Reading, Writing, and Repetition: Performance on Nonword Measures by Students With and Without Language-Learning Disabilities

Patricia J. Tattersall
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READING, WRITING, AND REPETITION: PERFORMANCE ON NONWORD MEASURES BY STUDENTS WITH AND WITHOUT LANGUAGE-LEARNING DISABILITIES

by

Patricia J. Tattersall

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the requirements for the Degree of Doctor of Philosophy
Interdisciplinary Health Sciences
Advisor: Nickola W. Nelson, Ph.D.

Western Michigan University
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The central purpose of this three-paper dissertation was to explore the ability of school-age children with and without language-learning disabilities (LLD) to apply sound/word level structure knowledge when performing speaking, spelling, and reading tasks. Data came from a larger investigation that used stratified sampling to create two ability groups—children with typical language (TL) and with LLD—comparable in terms of age (range 6 through 18 years), sex, race/ethnicity, and socioeconomic status.

The first study addressed questions about whether a short probe of nonword stimuli that are more wordlike (contained true morphemes) or less wordlike (contained no true morphemes) are better suited for discriminating the spoken word repetition abilities of students with TL and LLD at different ages. Both word lists differentiated children with TL and LLD with large effect sizes at all four age levels, and both appear to have diagnostic value.

The second study examined relationships of nonword processing performance in students with and without LLD across the three tasks of nonword speaking (repetition), spelling, and reading with two additional variables, phonemic awareness (PA) and vocabulary awareness (VA). Regression analysis showed that PA was associated
significantly with all tasks for LLD students and with reading and spelling for students with TL. VA was associated significantly with all tasks for TL students, but only with nonword spelling for students with LLD.

In the third study, fine-grained error analysis was used to describe error profiles (phonemic, orthographic, and morphemic) for TL and LLD on nonword spelling and reading tasks. At the elementary level, both groups made significantly more morphemic errors in spelling than reading; also, students with TL made significantly more orthographic errors in spelling than reading. At the secondary level, the LLD students exhibited significantly more phonic and morphemic errors in spelling than in reading. Thus students with LLD appear to exhibit error patterns that are qualitatively different and go beyond simple differences in degree from students with TL.

Collectively, these studies contribute to understanding of sound/word level structure knowledge in oral and literate tasks. Findings have practical implications for designing assessment measures and intervention programs targeting inter-modality abilities.
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Patricia J. Tattersall
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CHAPTER I

INTRODUCTION

The central purpose of this dissertation was to explore the ability of school-age children with and without language-learning disabilities (LLD) to apply knowledge of sound/word level structure when performing speaking, spelling, and reading tasks. The dissertation consists of five chapters including an introduction (Chapter I), three separate research study reports (Chapters II, III, and IV), and a conclusion (Chapter V). Each of the study chapters addresses unique goals, but all support the central purpose of contributing to understanding of the development of word-structure knowledge by children with and without language-learning disabilities. The concluding chapter is used to integrate the results of the three studies, discuss the theoretical and clinical significance of the findings, and offer recommendations for further studies.

Background

Proficiency in literate language, which includes reading decoding and comprehension, as well as spelling and written expression, generally follows proficiency with spoken language abilities that develop prior to learning to read and write. A large body of research demonstrates strong links among speech-language impairments, reading disabilities, and academic difficulties (Bishop, 1998, 2001; Catts, 1986, 1993; Catts & Kamhi, 2005; Smith, Roberts, Smith, Locke, & Bennett, 2006).
Individuals with language deficits may present with impaired comprehension and/or expression of spoken and written language. Problems may be observed in any of the four areas of language use—listening, speaking, reading, and writing—and may involve varied combinations of the five systems of language—phonology, morphology, syntax, semantics, and pragmatics (American Speech-Language-Hearing Association [ASHA], 1993). In the school-age years, reading and spelling difficulties are frequently observed as symptoms of LLD (Bishop & Adams, 1990; Catts, Fey, Tomblin, & Zhang, 2002; Kamhi & Catts, 1986). Deficits at the sound/word level involving phonology, morphology, and semantics can impact word learning and fluent retrieval when reading, writing, and speaking (Carlisle, 1987; Edwards, Beckman, & Munson, 2004; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005; Rice & Wexler, 1996; Rubin, Patterson, & Kantor, 1991). Questions remain about whether a common deficit in phonological and morphological abilities underlies word-level difficulty in word imitation (repetition), reading decoding, and spelling of novel words, and whether difficulties with any of the tasks can be dissociated from difficulties in the other tasks (Greenberg, Ehri, & Perin, 1997; Guthrie, 1973; Hester & Hodson, 2004; Kamhi & Catts, 1986; Snowling, Nation, Moxham, Gallagher, & Frith, 1997).

Figure 1.1 represents potential interacting influences of vocabulary knowledge, phonemic awareness, morpheme awareness, letter knowledge, and sound-letter(s) correspondence with the word-level skills of decoding (reading), encoding (spelling), and repetition (speech imitation). Within the three studies of this dissertation, the relationships among the word-level abilities of decoding, encoding, and repetition with
the foundational skills of vocabulary awareness, phonemic awareness, morpheme awareness, and sound/letter correspondence were investigated.

Figure 1.1. Components in a hypothetical interactive model of language.

The reading, spelling, and repetition tasks for the three studies all utilized nonwords rather than true words. The rationale for the use of nonwords rather than real words to assess application of word structure knowledge in reading decoding, spelling encoding, and repetition was to minimize the influence of the participant’s previous vocabulary knowledge and memorized word patterns. This is crucial in studies comparing children with typical language (TL) to those with LLD. Children with LLD have been found to have deficits in vocabulary knowledge as compared to their peers with typical language (e.g., Catts, Fey, Zhang, & Tomblin, 1999; Gray, Plante, Vance, & Henrichsen, 1999; Heilmann, Miller, & Nockerts, 2010). If real words are used, vocabulary
knowledge (or lack thereof) could overshadow evidence of other aspects of word structure knowledge in influencing students’ scores. Thus, nonwords are used to control for this variable.

Some studies employing nonwords as a means of controlling for vocabulary knowledge have used phoneme manipulation tasks (e.g., requests to delete initial or final phonemes or to reverse the order of phonemes in a “pretend word”) to assess phonemic awareness (e.g., Hester & Hodson, 2004; Hogan, Catts, & Little, 2005; Kamhi & Catts, 1986; Preston & Edwards, 2007). Others have used nonword repetition tasks to assess the ability to map novel word structure when speaking (e.g., Archibald & Gathercole, 2006; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Gathercole, Willis, Emslie, & Baddeley, 1991; Graf Estes, Evans, Else-Quest, 2007; Kamhi & Catts, 1986; Masterson, Laxon, Carnegie, Wright, & Horslen, 2005; Munson, Edwards, & Beckman, 2005; Vitevitch & Luce, 1998). Still other researchers have used nonwords to assess reading decoding (e.g., Hester & Hodson, 2004; Hogan et al., 2005; Kamhi, Catts, Mauer, Apel, & Gentry, 1988). Nonword items also have been used to assess children’s knowledge of phoneme and morpheme word structure when spelling (e.g., Campbell, 1985; Cassar, Treiman, Moats, Pollo, & Kessler, 2005; Hagiliassis, Pratt, & Johnston, 2006; Perry, Ziegler, & Colheart, 2002).

The rationale for using nonword tasks to assess word structure knowledge is that removing the meaning of known words minimizes the influence of the participant’s vocabulary-specific knowledge, permitting relatively direct measurement of sound/word level structural knowledge. There are, however, variations in how closely nonwords are related to true words. The degree of “wordlikeness” differs between studies. Some
research has incorporated real morphemes (e.g., -ed, -ing, -tion) as affixes to nonwords. Morphemes are the smallest meaningful components of words. These might then be referred to as “pseudowords.” Such tasks are designed to assess whether participants can make use of morphemic knowledge apart from their knowledge of particular vocabulary (e.g., McBride-Chang et al., 2005; Siegel, 2008). In contrast, other researchers have recommended using nonwords that have phonological structures that are as unlike real words as possible (e.g., Dollaghan & Campbell, 1998).

The current studies utilized subsets of words varying in wordlikeness that were created for use in the beta standardization version of the Test of Integrated Language and Literacy Skills (TILLS) (Nelson, Helm-Estabrooks, Hotz, & Plante, 2007). The goal was to investigate how children with and without language-learning disabilities would apply sound/word knowledge when attempting oral and written language tasks. Results are expected to add to the literature regarding whether children with disabilities have significantly more difficulty than similar age peers on various sound/word level tasks (repetition, reading, and spelling), whether the types of word demands influence their performance, and whether difficulties with any of the tasks can be dissociated from difficulties in the other tasks. The results also have practical implications for test design and intervention. The more specific purposes and features of each of the three studies are summarized in the sections that follow.

Paper One (Chapter II)

Paper one addresses questions about whether nonword stimuli that are more or less wordlike are better suited to discriminating the spoken word repetition (imitation)
abilities of students with and without language-learning disabilities (LLD) at different ages. Gathercole et al. (1991) proposed that nonwords resembling true words activate representations of similar words from long term memory, which then creates an abstract phonological frame that can aid in nonword retrieval. Previous studies with children with disabilities have disagreed on the effect of wordlikeness on repetition ability (e.g., Coady, Evans, & Kluender, in press; Masterson et al., 2005; Marton, 2006; Munson, Edwards, & Beckman, 2005; Munson, Kurtz, & Windsor, 2005). Edwards, Beckman, and Munson (2004) and Munson, Edwards, and Beckman (2005) found that children from 3 to 6 years of age with typical language as well as those with phonological delays repeat common sound sequences more accurately than rare sequences. The children with phonological delays did not appear to be at a larger disadvantage for the low-frequency words. However, results of a study by Masterson et al. (2005) with 5- and 6-year olds showed that children with poorer repetition skills are significantly affected by wordlikeness, as determined by neighborhood density. In their meta-analysis of nonword repetition tasks, Graf Estes et al. (2007) found larger effect sizes for differences between students with and without SLI for nonwords with increasing length, articulatory complexity, and varying wordlikeness.

