As expected, a statistically significant negative correlation was also revealed between PAL-II RC and WCA scaled scores and DORF-Errors in the second grade sample. An inverse relationship between PAL-II subtests and DORF-Errors was expected, as DORF-Errors is a measure of skill deficit in reading. Therefore, a higher score on DORF-Errors indicates a higher level of skill deficit. Higher scores on the PAL-II subtests, on the other hand, indicate higher performance in the area assessed.

These findings are also consistent with theoretical basis behind the models of reading suggesting that children learn to read using both lexical and non-lexical routes. According to Castles (2006), readers who are able to read passages fluently might be relying on a strong store of words, or lexicon, which allows them to read words without having to expend extra cognitive resources decoding each word they are presented with. This method of reading relies on the lexical route. The previous research of Romani et al. (2008) revealed that difficulty with lexical processing will result in an inability to read irregular words, and deficiencies in non-lexical processing result in a diminished ability to read non-words. Recall that orthographic coding ability allows a child to use word-specific patterns in order to aid in word recognition (Pennington &

Bishop, 2009). Current results reveal a positive correlation between orthographic coding ability and fluency, thus supporting the previous research that higher orthographic coding ability can contribute to fluent reading.

Research Question Two

The second research question examined the relationship between Receptive Coding and Word Choice Accuracy scaled scores on the PAL-II and previously obtained MOY DIBELS scores for third grade students. As with the first question, the purpose of this question was to determine if the constructs of Orthographic Coding Ability and Early Literacy Skills are correlated. Probes used in third grade differ from those used in second grade. Third grade participants were also assessed with Daze, which is a measure of comprehension. The Daze assessment produces three additional scores: Daze-Correct, Daze-Incorrect, and Daze-Adjusted. As a result, MOY DIBELS assessed utilized in this analysis included DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, Daze-Incorrect, Daze-Adjusted, and DORF-Errors.

It was hypothesized that PAL-II Receptive Coding and Word Choice Accuracy scaled scores would correlate positively with performance on the MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted, and negatively in the area of DORF-Errors and Daze-Incorrect. As with the first question, this question was addressed utilizing a Spearman's rank-order correlation.

Overall, results of the analyses partially confirmed the hypothesis that there would be statistically significant correlations between MOY DIBELS and PAL-II subtests.

Statistically significant positive correlations were revealed between both PAL-II subtests and performance on DORF-Words Correct and DORF-Retell. These findings support previous research that has established a connection between the constructs of orthography and reading fluency (Moats, 1998; Munro, 1995). Results revealed that the better a student performed on DORF-Words Correct and DORF-Retell, the better they would perform on both PAL-II subtests. Statistically significant negative correlations were revealed between DORF-Errors and both PAL-II subtests, indicating that the higher the number of errors students obtained on DORF-Errors, the lower their performance would be on PAL-II subtests. However, the relationship between DORF-Retell Quality and both PAL-II subtests was positive but not statistically significant. The negative relationship between Daze-Incorrect and both PAL-II subtests were also not statistically significant.

Rathvon (2004) defines comprehension as, “the ability to derive meaning from text” (p. 156). Furthermore, she notes that children cannot understand the meaning of text if they are unable to identify the words that they are reading. Previous research has established the importance of orthography as a precursor to comprehending text. For instance, Pennington and Bishop (2009) note that phonological coding and orthographic coding result in fluent printed word recognition skills, which subsequently allow readers to extract meaning from text and comprehend what they are reading.

Findings of the current study support this previous research, which established a relationship between orthography and comprehension. A statistically significant relationship between PAL-II scores, Daze-Correct, and Daze-Adjusted was anticipated

and confirmed by the results of the Spearman's rank-order correlation. Statistically significant positive correlations were revealed between the PAL-II RC scaled score, Daze-Correct, and Daze-Adjusted. The correlation between PAL-II WCA, Daze-Correct, and Daze-Adjusted was more conservative ($r_s = .490$, $r_s = .514$, respectively); however, both correlations are statistically significant in expected direction and support previous research that has established a relationship between orthography and comprehension.