Paper one describes the theoretical basis for the development of the nonword repetition stimuli for the beta version of the TILLS. The nonword repetition lists developed for the TILLS contain nonwords that vary in length. Additionally, they include a variety of earlier and later phonemes and some include recognizable morphemes. Paper one also describes a study comparing performance by students with and without LLD repeating two distinct sets of nonword stimulus items, each of which includes 12 items.
The key distinguishing variable was that one word set included true morphemes and the other did not. The study used data from a larger investigation that used a stratified sampling approach to create groups comparable in terms of age, sex, race/ethnicity, and socioeconomic status across the age range from 6 through 18 years (in the four grade level groups—grades 1–2, 3–5, 6–8, and 9–12). The age range, comparable groups, and control of word type set this study apart from the existing research. Although both word sets had low wordlikeness values (compared to commonly used words), those with true morphemes had values that are slightly higher.

Research questions for paper one addressed whether the two word sets would be equally difficult, whether children with disabilities would perform significantly more poorly than the students without disabilities, and whether there would be any interaction of ability group with age and set of words with and without morphemes. A mixed methods ANOVA was used to consider main effects and interaction effects for the two between subject (age and ability) and two levels of within subjects (word type). An additional question related to whether there might be advantages of using one or the other of the lists, or a combined list, was examined by using descriptive methods and effect size as well as receiver operating characteristic (ROC) curve analysis.

**Paper Two (Chapter III)**

The second paper describes a study of the relationships of nonword processing performance across the three tasks of nonword speaking (repetition), spelling, and reading. Two additional variables, phonemic awareness and vocabulary awareness, which were computed as composite scores for relevant subtests, were included in this study.
This made it possible to investigate the association of vocabulary and phonemic awareness skills with performance on the three task-specific assessments of nonword repetition, spelling, and reading.

Study two used the data from eight subtests of the beta version of the TILLS, including: the three nonword tasks measuring repetition, spelling, and reading; a phonemic awareness composite score (for two subtests combined); and a vocabulary awareness composite score (for three subtests combined). The participants in this study were the same as those in paper one. For this study, however, within and between group differences in performance on these tasks were compared for two age groups—elementary school-age (grades 1 through 5) and secondary school-age (grades 6 through 12)—in two ability groups (with LLD and with TL).

A relatively small body of literature exists regarding the sound/word level skills of adolescents with typical language (e.g., Scarborough, Ehri, Olson, & Fowler, 1998) and those classified with speech and/or language disability (Preston & Edwards, 2007). Although the literature contains numerous studies comparing reading and spelling at the word level by students with and without disabilities (e.g., Guthrie, 1973; Greenberg et al., 1997), the type of stimulus items between tasks in these studies has not been controlled. The study reported in paper two bridges a gap in the literature by providing data to compare all three nonword tasks in one study.

Paper two had the purpose of investigating relationships among the three types of nonword processing skills (repetition, spelling, and reading) for groups of school-age children with and without LLD. It addressed questions whether school-age children with LLD differ significantly from students with TL in their performance of the sound/word level skills.
level skills as measured by related tasks of nonword repetition, nonword spelling, and nonword reading, as well as in the areas of phonemic awareness (PA) and vocabulary awareness (VA). A second question asked whether there is a fundamental difference in the nature of the relationships for students with TL and with LLD at the elementary and secondary level. These results are expected to add to the discussion of theoretical questions about difference in abilities between children with and without language impairment across the grade levels (1st through 12th).

**Paper Three (Chapter IV)**

The third paper investigates students' abilities for applying word structure knowledge when attempting the literate language tasks of nonword spelling and reading. It involved a fine-grained error analysis to describe the types of errors (phonemic, orthographic, and morphemic) that students demonstrate on nonword spelling and nonword reading tasks when they vary by ability group (TL vs. LLD) and age group (elementary vs. secondary). The data for study three came from application of a complex scoring method designed to code participants' ability to represent phonological, orthographic, and morphological structure of nonword spelling and reading subtests of the TILLS.

The literature reflects some discrepancy regarding interpretation of the errors in reading and spelling in children with specific reading impairment (called *dyslexia*) compared to typical readers. Carney and Martin (2003), for example, studied the performance of children with dyslexia (mean age 11;3) in comparison with chronological age controls (mean age 11;3) and reading age matched controls (mean age 7;11) on real
word and nonword reading tasks. Their results indicated that children with dyslexia displayed errors that were qualitatively different from those made by both control groups. On the other hand, Cassar et al. (2005) compared spelling performance of children with and without dyslexia on real and nonword spelling tasks and found that the spelling of older students with dyslexia was quite similar to that of the younger typical children.

Paper three addressed questions regarding patterns of errors. These included questions about quantity (number) and quality (type) of errors exhibited by students with LLD compared to those with TL across the grade levels. Data were analyzed to describe patterns of performance for groups by disability (TL and LLD) and age (elementary and secondary) as well as between tasks (nonword spelling and reading) for the three dependent variables (phonic errors, orthographic errors, and morphemic errors). Questions asked included whether there would be a qualitative difference in patterns of error across tasks when students with TL and LLD spell and read two sets of nonword items that have comparable word structure. An additional question was whether the relationships would differ between groups at elementary and secondary grade levels.

**Conclusion**

In summary, the three studies used data collected using sets of nonwords constructed for the beta version of the TILLS. The purpose was to explore the application of sound/word level knowledge in the tasks of speaking, spelling, and reading in children with and without LLD at the elementary (grades 1–2 and 3–5) and secondary (grades 6–8 and 9–12) levels. The first study explored whether words that are more or less wordlike, as determined by inclusion of true morphemes, discriminate more accurately between
children with and without LLD. In the second study, relationships were investigated for the three modality specific nonword tasks to phonemic awareness and vocabulary awareness in order to assess how relationships varied for groups by age and ability. Error patterns in nonword reading and spelling were compared within and across groups and ages for children with and without LLD in the third study.

Theoretical and clinical implications are discussed within papers reporting each of the studies. The discussion of the final chapter integrates the results for all of the studies. Considered together, the results of these studies provide a profile of relationships between word-level tasks of repetition, reading and spelling, and the foundational skills of vocabulary and phonemic awareness for comparable groups of children who range from elementary to secondary levels and either have typical language or have been identified with a primary language disability. This set of studies is expected to add to the literature regarding quantitative as well as qualitative performance for children with LLD.

References


CHAPTER II

PAPER ONE: WORD STRUCTURE EFFECTS ON PERFORMANCE ON NONWORD REPETITION BY STUDENTS WITH AND WITHOUT LANGUAGE-LEARNING DISABILITIES

Nonword tasks have been developed to assess children’s knowledge of word structure using tasks such as nonword repetition, nonword spelling, and nonword reading. The rationale for using nonwords rather than real words is to minimize the influence of the participant’s vocabulary-specific knowledge. This allows cultural and racial biases to be minimized (Ellis Weismer et al., 2000). However, caution should be taken when analyzing studies containing “nonwords,” as there are variations in how closely nonwords are related to true words. The purpose of this study was to explore the association of “wordlikeness” (as defined by whether or not the nonwords included true morphemes) with nonword repetition/imitation by school-age children across elementary and secondary grade levels with language/learning disabilities (LLD) and typical language (TL).

Although the literature supports a statistically significant difference in performance on nonword repetition tasks for children with and without language impairment (e.g., Conti-Ramsden, 2003; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990; Graf Estes, Evans, & Else-Quest, 2007), conclusions from previous studies have differed in the effect of wordlikeness on repetition abilities of children with disabilities (e.g., Archibald & Gathercole, 2006; Coady, Evans, & Kluender, in press;
Graf Estes et al., 2007; Marton, 2006; Masterson, Laxon, Carnegie, Wright, & Horslen, 2005; Munson, Edwards, & Beckman, 2005; Munson, Kurtz, & Windsor, 2005).

**Measures of the Degree of Wordlikeness**

Two primary methods of measuring degree of wordlikeness quantitatively are neighborhood density and phonotactic probability. Neighborhood density is measured by counting the number of real words that are similar to a word (or nonword) when a single phoneme is substituted, deleted, or added (Luce & Pisoni, 1998). Phonotactic probability is measured by computing the frequency with which sound segments and sequences of segments occur in the language of interest (Jusczyk, Luce, & Charles-Luce, 1994).

The two common measures of wordlikeness, phonotactic probability and neighborhood density, are related, but not identical. Nonwords with sound sequences found frequently in a language also are likely to have many close neighbors. Caution must be used particularly when probes contain nonwords of various lengths. Phonotactic probability and word length are positively correlated because the frequency of each sound or each sound combination in the word/nonword is summed. This means that shorter words have lower phonotactic probability values and longer words have higher values naturally. Neighborhood density, on the other hand, is negatively correlated with word length. This is because the substitution of one phoneme in short words tends to result in more neighbors than a single substitution in longer words.

Vitevitch and Luce (1999) found that phonotactic probability and neighborhood density were positively correlated when assessing three phoneme CVC (consonant-vowel-consonant) sequences. That is, short, length-controlled nonwords resulted in common
sound sequences in dense neighborhoods, whereas rare CVC sequences were more likely to be found in sparse neighborhoods. Storkel (2004) analyzed words of varying length and found that the robustness of the association between phonotactic probability and neighborhood density decreased as word length increased. Therefore, although these measurements are related, both must be considered separately when determining the degree of wordlikeness of a target item.

**Nonword Processing**

Vitevitch and Luce (1998) described two levels of representation and processing—lexical and sublexical. For words and nonwords, they manipulated neighborhood density and phonotactic probability. They found that adults repeated true words with low-density, low-probability phonotactic patterns faster than those with high-density, high-probability, but that the opposite was true for nonwords. Their findings indicated that true words are processed predominantly at a lexical (meaningful word) level, whereas nonwords are processed primarily at a sublexical (phonetic segment structural) level. In a series of experiments, some using the nonwords stimulus items designed by Vitevitch and Luce (1998), Lipinski and Gupta (2005) digitally manipulated the items and presented them to university students. They found that high neighborhood density nonwords were not always repeated faster than those of low neighborhood density when the stimulus duration was controlled. Their results indicated that both the lexical and sublexical levels are impacted similarly by competing effects found in higher density neighborhoods.
Gathercole, Willis, Emslie, and Baddeley (1991) proposed that influences from general lexical knowledge and phonological memory influence nonword repetition. Nonwords resembling true words activate representations of similar words from long term memory, which then creates an abstract phonological frame that can aid in nonword retrieval. This type of support is not present for nonwords that do not resemble true words, making them more difficult to process. Edwards, Beckman, and Munson (2004) found that, for children with typical language, the difference in repetition accuracy between words with higher and lower phonotactic probability decreased with age and vocabulary growth. This “frequency effect” was noted to be less in children with larger vocabularies.

Prior Studies Using Words with Varied Wordlikeness

Nonword repetition tasks have been shown to have diagnostic value for differentiating children with and without developmental language-learning disabilities. Kamhi and Catts (1986) and Kamhi, Catts, Mauer, Apel, and Gentry (1988) used multisyllabic words derived from real words in two studies of the performance of children with spoken language-impairment (LI) and children with reading impairment on measures of phonological, morphological, and lexical processing. Although the groups performed at a comparable level on many of the measures, the children with LI performed significantly lower on the nonword repetition task. Subsequent studies have shown that children with LI perform poorer on nonword repetition tasks than their typically developing peers (e.g., Conti-Ramsden & Hesketh, 2003; Dollaghan & Campbell, 1998;
Children with and without LI repeat nonwords that are more wordlike more accurately and with greater consistency than nonwords that are less wordlike (e.g., Munson, Edwards, & Beckman, 2005). However, there are discrepancies in the literature regarding the effect of wordlikeness on the repetition abilities of children with disabilities. Masterson et al. (2005) studied a group of 5- and 6-year-old children who were not identified with a language disability but had been shown to have poorer repetition skills on the Children's Test of Nonword Repetition (CNRep) (Gathercole, Willis, Baddeley, & Emslie, 1994), which contains items of both high and low wordlikeness. Masterson et al. also administered a task using nonwords with low neighborhood density and found that the children with poor scores on the CNRep performed significantly poorer on the task involving the repetition of nonwords with few neighbors but did not differ significantly from children with good repetition skills on nonwords with many neighbors.

Munson, Kurtz, and Windsor (2005) studied the repetition abilities of children with SLI in comparison with chronological age matched peers and vocabulary-size matched controls. Their results indicated that phonotactic probability influenced the repetition accuracy more for the children with SLI than for the age matched peers. Marton (2006) contrasted multisyllabic words containing no meaningful parts to ones with one monosyllabic real word combined with 2–3 syllables with no meanings. The children with LI did not show a difference in performance accuracy between the two types of nonwords, whereas the age matched and language matched controls exhibited better
performance on the items containing the true words. Coady et al. (in press), however, found contrasting results. They studied children with and without LI and found that, although children with LI are less accurate overall, they exhibit the same sensitivity to phonotactic frequency as children with TL. Munson, Edwards, and Beckman (2005) studied nonword repetition among 3- to 6-year-old children with and without phonological disorders (PD) using a set of stimuli that included both high- and low-frequency nonwords. Although the children with PD were less accurate overall, they did not appear to be at a larger disadvantage for the low-frequency words.

Although the literature supports the use of nonword repetition tasks for differentiating children with and without developmental language-learning disabilities, the impact of word structure on the performance of children with LLD is less clear. Some studies have shown children with LLD to respond to words with high and low wordlikeness similarly to children without LLD (e.g., Archibald & Gathercole, 2006; Coady et al., in press), whereas other studies indicate that children with LLD do differ in their sensitivity to degree of wordlikeness as compared to children with TL (e.g., Marton, 2006; Munson, Kurtz, & Windsor, 2005).

**Considerations in Nonword Structure**

Items within measures of nonword repetition vary significantly in structure. This confounds comparisons of results across studies, as the different stimulus items may, in fact, measure different abilities. Dollaghan and Campbell (1998) urged that nonwords be designed to differ systematically and as much as possible from any true word in the English language without violating the phonotactic constraints (i.e., allowable rules for
ordering sounds in words) of English. This would decrease the possibility that the participant’s vocabulary knowledge would affect the results and might moderate advantages for children with typical language development over those with a language disability related to their vocabulary knowledge. At the same time, it would increase the potential value for diagnosing disorder. They developed a set of criteria focused on phoneme selection and placement and following rules that would reduce the likelihood that any of the individual syllables would correspond to an English word. Related variables considered were phonotactic probability and phonological neighborhood density.

Using these criteria, Dollaghan and Campbell (1998) designed a nonword repetition task (NRT) consisting of 16 nonwords varying in length from one to four syllables. They administered the nonwords, as well as the Test of Language Development-2 (TOLD-2) (Hammill & Newcomer, 1988), to 44 children with LI and 41 with TL ages 5;8 to 12;2. Results indicated that the nonword task containing low frequency phonological sequences was able to differentiate elementary school children with and without language impairment with a higher degree of accuracy than the TOLD-2. Their findings indicated that children with LI have a deficit in nonword repetition that cannot be attributed to differences in language knowledge. Numerous follow up studies have supported the use of this tool to discriminate between children with LI and those with typically developing language (e.g., Ellis Weismer et al., 2000).
The Inclusion of True Morphemes in Nonword Structure

The inclusion of true morphemes in nonwords makes nonword stimuli even more like pseudo-words than merely incorporating high probability phonemic sequences. Such an approach clearly is inconsistent with rules for forming nonwords with low phonotactic probability and low neighborhood density. However, nonword repetition tasks that include real morphemes may have added diagnostic value if children with TL benefit more from the presence of true morphemes than those with LI.

A morpheme is considered to be the smallest meaningful unit of language (Nicolosi, Harryman, & Kresheck, 2004). A free morpheme can stand alone to designate meaning, whereas a bound morpheme (inflectional and derivational) must be joined to another morpheme. Inflectional morphemes are added to the root word to inflect the word to fill a syntactic role in a specific sentence, such as to indicate number (dog/dogs), person (sit/sits), tense (jump/jumped), or comparison (old/older/oldest). On the other hand, derivational morphemes are used to derive new vocabulary items, which have related but slightly different meanings and may vary in part of speech, such as from adjective to adverb (calm/calmly) or from verb to noun (vacate/vacation). Inflectional suffixes make up a small closed set that develop during the preschool years and are refined in the school-age years; whereas derivational prefixes (un-, dis-, non-, ir-) and suffixes (-ology, -tion) of Anglo-Saxon, Latin, and Greek origin develop more slowly, extending over the school-age years (Nagy, Diakidoy, & Anderson, 1991).

Although the inclusion of real morphemes in nonwords increases wordlikeness, which may make words easier to repeat (hence, less discriminative), their inclusion can
make it possible to capture evidence of children’s morphemic as well as phonemic knowledge and processing abilities. Studies of the morphosyntax of children with and without specific language impairment (SLI) (e.g., Rice & Wexler, 1996) have found a statistically significant difference in the performance of children with SLI as compared to peers with typical language; the children with SLI have more difficulty with grammatical morphemes. Other research has shown that students with learning disabilities differ significantly from students without disabilities in their knowledge of words containing derivational morphemes (Carlisle, 1987). Therefore, nonword repetition tasks that include real morphemes may have added diagnostic value if, indeed, language impairment involves difficulty in acquiring knowledge about the morphemic structure of language.

Gathercole, Willis, Baddeley, and Emslie (1994) designed the Children’s Test of Nonword Repetition (CNRep). It contains words with true morphemes as well as words with consonant clusters, differentiating it from the word sets developed with the rules suggested by Dollaghan and Campbell (1998). The nonwords on the CNRep are divided into low and high wordlikeness sets based on the subjective judgment of adults. Results of numerous studies using the CNRep have found nonword repetition using this type of word structure also to be accurate in identifying children with SLI (e.g., Bishop, North, & Donlan, 1996). Archibald and Gathercole (2006) compared the CNRep to the NRT (Dollaghan & Campbell, 1998) and found that, although the SLI group performed significantly poorer than the age-matched group on both measures, a significant difference between the SLI group and the language-matched group was found only on the CNRep. They attributed this to the inclusion of consonant clusters and morphemes in the CNRep stimuli. From their results, Archibald and Gathercole concluded that deficits in
nonword repetition are related to multiple factors, including short-term memory, lexical knowledge, and output processes. By including morphemes and articulatory complex consonant clusters, the type of nonword structure on the CNRep, may probe these areas and serve as a more inclusive assessment of the overall construct of nonword repetition as compared to the NRT.

**Effect of Stimulus Item Design**

Graf Estes et al. (2007) conducted a meta-analysis including 23 studies of the difference in nonword repetition performance between children with \( n = 549 \) and without \( n = 942 \) specific language impairment ranging in age from 4 to 12 years of age. They found that the design characteristics of the stimulus items contributed to differences in effect size reported across studies. They considered the wordlikeness of stimulus items, articulatory complexity, word length, and scoring method (partial credit vs. correct/incorrect). In general, the meta-analysis revealed larger effect sizes when studies used nonword lists with a mixture of higher and lower wordlikeness, consonant clusters, and later developing phonemes. The meta-analysis also showed larger effect sizes for longer nonwords scored simply as either correct or incorrect rather than as percentage of phonemes produced correctly. These results point to the need for further investigation into the impact of wordlikeness on performance in children with language impairment using lists controlled for the inclusion of morphemes in order to better understand the underlying constructs involved and to explore performance in adolescence as well as in early childhood.
Summary

The performance of various clinical populations on nonword tasks has been of interest to researchers as a means to identify children with disabilities and better understand their underlying deficits. Work continues to identify the contribution of individual skills as well as the interaction of multiple skills in this task, as nonword repetition continues to be investigated as a tool with validity for identifying language impairment in the preschool years through adolescence.

The structure of the nonwords has varied between previous studies, making it difficult to generalize results. Inconsistencies exist across studies as to the association of wordlikeness with the repetition abilities of children with disabilities compared to their typically developing peers. The current study focused specifically on how children with and without disabilities responded to two lists of words, both with relatively low phonotactic probability and neighborhood density. The two word lists differed in whether or not they included true morphemes.

Purpose of Paper One

The purpose of this paper was to investigate differences in performance by students with and without language-learning disabilities across grade levels for repeating nonword stimuli that are more wordlike because they contain true morphemes as well as for repeating items considered less wordlike based on the exclusion of real morphemes. The results should help to clarify the inconsistent evidence regarding the effect of wordlikeness and underlying nonword processing ability in children with language-
learning disabilities. In addition, this study was designed to provide data for older students and to have practical implications for designing clinical assessment measures.