Results of the correlational analysis for the third grade sample supported the theoretical models of reading suggesting that reading is equally dependent on language comprehension and decoding skills (SEDL, 2001). Results showed that higher performance on MOY DIBELS equated to higher performance on PAL-II subtests. Recall that Slowiaczek and Kahan (2014) determined that orthographic processes are more automatic than phonological ones. Thus, one would anticipate that stronger orthographic coding skills, which rely on a more direct route, would also correlate with fluent reading ability. This findings supplement the work of the SEDL (2001) by providing additional evidence that literacy skills such as fluency and comprehension are positively correlated with orthographic coding ability.

Research Question Three

The third research question was designed to determine if orthographic coding performance, as assessed by the Receptive Coding and Word Choice Accuracy scaled scores of the PAL-II accurately predict disability group membership. The purpose of this question was to evaluate the utility of using orthographic coding ability as a marker for identifying students with language based disabilities. It was hypothesized that

orthographic coding ability, as measured by performance on the Receptive Coding (RC) and Word Choice Accuracy subtests of the Process Assessment of the Learner-Second Edition (PAL-II) would accurately predict disability group membership. In order to address this question, a Discriminate Function Analysis was conducted. This hypothesis was supported.

Two discriminant functions were calculated. With both functions included, results of the Wilks-Lambda reveal a significant relationship between predictors and groups. When the first discriminant function was removed, however, the prediction was no longer significant. Taken together, the first function accounts for 69.8% of between group variability. Alone, the second function only accounts for 30.2% of between group variability. Canonical $R^2 = .39$ for the first discriminant function and .22 for the second discriminant function. Therefore, the two functions account for about 39% and 22% of the total relationship between predictors and between groups. Thus, results show that orthographic coding ability adds to the ability to differentiate between the groups. This finding supports the notion that orthographic coding may be considered a useful marker for identifying children at risk for reading problems.

As seen in Figure 2, the first discriminant function maximally separates Reading SLD from the other two groups. The correlations between outcomes and discriminant functions revealed that PAL-II RC scaled score loaded positively and highly on the first function. The standardized discriminate function coefficients suggest that the best predictors for distinguishing between Reading SLD and the other two groups is orthographic coding ability, as measured by the PAL-II RC scaled score.

A review of standardized canonical discriminant function coefficients reveal that that in function one, the No Disability group presents the highest multivariate mean, while the Reading SLD group presents the lowest multivariate mean. This result indicates that students in the Reading SLD group have lower orthographic coding scores than do students in the other two groups. Conversely, students in the No Disability group had the highest orthographic coding scores. As the first function is best characterized by orthographic coding ability, these multivariate mean values indicate that orthographic coding ability best discriminates between the No Disability and Reading SLD groups. Thus, it can be concluded that performance on the Receptive Coding subtest of the PAL-II may be used to accurately predict disability group membership. This finding is in line with the work of Breznitz (2003), who indicated that when a child develops the ability to fluently associate a word's visual appearance to its pronunciation, they lay the groundwork for enhancing sight word recognition by improving memory for spelling patterns.

Furthermore, results indicated that the model was best at predicting membership in the No Disability group. More specifically, 89.5% of membership in the No Disability group was correctly predicted by the model. The model was less sufficient at predicting group membership in the Reading SLD group (66.7% correctly predicted) and the Speech or Language Impairment Group (63.6% correctly predicted). This makes sense, based on findings of Pennington and Bishop (2009) in their work on comorbid reading and speech disabilities. They found that models explaining both reading development and speech development involve semantics and phonology. In contrast,

only the reading model includes an orthographic component, while the speech model includes both acoustic features and articulatory features. The findings of the current study, which show that the model does least well predicting membership in the Speech or Language Impairment group, indicates that orthographic coding might be least indicative of this type of disability.

Limitations

Limitations in the current study include threats to internal validity. One limitation is that the researcher was unable to externally validate decisions used to form special education groups. Rather, it was assumed that teams made correct placement decisions, according to the operational definitions of the IVs presented in Chapter 3. However, evidence exists that educational teams make incorrect or inconsistent classification decisions. Lester and Kelman (1997) discuss disparities across states with regard to identification of learning disabilities. The researchers attributed these discrepancies, in part, to distinctions in diagnostic practice, influence of sociopolitical and demographic variables, and influence of educational practice, such as mainstreaming. One potential delimitation was to review each participant's evaluation or re-evaluation reports to determine if identification of each participant adhered to IV criteria, as it was operationally defined for the purposes of the study.