**Methods**

**Participants**

This study analyzed secondary data from 112 school-age students who participated in a larger study of a beta research version of a new Test of Integrated Language and Literacy Skills (TILLS) (Nelson, Helm-Estabrooks, Hotz, & Plante, 2007). Fifty-four students were identified as meeting inclusion and exclusion criteria as having language impairments and/or learning disabilities (LLD). The other 58 participants met criteria as having typical language development (TL). A stratified sampling approach was used to create groups comparable for chronological age, sex, race/ethnicity, and socioeconomic status based on whether they qualified for free or reduced lunch.

The students in the LLD group met criteria for having normal hearing as confirmed by an audiometric screening and were receiving services for language impairment and/or learning disabilities in public schools or private clinics. Most of the students \( (n = 37) \) obtained a standard score of < 85 on the Core Language Score Composite of the *Clinical Evaluation of Language Fundamentals*, Fourth Edition (CELF-4) (Semel, Wiig, & Secord, 2003). A portion of them \( (n = 17) \) met the criterion of receiving services for LLD based on other measures of language and literacy development, although they did not meet the criterion of scoring below 85 on the Core Language Score of the CELF-4. The rationale for this was that the CELF-4 measures
spoken language proficiency only, and the research team was interested in the performance of students whose language difficulties involve their reading or written language, and perhaps not listening and speaking. With the exception of attention deficit disorders \((n = 8)\), none of the participants had any other diagnosis comorbid to their identification as having a disorder of spoken and/or written language.

Students in the typical language (TL) group had never been identified as having language or learning disabilities (nor as having any special education diagnosis other than attention deficit hyperactivity disorder; \(n = 6\)). That is, they did not have deficits in speaking, reading, writing, or social skills. They also had passed a recent (within 12 months) hearing screening test. All were administered the CELF-4 as part of the larger study and were confirmed to achieve a standard score of \(> 85\) on the Core Composite. Participant criteria are summarized in Table 2.1.

Table 2.1

*Participant Criteria*

<table>
<thead>
<tr>
<th>Typical Developing (TL)</th>
<th>Language-Learning Disability (LLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No deficits in speaking, reading, writing, or social skills</td>
<td>• Deficits in spoken and/or written language/IEP-special services</td>
</tr>
<tr>
<td>• (&gt; 85) Std Score on the Core Composite of the CELF-4</td>
<td>• &lt; (85) Std Score on the CELF-4 Core Composite ((n = 38)) OR &gt; (85) Std Score on the CELF-4 Core Composite and other data supporting diagnosis ((n = 17))</td>
</tr>
<tr>
<td>• No special ed Dx</td>
<td>• No other special ed Dx</td>
</tr>
<tr>
<td>• Passed hearing screening</td>
<td>• Passed hearing screening</td>
</tr>
</tbody>
</table>
Of the 58 students with TL, 27 were male and 31 female; of the 54 students with LLD, 28 students were male and 26 female (see Table 2.2). The students with TL ranged in age from 6;0 to 17;9 (mean 11;5); the students with LLD ranged in age from 7;2 to 17;10 (mean 11;4). In the TL group, 59% of the participants were Caucasian, 24% were Hispanic (any race), 12% were African-American, and 5% Asian. This is comparable to the LLD groups in which 57% of the participants were Caucasian, 24% were Hispanic (any race), 17% were African-American, and 2% Asian. Some of the students in both groups came from homes where languages other than English are spoken, but such students were recruited in age strata (within 9 months) paired with others in the opposite group who had the same sex and similar language experience. All participants were identified by speech/language pathologists and other school professionals as speaking English at least as well as any other language used for academic purposes at school.

**Measure Description and Development**

The nonword repetition task that was developed for use in this study was modified from earlier versions of the subtest that had been piloted for inclusion in the TILLS (Nelson et al., 2007). This study utilized data collected from the Nonword Repetition subtest, which was 1 of 11 subtests evaluated in the TILLS beta research trial.

The nonwords were designed with attention to phoneme choice and word position, length in syllables, phonotactic probability, and neighborhood density. One set of nonword stimuli was designed to be used to assess nonword repetition-only, whereas a second set (the one that included real morphemes) was designed to assess nonword
spelling as well as nonword repetition. For example, students were asked to “Say tilding” and then “Spell tilding.”

Table 2.2

Participant Demographics

<table>
<thead>
<tr>
<th>Groups</th>
<th>Typical Language (TL)</th>
<th>Language-Learning Disability (LLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 58</td>
<td>N = 54</td>
</tr>
<tr>
<td>AGE (yrs;mos)</td>
<td>Mean 11;5</td>
<td>Mean 11;4</td>
</tr>
<tr>
<td></td>
<td>(6;0-17;9)</td>
<td>(7;2-17;10)</td>
</tr>
<tr>
<td></td>
<td>SD=2;11</td>
<td>SD=2;10</td>
</tr>
<tr>
<td>GRADE LEVEL: % =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st-2nd</td>
<td>15.5</td>
<td>19</td>
</tr>
<tr>
<td>3rd-5th</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td>6th-8th</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>9th-12th</td>
<td>15.5</td>
<td>13</td>
</tr>
<tr>
<td>GENDER: % =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47</td>
<td>52</td>
</tr>
<tr>
<td>Female</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>RACE/ETHNICITY: % =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>59</td>
<td>57</td>
</tr>
<tr>
<td>Hispanic</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>African-American</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Asian</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>FREE/REDUCED LUNCH: % =</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>No</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>Missing data</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

The Dollaghan and Campbell (1998) guidelines for spoken nonword tasks were held in consideration for the creation of the list of nonwords that were developed for repetition-only, as were low phonotactic probability and sparse neighborhoods. That is, they were structured to be as unlike real words as possible but still to be consistent with
English phonology. These criteria were expected to minimize the influence of the participant’s vocabulary-specific knowledge on the response. Accordingly, none of the individual syllables were designed to correspond to an English word. Although none of the stimuli (according to Dollaghan and Campbell) should have included consonant clusters or any of the “late eight” consonants (r, l, j as in shoe; θ as in thin; ð as in this; tʃ as in chair; dz as in jam; zh as in measure), some of the nonword items on the TILLS list of 12 words without morphemes did include the phonemes /tʃ/ as well as /dz/ (consistent with findings by Archibald and Gathercole, 2006). Using these criteria, consonants were assigned to word positions in which they can occur but in which they normally would occur only ≤ 25% of the time according to data on the percentage of occurrence (Shriberg & Kent, 1982).

In developing the list of stimuli to be used for both for repetition and spelling, different criteria were utilized. In order to take into account additional skills/strategies individuals utilize in decoding/encoding written material, developmental data for reading/spelling with various vowel patterns and consonant diagraphs were considered for their potential in assessing orthographic knowledge (considered in paper three of this dissertation, which is reported in Chapter IV). Vowel patterns include short, long (vowel + silent “e”), vowel digraphs (e.g., “oa”), diphthongs (e.g., “oi”), and r-controlled vowels. Consonant blends (initial and final) and consonant diagraphs were included as well. In addition, inflectional (-ed, -ing) English morphemes and derivational morphemes of Anglo-Saxon, Latin, and Greek origins were included. As prior research has shown, students with language-learning disabilities often have difficulty with morphemes
(Carlisle, 1987; Rice & Wexler, 1996). Therefore, the researchers felt that it was important to include these forms.

For this study, all 12 of the words without morphemes designed for repetition-only were utilized, and 12 of the 18 other nonwords were selected that contained true morphemes. Both lists include words of varying length. The list of 12 nonwords without morphemes includes items that range from two to six syllables, and the list of 12 nonwords with morphemes includes items that range from one to five syllables. Previous studies have indicated that although children with language impairment perform worse than children with normal language at each syllable length, the most significant difference occurs when the words reached three to four syllables in length (Dollaghan & Campbell 1998; Ellis Weismer et al., 2000).

**Evaluating the Wordlikeness of the Nonword Items.** Steps also were taken to measure the phonotactic probability and neighborhood density of both sets of nonwords. Vitevitch and Luce (2004) designed a Web-based interface that calculates phonotactic probability (retrieved October 30, 2009, from http://www.bncdnet.ku.edu/cgi-bin/DEEC/post_ppc.vi). This algorithm was used to ensure that the frequency with which sound segments and sequences of segments occurred in the 12 nonwords without true morphemes was relatively low when compared to true words in the English language and that the sequences in the contrasting list were as low as possible given that the words incorporated true morphemes. Furthermore, both sets of nonwords were assessed to ensure that they were from sparse neighborhoods and had few or no true words related to their phonological structure. These qualities were confirmed by utilizing Washington

In order to determine the phonotactic probability of a word, the positional segment frequency for each sound in the word (likelihood of occurrence of a given sound in a given word position) and biphone frequency (likelihood of occurrence of two adjacent sounds) was summed. Therefore, the measure was influenced by word length. Vitevitch and Luce (1999) found that when word length is controlled, phonotactic probability and neighborhood density are positively correlated; that is, common sound sequences are found in dense neighborhoods. However, words of shorter length tend to have more neighbors, resulting in a negative correlation for word length and neighborhood density when length is not controlled. Considering each of these parameters was important because Storkel (2004) found that, although the two measures of phonotactic probability and neighborhood density are correlated, the magnitude was lower than reported by Vitevitch, Luce, Pisoni, and Auer (1999). Storkel attributed this difference to the neighborhood density remaining almost constant in words containing seven or more sounds, whereas the phonotactic probability continues to vary. Because 92% (22/24) of the stimulus nonwords in this study contained seven or more phonemes, it was important to evaluate wordlikeness for each of the items using both methods.

To account for the varied interactions of phonotactic probability, neighborhood density, and word length, the methods outlined by Storkel (2004) were followed to assess the nonword stimuli with respect to both neighborhood density and phonotactic
probability, controlling for the length of each nonword item. Table 2.3 reports the results of these computations.

Table 2.3

Number of Syllables, Phonological Neighborhood Density, * and Phonotactic Probability z-score of Nonwords

<table>
<thead>
<tr>
<th>Nonwords Without True Morphemes</th>
<th>Nonwords Containing True Morphemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonword No. of syllables</td>
<td>Neighbors</td>
</tr>
<tr>
<td>nivok (2)</td>
<td>0</td>
</tr>
<tr>
<td>chanoop (2)</td>
<td>0</td>
</tr>
<tr>
<td>votajeeb (3)</td>
<td>0</td>
</tr>
<tr>
<td>dooneechof (3)</td>
<td>0</td>
</tr>
<tr>
<td>tobavip (3)</td>
<td>0</td>
</tr>
<tr>
<td>natofeevoop (4)</td>
<td>0</td>
</tr>
<tr>
<td>dookoneepab (4)</td>
<td>0</td>
</tr>
<tr>
<td>tafoonichod (4)</td>
<td>0</td>
</tr>
<tr>
<td>voonopeechike (4)</td>
<td>0</td>
</tr>
<tr>
<td>naitojeetauf (4)</td>
<td>0</td>
</tr>
<tr>
<td>choveibopenoog (5)</td>
<td>0</td>
</tr>
<tr>
<td>veinaichootoogeedape (6)</td>
<td>0</td>
</tr>
</tbody>
</table>

*Neighborhood Criteria: Substitution, Deletion, Addition

Using the online calculators and Storkel’s (2004) method of correcting for word length, z-scores for phonotactic probability of all nonwords based on the mean and standard deviation for words of the same length utilizing the Hoosier Mental Lexicon (HML) were calculated. For the 12 nonwords without morphemes, both the mean of the positional segment average and biphone average z-scores were calculated. The positional
segment average z-score was −1.8430 (range = −1.0930 to −2.6442 as seen in Table 2.3) and the biphone average z-score was −1.6179 (range = −1.2 to −1.9167). According to Storkel, a positive z-score is classified as common/dense, whereas zero or a negative z-score is indicative of rare/sparse. None of the items on the list of 12 without morphemes was found to have neighbors based on substitution, deletion, or addition of a single phoneme; therefore, the word length correction involving z-scores suggested by Storkel was not needed for neighborhood density. The results of phonotactic probability and neighborhood density for the list of 12 nonwords without morphemes indicate items of low wordlikeness; the frequency with which such sound segments and sequences of segments within the targeted nonwords occur in the English language is rare.

For the 12 nonwords containing true morphemes and/or developmental consonant and vowel patterns, the mean of the positional segment average (phonotactic probability) z scores was −.5318 (range = .9174 to −1.7373 as seen in Table 2.3) and the biphone average z-score was −.3983 (range = .7360 to 1.6538), which was slightly higher and, thus, slightly more wordlike than the list of 12 words without morphemes. As seen in Table 2.3, "brapt" was the only nonword found to have one or more phonological neighbors as determined by the online calculator. These neighbors were derived by substituting a single phoneme (brapt→bract) or deleting a single phoneme (brapt→brat, rapt). Since this was the only stimulus item found to have neighbors, z-scores to correct for word length were not calculated for neighborhood density on this set. Taken as a whole, this list of 12 nonwords containing morphemes also represents low wordlikeness, although they have structures that more closely resemble true words than the list of 12 without morphemes. When the lists were combined and phonotactic probability assessed,
the mean of the positional segment average z-score for the list of 24 items was -1.0426 (range = .9174 to -2.6442) and biphone average z-score was -1.0081 (range = .736 to -1.9167), which indicates low wordlikeness for the combined list.

Internal consistency for the 31 words Nonword Repetition subtest of the TILLS is supported by a Cronbach’s alpha coefficient of .85 and interscorer reliability is 99.2%. For the separate lists that were created for this study, Cronbach’s alpha coefficient for the word list without morphemes was .78 and the alpha for the word list with morphemes was .68. The alpha for the combined list was .84, which reflects its greater length.

Testing Procedure

The data were gathered at sites in California, Illinois, Massachusetts, Michigan, Nevada, North Carolina, and Texas by speech-language pathologists with state licensure or certification. These research clinicians were trained to gather parental permission and child assent using procedures approved by a Human Subjects Institutional Review Board and to administer all subtests of the TILLS in random order. Testers followed instructions in the examiner’s book, which contained explicit instructions as to how to introduce each task, including the nonword repetition and spelling tasks (administered in tandem), to the student.

Nonword stimuli for repetition were presented via audio CD to ensure consistency in the spoken stimulus pronunciations across clinicians. All items were presented using a digitized recording of a woman’s voice. The clinician was instructed to check the sound level on the two practice stimuli to make sure that the volume of the CD player was appropriate and the stimuli were easily audible for the students (all of whom had passed a
recent hearing screening test). An item was repeated only if ambient noise interfered with the presentation. The clinician transcribed the student’s repetition response using standard International Phonetic Alphabet (IPA) notation in the examiner’s book. The clinician was provided both orthographic and phonetic representations of the stimulus items.

For this study, responses were scored as correct or incorrect. Any variation that could not be attributed to a consistent developmental speech-sound substitution noted in the participant’s conversational speech was considered incorrect. Errors attributed to consistent developmental speech-sound substitution were scored as correct. Inter-scorer reliability was computed as 99.2% item-by-item agreement.

Analysis

In order to answer the theoretical question regarding relative abilities of children on words that have more or less wordlikeness and the practical question about the most appropriate list of words to use to evaluate children, data from a subtest of the nonword repetition subtest of the TILLS were analyzed in two sets (12 items with no true morphemes; 12 items containing true morphemes). Analysis of group differences was also performed with the total set of 24 items. Performance on the lists by children with and without LLD was examined by calculating means and standard deviations. A mixed model repeated measure analysis of variance (ANOVA) was used to examine differences in performance of the TL and LLD groups across grade levels on each of the lists and to examine for any interactions effects. Effect sizes were calculated with Cohen’s $d$ for differences that were found to be significant with ANOVA. The ability to classify students correctly based on their performance on each word list of 12 nonwords (with and
without true morphemes), and on the total list of 24, was examined by considering effect sizes. An additional analysis was conducted to examine the percentage of students with TL and LLD who earned scores from 1–12 on each word list to investigate the relative ability of the two word lists and total list to correctly classify children with LLD. A receiver operating characteristic (ROC) curve analysis also was completed for the students with and without LLD for the two nonword lists as well as the combined list. This type of analysis provides a useful means to assess the diagnostic accuracy of a test. A ROC curve illustrates the relationship of the true positive rate (sensitivity) to the true negative rate (specificity) for different cut-off points of a test measure (Straus, Richardson, Glasziou, & Haynes, 2005). The area under the ROC curve is a measure of how well a test measure distinguishes between the two diagnostic groups. If the test were perfect, every child with LLD would have a lower result than every child with TL resulting in the area under the curve equaling 1.00. If the test’s ability to distinguish between children with and without language learning disorders was no better than chance, the area under the curve would be 0.5 indicating 50% sensitivity and 50% specificity.

Specifically, the research questions posed by this study were:

1. Do lists of nonwords with or without true morphemes differ in difficulty for school-age students (grades 1–12) regardless of ability group? That is, is there a repeated measures (within subjects) main effect for word-list type?

2. Do children with TL and LLD perform differently between groups on:
   (a) nonwords without true morphemes?
   (b) nonwords containing true morphemes?
3. Does performance differ across age? That is, is there a significant main effect for grade level, regardless of ability group or word-list type? Are there any interaction between grade level (4 levels), ability group (TL or LD), and word-list type (with and without true morphemes)?

4. Does one word list discriminate more accurately than the other between students with TL and students with LLD? Or is there any advantage to using them both?

Results

Data collected on the Nonword Repetition subtest of the TILLS during the beta standardization trial were used to answer the questions posed by this study. Means and standard deviations are shown in Table 2.4 for the 112 children with and without LLD at four grade levels on the lists of nonwords without morphemes, with morphemes, and a combined list.

Performance on Differing Word Lists

To answer to questions about within and between group differences, a mixed model repeated measure analysis of variance (ANOVA) was performed. This analysis was used to examine the performance of the two ability groups (TL and LLD) on the two lists of nonwords (with and without morphemes) at the four grade levels (1–2, 3–5, 6–8, and 9–12). The results showed a significant main effect for the type of nonwords, $F(1, 104) = 182.67, p < .0001, d = 1.47$. As seen in Table 2.4, the mean score for nonwords without morphemes was significantly lower than for nonwords with
morphemes regardless of ability group or age group. Figure 2.1 shows difference in mean scores calculated by subtracting the mean of the nonwords without morphemes from the mean of the nonwords with morphemes for all of the participants by group across the grade levels.

Table 2.4

Differences in Performance Among Groups Across Lists

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>1st–2nd M(SD)</th>
<th>3rd–5th M(SD)</th>
<th>6th–8th M(SD)</th>
<th>9th–12th M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TL N=12</td>
<td>LLD N=10</td>
<td>TL N=23</td>
<td>LLD N=24</td>
</tr>
<tr>
<td>Nonwords</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/o Morphemes</td>
<td>6.08 (2.54)</td>
<td>7.43 (2.31)</td>
<td>7.86 (2.54)</td>
<td>8.11 (2.15)</td>
</tr>
<tr>
<td></td>
<td>2.60 (1.51)</td>
<td>4.96 (2.73)</td>
<td>4.86 (2.98)</td>
<td>5.83 (2.40)</td>
</tr>
<tr>
<td></td>
<td>1.67</td>
<td>1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohen’s d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonwords</td>
<td>9.58 (1.78)</td>
<td>10.13 (1.52)</td>
<td>10.21 (1.81)</td>
<td>11.22 (0.97)</td>
</tr>
<tr>
<td>w/ Morphemes</td>
<td>6.50 (2.76)</td>
<td>8.50 (2.21)</td>
<td>8.36 (2.13)</td>
<td>8.50 (1.64)</td>
</tr>
<tr>
<td></td>
<td>1.33</td>
<td>0.86</td>
<td>0.94</td>
<td>2.02</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined List</td>
<td>15.67 (3.68)</td>
<td>17.57 (2.89)</td>
<td>18.07 (3.75)</td>
<td>19.33 (2.60)</td>
</tr>
<tr>
<td></td>
<td>9.10 (4.07)</td>
<td>13.46 (4.60)</td>
<td>13.21 (4.53)</td>
<td>14.33 (3.72)</td>
</tr>
<tr>
<td></td>
<td>1.69</td>
<td>1.07</td>
<td>1.17</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Figure 2.1. Differences in mean scores on nonword lists with and without morphemes by groups across grade levels.
Performance of Groups by Ability

In order to answer the second question regarding relative abilities of children with and without LLD to repeat words that are more wordlike (contain true morphemes) or less wordlike (contain no morphemes), the relationships between performance of the two groups of children on the lists of nonwords without morphemes and nonwords with morphemes were examined. A significant main effect of ability (TL vs. LLD) was found, with the TL group out performing the LLD group, $F(1, 104) = 41.31, p < .0001, d = 1.21$ on both lists.