A second potential threat to internal validity was history of the participants. According to Michael (2002), history refers to an event that occurred that might impact variables under consideration in the study. Though demographic information was collected, history was not controlled for in the study. Some participants in the study

had previously identified disabilities, while others served as a regular education control group. However, etiology of the disability varied by group and by individual participant history, as well as by an individual's exposure to interventions. For instance, students in both regular and special education at the study site had access to a variety of intervention types and programs. Due to the nature of the study, some participants received learning support, some received speech and language support, and others received both speech and language support and learning support. Differential selection existed for groups, as groups were based on previously existing criteria. The sample used in this study was partially clinical in nature and, as an extension of its origination from a special education population, has received varying levels of intervention in the school setting. Type of service received was noted in the file review for descriptive purposes.

A third potential threat to internal validity was biological and psychological maturation. According to Michael (2002), maturation refers to developmental processes that occur as a function of time. In the treatment groups, students were identified for special education and began receiving support through specially designed instruction in order to improve their skill area deficits. Though time in special education service can be controlled statistically, variability in the services that students may have received both in school and outside of school cannot be controlled. An example of an outside service might include tutoring. With regard to in-school services, the district has made attempts to achieve consistency of support across elementary schools. However, inconsistencies still exist with regard to services and staff available to support students

across elementary schools. Examples of these inconsistencies include allocation of reading support staff, administrative initiatives, and how child study teams operate across buildings and grade levels.

One delimitation that was attempted involved the selection of the MOY DIBELS probes in the analysis. These MOY probes were administered between the dates of January 3 and January 6, 2017. The PAL-II was administered to all participants between the November 28, 2016 and March 3, 2017. The MOY DIBELS assessment aligns most closely to the time of the PAL-II administration. Latency was minimized to the greatest extent possible. No PAL-II assessment session was conducted more than two months before or two months after MOY DIBELS information was collected. However, participants, particularly those in the special education groups, might have previously received up to a year or so of educational intervention between their time of identification and the time that they were evaluated with the PAL-II.

A fourth potential threat to validity was the selection of subjects. No random group assignment was possible in the current study. Groups were determined based on previously existing criteria. Though the study site has made every effort to adhere to state criteria by standardizing the assessment and eligibility process as much as possible, variability can still occur. One delimitation that was established was data collection (via the file review process), regarding the type of program a child receives (i.e., regular education, learning support, etc.). However, program provision and service specifics might vary across building and group.

In order to be identified as a student with a learning disability in reading, students must receive a standardized assessment of cognitive ability, as well as a standardized assessment of academic achievement. However, this assessment is only a very small fraction of a child's skills captured at a very brief moment of their educational career. Illness, hunger, time of day, stress level, and any number of other variables might impact a child's performance on a standardized assessment. Both cognitive and academic achievement assessments must be administered by a certified school psychologist. However, in addition to assessment results, psychologists and speech language therapists also rely on clinical judgment. Fidelity checks were not completed due to the fact that assessment data were archival.

Limitations in the current study are also associated with threats to external validity. The sample used in the study was a convenience sample. Therefore, caution must be used when applying findings from the sample to the overall population of second and third grade students with disabilities. In other words, results should not be generalized to students in other grade levels, districts, disability types, or those who receive special education supports that differ from those at the study site.

Another possible threat to external validity was treatment-subject interaction. The examiner did not manipulate the dependent variable in any way. Instead, groups are based on prior eligibility determinations. Furthermore, participants received both interventions and experiences both inside and outside of school according to both their disability and individual need. Students identified with Speech or Language Impairment received speech and language therapy, according to their individual assessment results.

Students identified with a Reading SLD received special education support, also according to their individual disability and need.