Performance by Age

The third question asked about whether performance on the two nonword lists differed with age and whether there were any interactions of ability group, nonword-list type, and age. A main effect was found for grade level, $F(3, 104) = 4.96, p = .003$. That is, the children improved in their ability to repeat both types of nonwords with grade level. Post hoc comparisons for grade levels using the Bonferroni method showed, however, that a significant difference was found only in the performance of the 1st–2nd grade group compared to the 3rd–5th graders ($p = .036, d = .593$), 6th–8th graders ($p = .048, d = .603$), and 9th–12th graders ($p = .003, d = 1.032$). No significant differences were found in performance by grade level between the 3rd–5th, 6th–8th, and 9th–12th grade students ($p > .05$). In answer to the question about whether any of the other significant differences between word-list type or between ability groups differed by age, the mixed model ANOVA revealed no interactions between types of nonwords x grade.
level, $F(3, 104) = .591, p = .622$; types of nonwords $\times$ ability, $F(1, 104) = 1.081, p = .301$; grade level $\times$ ability level, $F(3, 104) = .509, p = .677$; or types of nonwords $\times$ grade level $\times$ ability, $F(3, 104) = .447, p = .720$. The means for each word list by the two ability groups at the four age levels are shown in Figure 2.2.

![Graph showing performance on nonword lists by grade and ability](image)

**Figure 2.2.** Performance on nonword lists by grade and ability.

**Ability Group Membership Based on Performance**

In order to address the final question regarding which word list most accurately discriminated between students with TL and students with LLD, effect sizes (Cohen’s $d$) were examined to describe the degree to which each word-list differentiated students by ability group within each of the four age levels. Cohen’s $d$ provides a standardized unit of measure in terms of the number of standard deviations between group performances. Cohen (1988) suggested that this type of effect size be interpreted as small ($d = .2$), medium ($d = .5$), and large ($d = .8$). An effect size of at least 1.0 standard deviation ($SD$)
is desirable for a test to be considered discriminative. Previous studies of sensitivity and specificity found that tests or subtest with an effect size of at least 1.0 $SD$ difference have a strong probability of resulting in accurate identification (Fuchs, 2003; Perona, Plante & Vance, 2005; Plante & Vance, 1994).

These Cohen’s $d$ values are shown in Table 2.4 and repeated here for ease of reference. There was a large effect size for performance of the two groups by ability for both nonword lists at each of the four grade levels (Cohen’s $d$ = .86–2.02). For the nonwords without morphemes, the Cohen’s $d$ were found to be: 1.67 for 1st–2nd grade, .98 for 3rd–5th grade, 1.08 for 6th–8th grade, and 1.00 for 9th–12th grade. Performance between the groups on the list with morphemes was found to be less consistent with effect sizes as follows: 1st–2nd grade, $d = 1.33$; 3rd–5th grade, $d = .86$; 6th–8th grade, $d = .94$; and 9th–12th grade, $d = 2.02$. Although the high school students with and without LLD performed significantly different on the nonwords with and without morphemes, the additional of true morphemes significantly impaired the performance of the students with LLD as compared to the students with TL.

An additional comparison was made for the total word list of 24 words. The effect sizes for the grade levels were: 1.69 for 1st–2nd grade, 1.07 for 3rd–5th grade, 1.17 for 6th–8th grade, and 1.56 for 9th–12th grade. In this case, the effect size exceeded 1.0 at all four grade levels. The means for the two groups by ability for the combined list of words is shown in Fig 2.3.
An additional analysis was conducted to examine the ability of the two nonword lists to discriminate between the two groups by ability. Crosstabs were used to determine the percentage of students with TL and LLD who earned scores from 1–12 on each of the word lists. Results of this analysis are found in Figure 2.4. A strong linear relationship was found with both lists; the percentage of students with LLD achieving a score decreased as the scores increased. Examination of data by grade levels netted more consistent results on the list with morphemes as compared to the list without across 1st through 8th grade; however, performance at the 9th through 12th grade level by the 19 students with and without LLD on both lists was inconsistent.

Results of ROC analysis are presented graphically in Figure 2.5. The two nonword lists discriminated the two groups with equal areas under the curve (.775 for the nonwords with morphemes and .778 for the nonwords without morphemes). The ROC analysis showed that .804 was represented under the ROC for the combined list. Based on likelihood ratios (Simon, 2008), a suggested interpretation is for ROC results of 0.5 to
0.75 to be considered fair, 0.75 to 0.92 to be considered good, 0.92 to 0.97 to be considered very good, and 0.97 to 1.00 to be considered excellent. Using these guidelines, the results for the two separate nonword lists and the total nonword lists in the present study fall in the "good" range.

Figure 2.4. Percent of LLD students earning each score.

Figure 2.5. ROC curve illustrating the relationship of the true positive rate (sensitivity) to the false positive rate (specificity) for the three nonword lists.
Discussion

The purpose of this study was to explore the association between two lists of nonwords, varying in the degree of “wordlikeness” as determined by the presence or absence of true morphemes, with performance on nonword repetition skills by school-age children with language/learning disabilities and children with typical language skills in the 1st through 12th grade age range. Results of previous studies have differed in conclusions about the effect of wordlikeness on repetition abilities by children with and without disabilities. Little is known about the abilities of adolescents on nonword repetition tasks.

The current study differed from previous studies in the inclusion of true morphemes as the determiner of more or less “wordlike.” Both nonword lists contained items of similar structure. Both represented low wordlikeness as determined by low levels of phonotactic probability and neighborhood density (only one nonword had a neighbor). The age range (1st–12th grade) allowed for data to be gathered for the older students for which limited research currently exists.

In the present study, all children, regardless of their ability, performed significantly better on the nonwords containing morphemes. This suggests that all of the children were able to utilize the support provided by the inclusion of the true morphemes to improve their performance. The results of this study support previous findings (e.g., Archibald & Gathercole, 2006; Coady et al., in press; Munson, Edwards, & Beckman, 2005) that found performance by children with language based disabilities less accurate in their overall performance as compared to children with TL, but with limited impact from
varying wordlikeness. Although children with LLD have been found to have deficits in morphological knowledge (e.g., Rice & Wexler, 1996), the results of the current study point to children’s ability to use the knowledge that they do possess. However, it should be noted that the most significant difference in performance was found at the high school level; students of this age with LLD were more significantly impaired than their peers in performance on the nonwords with morphemes. These results suggest that for this group of students in this study, the morphological deficits continue to impact ability into adolescence.

The results of the current study differed from those of Munson, Kurtz, and Windsor (2005), who found that, although children with SLI repeated nonwords of high phonotactic probability with better accuracy than nonwords of low phonotactic probability, they were more affected by the difference in wordlikeness than their CA peers. The current study included two sets of stimulus items, both of which had low phonotactic probability (compared to real words), but with and without true morphemes. The main distinction was that, in the current study, both groups of children appeared to benefit from wordlikeness in similar ways.

Edwards et al. (2004) found a decrease in the difference in mean accuracy scores between words with low and high frequency sequences with age. Their study included typically developing children ages 3 to 8 years and adults ranging in age from 21 to 34 years. The results of the current study expand on those of Edwards et al. to include students with LLD and students with and without LLD in later elementary, middle school, and high school. The nonwords in this study differed from those of Edwards et al. because they included true inflectional and derivational morphemes. The findings from
the current study generally corroborate those of Edwards et al., although the gap between performance on the two nonword lists seemed to widen for the high school students with TL, apparently related to their increased strength in performance on the list with true morphemes as compared to the list without morphemes. This difference may not be present in the LLD group due to lower vocabulary size (e.g., Catts, Fey, Zhang & Tomblin, 1999) and deficits in morphological knowledge (e.g., Rice & Wexler, 1996) compared to their same age peers. These results support the use of sublexical knowledge in phonology and morphology by both TL and LLD but point out the challenges for those with deficits in these elements of language as words become more complex. Given the small group size ($n = 9$), these results need to be viewed with caution; further research should be conducted to determine whether the increase in difference in performance between the two lists of nonwords by the TL high school group is due to their ability to recruit their morphological knowledge to more accurately produce the nonwords with morphemes.

In the present study, the TL group significantly out performed the LLD group at all grade levels. These findings are in line with previous studies that have established nonword repetition deficits in children with language impairment (Dollahan & Campbell, 1998; Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990). Significant differences in performance were found for 1st–2nd grade compared to the other three grade levels. Previous studies have focused on the skills of younger students. The results of this current study expand those of Conti-Ramsden and Durkin (2007), which targeted children 11 and 14 years of age by assessing the skills of older adolescents in 9th–12th grades. Findings indicate support for Conti-Ramsden and Durkin’s finding that nonword repetition
abilities are developmentally stable in older students with language impairment, who seem to show no evidence of "catching-up" to their typical peers.

Previous studies have supported the use of measures such as the NRT (Dollaghan & Campbell, 1998), in which nonwords were designed to minimize wordlikeness and no morphemes were included, to be a reliable measure in discriminating children with language impairment from their typically developing peers (Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000). Archibald and Gathercole (2006) compared the 40-item CNRep to the 16-item NRT and found that, although the SLI group performed significantly poorer than the age-matched group on both measures, a significant difference between the SLI group and the language-match group was found only on the CNRep, which contains true morphemes. The current study compared 12 nonwords containing true morphemes to 12 nonwords without true morphemes. Results indicated both types of nonwords to be useful in discriminating between children with and without LLD across grades 1st–12th. The list without morphemes, however, netted a larger between-group effect size for grades 1–8, although crosstab analysis of percentage of students with LLD earning each score, as shown in Figure 2.4, suggested performance by children with LLD to be less inconsistent on the list with morphemes as compared to the list without morphemes.

Although some differences in effect sizes were found for the two lists and combined list at different grade levels, large effect sizes were noted between the ability groups at all grade levels for the nonword list without morphemes, the list of nonwords with morphemes, and the combined list. In general, across the grade levels, a larger effect size was found between groups on the list without morphemes.
Given that an effect size of at least 1.0 SD is desirable for a test to be considered discriminative, the results suggest that the nonword list without true morphemes is closer to that benchmark at all four grade levels than the list with true morphemes. However, examination of descriptive data indicated that for students with LLD, their performance was more predictable on the nonwords with morphemes as compared to those without. When the results were plotted for students earning each score, within this small data set, more anomalies were noted for the list of nonwords without morphemes than for the words with morphemes, even though they were easier. Examination of the results from the ROC analyses additionally confirmed that, in this small study, both types of stimulus items (nonwords with and without true morphemes) performed in the “good” range for distinguishing between children with typical language and those with language learning disorders. Although the total list of 24 words performed in the “good” range as well, its effect size suggested that is might be slightly better than either list of 12 nonwords used separately. Additionally, the total list had an acceptable Cronbach’s alpha coefficient of .85 compared to the lower Cronbach’s alpha for the two word lists with and without morphemes which were .68 and .78, respectively. Thus the longer list would be preferred on the basis of internal consistency as well.

Using the TILLS database to investigate these study questions proved beneficial but limitations existed. The age range of the participants (1st–12th grade), the stratified sampling approach that allowed the creation of two ability groups comparable in terms of age, sex, race/ethnicity, and socioeconomic status, along with the control of word structure set this study apart from existing research which has not spanned this age range. The nonword lists for this study utilized nonwords from the Nonword Repetition Subtest
of the TILLS. The two nonword lists—one with true morphemes and the other without—were created by forming subtests of nonwords from the TILLS subtest. Therefore, although similar in word structure, phonotactic probability, neighborhood density and number of syllables, they do differ slightly in these parameters as they were not specifically designed for this study.

Generalization of the results of this study is compromised by the small sample size ($n = 112$), especially when it was further divided into four grade levels. Although the number of participants based on ability was closely matched in number at each grade level, there were not uniform numbers of participants across grade levels. Distribution of participants by grade level varied from 3rd–5th grade ($n = 47$) to 9th–12th grade ($n = 15$).

Another limitation is that the administration of the nonword lists was not counterbalanced. All of the participants repeated the list of nonwords with morphemes prior to those without morphemes. Although the clinicians watched the participants for observable signs of fatigue, performance on the list of nonwords without morphemes could have been negatively impacted by order of administration.

In summary, this study sought to explore the association between the degree of “wordlikeness” with performance on nonword repetition skills by school-age children with TL and with LLD. Previous studies have revealed inconsistent evidence regarding the effect of wordlikeness on performance by children with LLD. Results of this current study indicated that while children of all ages with TL out performed those with LLD on both types of nonwords, all children were more accurate in their repetition of nonwords containing true morphemes as compared to those without morphemes. Additionally, no interactions were found between age, ability, and wordlikeness based on morpheme
inclusion. However, the word list with true morphemes produced a larger effect size for adolescent students in grades 9–12 than words without morphemes. These findings lend support to studies by Coady et al. (in press) and Munson, Edwards, and Beckman (2005) that revealed that children with LLD do utilize their knowledge of word structure to improve their performance in a similar manner to those children with TL although they continue to exhibit significant deficits in morphological knowledge into adolescence.

A better understanding of the impact of wordlikeness on performance of children with LLD will have practical implications for designing clinical assessment measures. Results from the current study support use of short probes (12–24 items) of low phonotactic probability with and without true morphemes to discriminate between children with and without LLD across 1st–12th grade. Future research is needed to confirm these findings and should be completed on carefully designed lists of nonwords of varying wordlikeness in order to minimize confounding factors. Limited studies have focused on older students; future research utilizing nonwords to assess skills in older as well as younger children is crucial to understanding skill development in children with LLD.

References


CHAPTER III

PAPER TWO: READING, WRITING, AND REPETITION OF NONWORDS BY STUDENTS WITH AND WITHOUT LANGUAGE-LEARNING DISABILITIES

Difficulty in learning to read and write has been identified as a national health crisis affecting millions of Americans (Lyon, 1998). Proficiency in literate language (reading, spelling, and written expression) is built on a system of oral language abilities (National Institute of Child Health and Human Development [NICHD], 2000). A large body of research demonstrates strong links among speech-language impairments, reading disabilities, and academic difficulties (Bishop, 1998, 2001; Catts, 1986, 1993; Catts & Kamhi, 2005; Smith, Roberts, Smith, Locke, & Bennett, 2006).

The Report of the National Reading Panel (NICHD, 2000) identified five critical areas necessary for success in reading. Often referred to as the “building blocks for reading,” the first three—phonemic awareness, phonics, and vocabulary development—involves sound/word level skills; whereas the remaining two—reading fluency and reading comprehension—require sentence/discourse level skills in addition to sound/word level skills. Children with language impairments and language-based learning disabilities often have deficits in one or more of these areas, although the relationships between spoken and written language deficits are not completely clear or invariably consistent (e.g., Catts & Kamhi, 2005; Pennington & Bishop, 2009).
One component of the literature focuses on children labeled as having "dyslexia," which also is called specific reading impairment (SRI) (Catts & Kamhi, 2005) or a form of specific learning disability (SLD) (Fletcher, Morris, & Lyon, 2003). This literature often incorporates limited or no mention of oral language abilities. Other literature focuses on children labeled as having language impairment (LI), both specific language impairment (SLI) (Stark & Tallal, 1981) and nonspecific language impairment (NLI) (Catts, Fey, Tomblin, & Zhang, 2002). The literature written from the perspective of LI often incorporates emerging, but still limited, discussion of their literate language difficulties along with a primary focus on the students' oral language impairments.

Because oral language forms the essential basis for literate language development and communication (American Speech-Language-Hearing Association [ASHA], 2001), additional research involving children with language impairment/language-learning disabilities (LLD) is justified. Such research should investigate the relationships between children's oral and written abilities, as well as between their spelling and reading abilities, to contribute to understanding the associations and dissociations of various aspects of sound/word level knowledge in its oral and written forms. The current study was designed to investigate the relationships among the three types of nonword processing skills (repetition, spelling, and reading) for groups of school-age children with and without LLD at two grade levels (elementary and secondary). It addresses questions whether school-age children with LLD differ significantly from students with typical language (TL) in their performance of the sound/word level skills as measured by closely associated tasks of nonword repetition, nonword spelling, and nonword reading, as well as two composite measures of phonemic awareness (PA) and vocabulary awareness (VA).
Nonword Processing Skills

Nonword tasks also have been developed to assess children's ability to demonstrate knowledge of word structure when performing tasks such as nonword repetition, nonword spelling, and nonword reading. The rationale for using nonwords rather than real words to assess application of word structure knowledge in speech imitation, spelling encoding, and reading decoding is to minimize the influence of the participant's previous vocabulary knowledge and memorized word patterns.

Nonword imitation has been found to be a strong predictor of later phonological awareness, at least in the early grades. Wesseling and Reitsma (2001) found nonword repetition in kindergartners with TL to be a consistent predictor of later phonological awareness, even after controlling for vocabulary knowledge and current phonological awareness. Using nonwords specifically designed to differ from true words at the word, syllable, or phoneme level, Dollaghan and Campbell (1998) and Ellis Weismer et al. (2000) found that children with spoken language impairment performed at a significantly lower level than children with typically developing language skills on nonword repetition tasks.

Other research has suggested that nonword repetition tasks may be helpful in differential diagnosis of subtypes of reading disorders and other forms of language impairment. Although nonword imitation may predict the development of phonological awareness, the ability to repeat nonwords is not necessarily highly associated with reading. Kamhi, Catts, Mauer, Apel, and Gentry (1988) found that children with specific reading impairments performed better on a multisyllabic nonword repetition task than
children with general language impairments. Hester and Hodson (2004) also found that nonword repetition had a low association with reading ability for typical learners. They reported that multisyllabic nonword repetition results, using the words developed by Kamhi et al. (1988), were not significantly correlated with nonword reading decoding for 65 typically developing 3rd-grade children.

Carney and Martin (2003) used a nonword reading task to compare children with dyslexia to chronological-age and reading-age matched controls to investigate the relative contributions of phonological and orthographic awareness (i.e., for using analogy to recognize alphabetic patterns in unknown words). They found that, although in general, the children with dyslexia relied on the grapheme-phoneme (orthographic) rules for decoding, all of the groups used some phonological skills to help decode the words. This reflected Foorman and Liberman's (1989) conclusion that readers with typical skills use their knowledge of connections between orthographic and phonological information to decode an unknown word, whereas the children with dyslexia relied more on the use of orthographic information in isolation of phonology.

Nonwords have been utilized also to explore underlying theories of spelling. Campbell (1983) used real words to prime for nonword representation to investigate the influence of lexical knowledge on spelling. She found that sound/letter correspondence depends on lexical skills, even in adult readers. Similarly, Barry and Seymour (1988) analyzed vowel patterns and found that participants more frequently produced the most common sound-to-spelling correspondence of vowels than the second most common spelling; however, priming by rhyming words caused a lexical influence. Nation (1997) used nonwords to demonstrate that common versus unique rime units (vowel and any
following consonants within a syllable) is associated with 8- and 9-year-old’s spelling accuracy in a positive direction.

In order to explore the relationship between reading and spelling, Campbell (1985) administered a spelling task containing real words and nonwords to children ages 9–11 years of age. The spelling accuracy for both the true words and nonwords by the poorer readers was significantly worse than spelling by the more skilled readers. Additionally, both groups appeared to use their knowledge of real word spelling, however limited, to create acceptable forms of nonwords. Cassar, Treiman, Moats, Pollo, and Kessler (2005) compared the performance of real word and nonword spelling by older children with dyslexia (mean age 11 years, 7 months) to younger typical children (mean age 6 years, 8 months). They found that the children with dyslexia had difficulties with the same phonological structures as the typical younger students (e.g., reduced vowels and consonant clusters). In their study of university students with dyslexia, Snowling, Nation, Moxham, Gallagher, and Frith (1997) found that students with dyslexia had more difficulty than the age- and educationally-matched control group students reading nonwords, but their performance in nonword spelling was not significantly different.