Ecological validity refers to the setting or context of a study. One possible threat to ecological validity was multiple-treatment interaction. This threat refers to the treatments to independent variables interacting in a way that could influence results. In the current study, the researcher did not control for the type of interventions or experiences, both inside and outside of school, that a participant received before or after special education identification. Furthermore, one participant could have received a number of different interventions or extracurricular experiences leading up to and after special education identification. A second possible threat to ecological validity was history-treatment Interaction. This threat refers to occurrences before or during the study, which might affect results. As mentioned previously, no effort was made to control for participant history. A third threat to ecological validity is the time of measurement-treatment interaction. More specifically, the time at which the PAL-II was administered might influence performance. As mentioned previously, participants might have been exposed to special education intervention prior to participation in the study. If special education interventions were efficacious, participants might have an opportunity between identification and administration of the PAL-II to improve orthographic and related reading skills.

Future Research

The current research focused on the role of orthographic coding ability in students with previously identified language and learning disabilities. This research is

important because previous work of McArthur et al. (2000) found that 55% percent of children with a reading disability also exhibited impaired oral language, and 51% of children with language impairment also demonstrated impaired reading skills. Similarly, Catts et al. (2002) found that 52.9% of students initially diagnosed with language impairment also later met the criteria for a reading disability in second grade. Pennington and Bishop (2009) emphasize the importance of examining comorbidity between multiple disability types.

The current research offers several different avenues for continued work on the role of orthography as a unique marker for disability. Results of the DFA reveal that orthographic coding ability best discriminates between the No Disability and Reading SLD groups. This finding is an important contribution to the field, as it adds significant information that orthographic coding ability can serve as a unique marker for disability. However, future researchers might consider using the sample to cross-validate the model from the DFA.

Other researchers should attempt to replicate this work with a larger sample size. According to Tabachnick and Fidell (2013), when conducting a DFA, “the sample size of the smallest group should exceed the number of predictor variables” (2013, p. 383). The No Disability ($n = 19$), Speech or Language Impairment group ($n = 11$), and Reading SLD ($n = 6$) met this criteria, though the Reading SLD group did by just one participant. The proposed comorbid reading and speech group ($n = 2$); however, did not meet the cutoff and was therefore excluded from further analysis. This limited the

ability of the current research to make conclusions about an import group of students who met criteria for more than one disability type.

Insufficient sample size in the comorbid group prevented the researcher from drawing conclusions about the role of orthography in students with comorbid reading and speech disability types in the third question. According to Pennington and Bishop (2009), viewing multiple disorders through the lens of comorbidity can provide new information and perspective. Furthermore, Sattler and Hoge (2006) indicate that children with co-occurring disorders tend to have more complex and persistent problems than children with only a single disorder. As mentioned previously, researchers like Pennington and Bishop (2009) urge readers to consider that “comorbidity is of interest in its own right” (p. 284). Replicating the current study with a larger comorbid sample would offer beneficial contributions to the field in this area.

Though there is sufficient literature to define orthography as a construct (Pennington & Bishop, 2009; Rathvon, 2004), much less work has been done on how orthographic processing ability contributes to the development of reading skills (Rathvon, 2004). The current supplements previous research, which has established that orthographic coding ability, fluency, and comprehension skills are positively correlated. It also provides new insight into the role of orthography in developing literacy and in predicting disability group membership. However, continued work in this area needs to be done to allow researchers to draw practical conclusions about orthographic coding as a unique marker for disability, particularly in comorbid disability groups.

The definition of orthography itself implies a relationship between specific language impairment and specific learning disability. As mentioned in chapter one, previous research supports the notion that humans are predisposed to language acquisition (see Everaert, Huybregts, Chomsky, Berwick, & Bolhuis, 2015). Reading, on the other hand, is a skill that must be learned. The current study focused on the relationship between language and learning disability in second and third grade students. Future work might replicate the current research for students in lower or higher grade levels, or even conduct longitudinal work to examine how orthographic coding deficits impact students in later years on high-stakes standardized assessments. Future work might also focus on subtypes of language impairment, such as receptive, expressive, or pragmatic deficits.

The current research attempted to isolate orthography as an additional marker for predicting disability group membership. In the current study, results of the DFA reveal that orthographic coding ability does discriminate between the No Disability and Reading SLD groups. However, results indicate that the model was best at predicting membership in the No Disability group. More specifically, 89.5% of membership in the No Disability group was correctly predicted by the model. The model was less sufficient at discriminating membership between the Reading SLD group (66.7% correctly predicted) and the Speech or Language Impairment (63.6% correctly predicted).

However, orthographic coding ability is only one component that students must master to become successful readers. According to Aaron et al. (2009), word recognition, fluency, and automaticity are also important components of literacy

acquisition. Similarly, Shaywitz and Shaywitz (2008), emphasize that when first learning to read, children must also be taught how to map letters (i.e., orthographic processing) to sound (i.e., the phonemic processing). Phonological awareness focuses on the sound elements of spoken words (Tambyraja et al., 2015). The current findings establish positive correlations between orthography and the important skills of fluency and comprehension, and have begun to establish utility of orthographic coding as a unique marker for disability. Future research should examine phonological awareness and orthographic coding ability together, to better determine if each of these constructs contributes uniquely to predicting disability group membership.

The findings of the current research are preliminary and correlational. Future research attempting to replicate the current study should do so with a larger and more varied sample. Future research might also consider the use of other measures of reading. Likewise, an exploration of cause and effect relationships between orthography and reading would offer vital information for the future outcomes of students with orthographic coding deficits. The current research lays important foundations establishing orthographic coding ability as a unique marker for disability. Future work should examine the theoretical relationship between phonological and orthographic processing and outcomes for reading. Finally, future research should explore the utility of the current findings to improve the pre-referral process in school settings. This last endeavor will be particularly useful to educators in schools who are transitioning to the MTSS process at their sites.

Implications for Practice

This research offers a number of potential implications for educators at a variety of levels. As mentioned in chapter one, this research is important because it allows for further analysis of the role of orthographic coding ability in students with and without disabilities. The current research adds to the literature, which has previously established relationships between orthography, fluency, and comprehension (Moats, 1998; Munro, 1995; Pennington & Bishop, 2009). These findings are important to consider in the broader scheme of literacy acquisition. As emphasized in chapter one of the current study, reading is a complex process. Hale and Fiorello (2004) posited that reading disabilities are heterogeneous in nature. Furthermore, Castles (2006) postulated that it is unlikely that only one type of reading disability exists.

Mehta, Foorman, Branum-Martin, and Taylor (2005) examined the role of student and teacher characteristics on literacy development. As part of their study, Mehta et al. examined teacher and instructional components, in addition to student components, on literacy success. While the researchers found that teacher quality itself does not significantly predict literacy success, they emphasized that, “it was the literacy skills students brought to the classroom that predicted classroom literacy and the vast majority of individual differences among students” (p. 111). Though initially discouraging, the findings of Mehta et al. (2005) further emphasize the importance of concrete skill development. The National Reading Panel (2000) makes a similar assertion by advocating for literacy programs that teach important reading skills such as phonemic awareness, phonics, and the alphabetic principle, among others.

In order to extract meaning from print, children must first demonstrate mastery in the component areas of reading. According to Berninger, Lee, Abbott, and Breznitz (2013), “effective instruction might teach the alphabetic principle in both the reading direction (each child says the phoneme that corresponds to a grapheme) and in the spelling direction (each child writes the grapheme that corresponds to a heard phoneme)” (p. 2). These researchers also emphasize that, in order to read and spell words in English, a child must demonstrate understanding of morphology (parts of words that signify meaning), phonology (the relationship of sound units between words), and orthography. This study, in conjunction with the findings of the current research, emphasize the importance of establishing a relationship between orthography and fluency, a skill that is established as foundational in learning to read.

This research also offers unique contributions to the field of school psychology because it utilized a process assessment to gather more information about participants’ skills in the particular process of orthographic coding ability. Hale et al. (2006) indicate that the use of a comprehensive evaluation of cognitive processes allows psychologists to concretely identify various cognitive impairments and link them to academic deficits. According to the publishers of the PAL-II, the assessment allows educators to determine which processes are weak in a child who has been referred for an evaluation. This type of evaluation allows educators to better explain why a child is struggling in a particular deficit area (NCS Pearson, 2007). According to Hale and Fiorello (2004), the PAL-II focuses on processes associated with academic skills, which makes it particularly advantageous for linking assessment to intervention. Flanagan (2016) links the

construct of Gv (visual processing) to orthographic coding and sight-word acquisition. Gv is characterized as visual processing. Evaluating orthography as a construct provides educators with important information about why some readers struggle. According to Flanagan (2016), strategies to assist with visual processing, and by extension with orthography, include tools to support visual tracking, larger fonts, note taking strategies, books on tape, and natural lighting.

At the study site, school psychologists are important members of a child's multidisciplinary evaluation team (MDT). As mentioned in chapter three, the study site uses a discrepancy model to determine the presence of a specific learning disability. In order to make this determination, a certified school psychologist administers ability and achievement assessments to a student as part of a comprehensive psychoeducational assessment. A student meets the criteria for a specific learning disability in reading when a 15-point discrepancy between cognitive ability and academic achievement is revealed. However, low performance on an academic achievement assessment in itself offers limited information in how to develop programming for a child. According to publishers of the PAL-II, the assessment offers additional information about why a child performs low in a particular area, which better facilitates the formulation of recommendations (NCS Pearson, 2007).

Summary

The main purpose of the study was to determine if orthographic coding ability would accurately predict membership in one of three disability groups: No Disability, Speech or Language Impairment, or Reading SLD. In order to make this determination,

the study first examined correlations with other important components of reading, including fluency and comprehension, by comparing PAL-II scores with previously obtained MOY DIBELS scores. In the second grade sample, the results of the analysis partially supported the hypothesis of the first research question: that PAL-II RC and WCA subtests correlated positively with DORF-Words Correct, DORF-Retell, and DORF-Retell Quality and negatively with DORF-Errors. Statistically significant correlations were revealed between MOY DIBELS and PAL-II scores in all areas with the exception of DORF-Retell Quality and PAL-II performance. These findings support previous research linking fluency and orthography.

The results of the analysis also partially confirmed the hypothesis of the second question: that PAL-II Receptive Coding and Word Choice Accuracy scaled scores will correlate positively with performance on the MOY DIBELS probes in the areas of DORF-Words Correct, DORF-Retell, DIBELS-Retell Quality, Daze-Correct, and Daze-Adjusted, and negatively in the area of DORF-Errors and Daze-Incorrect in the third grade sample. Statistically significant correlations were revealed between MOY DIBELS and PAL-II scores in all areas with the exception of DORF-Retell Quality and Daze-Incorrect. These findings also support previous research linking orthography, fluency, and comprehension.

It was hypothesized that orthographic coding ability, as measured by performance on the Receptive Coding (RC) and Word Choice Accuracy subtests of the PAL-II would accurately predict disability group membership. This hypothesis was supported. Two discriminant functions were calculated. With both functions included,

results of the Wilks-Lambda reveal a significant relationship between predictors and groups. When the first discriminant function is removed, however, the prediction is no longer significant. Results of the DFA suggest that the best predictors for distinguishing between Reading SLD and the other two groups is orthographic coding ability, as measured by the PAL-II RC scaled score. A review of standardized canonical discriminant function coefficients reveal that that in function one, the No Disability group presents the highest multivariate mean, while the Reading SLD group presents the lowest multivariate mean. Results indicated that the model was best at predicting membership in the No Disability group, as 89.5% of membership in the No Disability group was correctly predicted by the model.

The current research offers several different avenues for continued work on the role of orthography as a unique marker for disability. Replicating the current study with a larger comorbid sample would offer beneficial contributions to the field in the role of orthography and comorbid language and learning disability. In addition, future work might also focus on subtypes of language impairment, such as receptive, expressive, or pragmatic deficits. The current findings establish positive correlations between orthography and the skills of fluency and comprehension, and have begun to establish utility of orthographic coding as a unique marker for disability. Future research should examine phonological awareness and orthographic coding ability together, to better determine if each of these constructs contributes uniquely to predicting disability group membership.

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Appendix A

Institutional Review Board (IRB) Approval Letter



Indiana University of Pennsylvania

www.iup.edu

Institutional Review Board for the
Protection of Human Subjects
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Stright Hall, Room 113
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P 724-357-7730
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November 11, 2015

Erin Haugh

Dear Ms. Haugh:

Your proposed research project, "Examining the Role of Orthographic Coding Ability in Elementary Students with Previously Identified Reading Disability Speech or Language Impairment, or Comorbid Language and Learning Disabilities," (Log No. 15-269) has been reviewed by the IRB and is approved. In accordance with 45CFR46.101 and IUP Policy, your project is exempt from continuing review. This approval does not supersede or obviate compliance with any other University requirements, including, but not limited to, enrollment, degree completion deadlines, topic approval, and conduct of university-affiliated activities.

You should read all of this letter, as it contains important information about conducting your study.

Now that your project has been approved by the IRB, there are elements of the Federal Regulations to which you must attend. IUP adheres to these regulations strictly:

1. You must conduct your study exactly as it was approved by the IRB.
2. Any additions or changes in procedures must be approved by the IRB before they are implemented.
3. You must notify the IRB promptly of any events that affect the safety or well-being of subjects.
4. You must notify the IRB promptly of any modifications of your study or other responses that are necessitated by any events reported in items 2 or 3.

The IRB may review or audit your project at random *or* for cause. In accordance with IUP Policy and Federal Regulation (45CFR46.113), the Board may suspend or terminate your project if your project has not been conducted as approved or if other difficulties are detected

Although your human subjects review process is complete, the School of Graduate Studies and Research requires submission and approval of a Research Topic Approval Form (RTAF) before you can begin your research. If you have not yet submitted your RTAF, the form can be found at <http://www.iup.edu/page.aspx?id=91683>.

Appendix B

File Review Form and Data Collection Sheet

Demographics

Sex:

Male ☐ Female ☐

Age:

Grade:

Second ☐ Third ☐

Family Income:

Free Lunch ☐ Reduced Lunch ☐ None ☐

Retained

Yes ☐

No ☐

If retained, what grade did retention occur:

Disability Type:

Reading Disability ☐ Both Reading Disability and Speech and Language Impairment* ☐

Please identify type of Reading Disability:

Reading Comprehension ☐

Degree of Discrepancy:

☐ <15 points

☐ 15-30 points

☐ >30 points

Basic Reading Skills ☐

Degree of Discrepancy:

☐ <15 points

- ☐ 15-30 points
☐ >30 points

Oral Reading Fluency ☐

Degree of Discrepancy:

- ☐ <15 points
☐ 15-30 points
☐ >30 points

Please identify type of Speech or Language Impairment:

- Expressive ☐
 Receptive ☐
 Other ☐

☐ Regular Education Student (not currently identified as a student with a disability in any area)

Curriculum Based Assessment Scores:

Please Complete Table 1 if student is in 2nd Grade and Table 2 if student is in 3rd Grade. It is not necessary to complete both tables. Complete only the table that corresponds to the child's current grade.

Table 1: Second Grade (DIBELS Next)

Measure	Period	Period	Period
	Beginning	Middle	End
Nonsense Word Fluency Correct Letter Sounds (CLS)			
Nonsense Word Fluency Whole Words Read (WWR)			
DIBELS Oral Reading Fluency Words Read Correctly (WRC)			

DIBELS Accuracy (percentage)			
DIBELS Retell Fluency (RF)			

Table 2: Third Grade (DIBELS Next)

Third Grade (DIBELS Next)

Measure	Period	Period	Period
	Beginning	Middle	End
DIBELS Oral Reading Fluency Words Read Correctly (WRC)			
DIBELS Accuracy (percentage)			
DIBELS Retell Fluency			

PAL-II Assessment Scores:

Subtest	Scaled Score	Percentile
Receptive Coding		
Orthographic Spelling		
Word Choice Accuracy (WCA) Total		
Word Choice Fluency (WCF) Total		

Type of Service Received:

- ☐ Speech or Language Support
☐ Learning Support
☐ Learning Support and Speech or Language Support