Nonwords have been useful in exploring the underlying theories in oral and literate (spelling and reading) language in a variety of clinical populations. However, relatively few studies have focused on or separated out children with oral language impairment (LI) from those with a reading impairment or “dyslexia” in studies of deficits in literate language. Schuele (2004) cautioned that oral language ability should be considered by professionals across disciplines who engage in research in the area of reading.
Caution should be taken when interpreting studies containing “nonwords.” Some nonwords, such as those created by Dollaghan and Campbell (1998), are designed to differ systematically from any true word in the English language, thus decreasing the possibility that the participant’s vocabulary knowledge would affect the results. At the same time, such words should not violate the phonotactic constraints (i.e., rules for ordering sounds in words) of English. Other “nonwords” are more like pseudo-words because they contain phonological, morphological, or orthographic structures that relate them directly to true words (Kamhi et al., 1988).

Dollaghan and Campbell (1998) outlined explicit criteria to create nonword stimuli that would be less like real words, which focused on phoneme selection and placement. Related variables that need to be considered when preparing nonword stimuli include phonotactic probability (i.e., frequency with which sound segments and sequences of segments occur in a language); phonological neighborhood density (i.e., number of real words that can be created by substitution, deletion, or addition of a single phoneme); and orthographic neighborhood density (i.e., number of real words that can be created by substitution, deletion, or addition of a single letter).

Gathercole, Willis, Emslie, and Baddeley (1991) proposed that nonwords resembling true words activate representations of similar words from long-term memory, which then creates an abstract phonological frame that can aid in nonword retrieval. For nonwords that do not resemble true words, this frame is not present. Showing the beneficial effects of wordlikeness, children repeat high-frequency sequences more
fluently and with more accuracy than low-frequency sequences (Edwards, Beckman, & Munson, 2004). Vitevitch and Luce (1998) described two levels of representation and processing—lexical and sublexical. For words and nonwords, they manipulated phonotactic probability and phonological neighborhood density by substituting, deleting, or adding single phonemes to real words (Luce & Pisoni, 1998). Results supported their hypothesis that words are processed at a lexical (word) level, whereas the nonwords are not linked to this type of unit of memory and are processed at a sublexical (phonetic segment) level.

The rationale for using low frequency phonological and letter sequences is to make tasks more discriminative. The inclusion of real morphemes in nonwords makes them more like real words, and thus, it is inconsistent with rules for forming nonwords with low phonotactic probability and low neighborhood density. However, children with LLD have exceptional difficulties with morphological components of words (as found by Carlisle, 1987). Therefore, tasks are needed that incorporate syllables with recognizable morphemic and orthographic structure along with syllables with low phonotactic probability. Such combinations of stimulus items may be particularly discriminative and/or have potential for informing intervention.

A review of the studies utilizing nonword reading tasks revealed variation in wordlikeness measures as a component of the study design. Many studies utilized tasks found in commercially available tests such as the Woodcock Reading Mastery Test-Revised (Woodcock, 1987) (e.g., Hogan, Catts, & Little, 2005; Lombardino, Riccio, Hynd, & Pinheiro, 1997); the Woodcock-Johnson Tests of Achievement (Woodcock & Johnson, 1989) (e.g., Hester & Hodson, 2004); and the Graded Nonword Reading Test
(Snowling, Stothard, McLean, 1996) (e.g., Gallagher, Laxon, Armstrong, & Frith, 1996). Other researchers have designed their own sets of nonwords using differing criteria, resulting in a variation of wordlikeness. In their study of the orthographic and phonological processing in nonword reading by children with dyslexia, Carney and Martin (2003) manipulated real words phonologically by changing the onset phoneme by one distinctive feature (e.g., \textit{ream}$\rightarrow$\textit{leam}). Goswami, Ziegler, Dalton, and Schneider (2003) created two types of nonwords to study reading in English and German students. “Large-unit” nonwords were orthographic neighbors to a real word (e.g., \textit{dake} for \textit{cake}) while “small-unit” nonwords were not (\textit{diak} for \textit{fake}). They quantified the orthographic distance using the orthographic similarity index (Marmurek & Kwantes, 1994).

\textbf{Comparison of Performance Across Tasks}

Currently, no one study compares sound/word level processing skills across all three tasks of nonword repetition, spelling, and reading using closely associated nonword lists controlled for word structure across the school-age years in students with typical language (TL) as well as LLD. Studies exploring the relationship of repetition, reading, and spelling have utilized very different tasks to compare the skills. In their study of typically developing 3rd graders, Hester and Hodson (2004) found nonword repetition of the multisyllabic words developed by Kamhi et al (1988) not to be significantly correlated with nonword reading as measured by a standardized nonword task containing items of varying length. Most previous studies comparing the two tasks of spelling and reading have not controlled for the structure of the (non)word stimulus items in the two tasks. For example, performance on nonword tasks in one area have been compared to true word
tasks in the other, or two independently designed lists of words or nonwords have been used (e.g., Greenberg, Ehri, & Perin, 1997; Guthrie, 1973). Results of these types of comparisons have shown the relationship between spelling and reading for individuals with and without disabilities to differ. Studies of elementary students (Guthrie, 1973) and adults with reading disabilities (Greenberg et al., 1997) have shown correlations between spelling and reading in readers without disabilities to be higher than in readers with disabilities.

Only one study was found that used comparable lists for two of the tasks. That is, Snowling et al. (1997) used the same nonword list for both reading and spelling tasks in their study of university students with and without dyslexia. They found significant differences in reading but not spelling between the two groups. Controlling for word structure across nonword tasks may more accurately reveal the association/disassociation between these tasks in groups of children with and without disability. Confounding factors such as lexical knowledge when utilizing true words compared to nonwords would be minimized. Processing differences between nonwords and true words as described by Vitevitch and Luce (1998) would additionally be taken into consideration.

Although nonwords have been used extensively for analyzing skills in speaking, reading, and writing, research comparing performance across all three tasks using similar stimulus items controlled for word structure was not found in an extensive literature search. The results of this study should enhance understanding of sound/word level processing across these tasks.
Phonemic Awareness

Phonemic awareness includes the ability to segment sounds within words. It is part of the broader construct of phonological awareness. Phonemic awareness is a metalinguistic ability that involves the aptitude to detect individual sounds (i.e., phonemes) within words. A summary by the National Reading Panel showed it to be one of the five fundamental skills associated with an individual’s ability to decode (read) and encode (spell) words (NICHD, 2000).

Many tasks have been devised to measure an individual’s skill with phonemic awareness. These have been classified into three broad categories: phoneme segmentation, phoneme synthesis, and sound comparison (Catts & Kamhi, 2005; Catts, Wilcox, Wood-Jackson, Larrivee, & Scott, 1997). Phoneme segmentation involves counting, isolating, deleting, adding and reversing single phonemes within words. Phoneme synthesis requires blending of single sounds to form a word (/b/-/a/-/t/ → bat). Sound comparison involves the matching of sounds (initial, medial, final) across words (which word starts with the same sound as in “bat?” ball or hat?). In general, these tasks are considered to measure different levels of skill within the same general ability (Stanovich, Cunningham, & Cramer, 1984).

Nonwords also have been used in studies of the relationship between phonemic awareness and literate language skills (reading and spelling) (e.g., Hogan et al., 2005; Nancollis, Lawrie, & Dodd, 2005). Stage and Wagner (1992) studied students in kindergarten through 3rd grade and found that, for the younger children, the relationship between nonword spelling and reading decoding is largely influenced by phonological
awareness and working memory. They used a set of 22 one- and two-syllable nonwords to assess spelling and also administered the Word Attack and Word Identification subtests of the WRMT (Woodcock, 1973) as measures of reading, a working memory task involving letter span (2–7 in length), and a phonological awareness task involving sound categorization (Bradley & Bryant, 1985). The latter required students to select one word that did not have the common sound from a set of 3 or 4 true words. The results showed that, for the older students, the effect of phonological awareness and working memory explained less variance in nonword reading and spelling tasks than for younger students. Stage and Wagner concluded that this could be due to the length and complexity of the stimulus items or the contribution of unspecified additional factors beyond the scope of their study.

Holmes and Quinn (2009) used both real words and nonwords in their study of university students with good reading ability and poor spelling. They found that, although there was not a significant difference in the poor spellers’ performance compared to that of good spellers on reading shorter words, the poor spellers were less accurate than good spellers in reading nonwords. Poor spellers also were slower at pronouncing lengthy words that were difficult to spell. Holmes and Quinn concluded that these students did not exhibit deficits in phonemic awareness or phonological memory as compared to good spellers, but instead evidenced orthographic deficits.

Vocabulary Awareness

Vocabulary knowledge, according to Harley (1996), is multi-faceted and a simple term for a complex multidimensional phenomenon. There is a receptive (understanding)
component as well as an expressive component to consider. Additionally, vocabulary meaning is associated with the word form as well as the phonological, morphological, and syntactical aspects of the word form itself. Vocabulary awareness differs from estimates of vocabulary size (e.g., by quantifying the ability to point to pictures representing vocabulary concepts) in that “awareness” refers to the ability to reflect on the meaning of words and relationships among them. The construct also includes the ability to use metalinguistic abilities to talk about the meaning of words and to benefit from vocabulary definitions.

The National Reading Panel included vocabulary as one of the five fundamental skills associated with success in reading (NICHD, 2000). Numerous studies have linked vocabulary to phonological awareness and performance on nonword tasks of repetition, spelling, and reading. Bowey (2001) found a reciprocal association between receptive vocabulary and nonword repetition; results of the study supported the hypothesis that this relationship is affected by underlying phonological processing ability. Dollaghan, Biber, and Campbell (1995) administered pairs of multisyllabic nonwords to males ranging in age from 9–12 years with typical language. They concluded that lexical knowledge is associated with nonword repetition performance based on the finding that the participants repeated nonwords with wordlike stress patterns more accurately than those with non-lexical stressed syllables. Marton (2006) created two sets of multisyllabic nonwords for a repetition task: one set with no meaningful parts and one set that contained a monosyllabic real word and 2–3 syllables with no meaning. She found that, although age and language matched controls were able to use the lexical information from the true words to improve their performance, children with LI did not. Edwards et al. (2004)
found expressive vocabulary size to be the best predictor of overall accuracy and effect of varying wordlikeness on nonword repetition in typically developing children 3 to 8 years of age.

**Purpose of Study**

The purpose of this study was to investigate whether there is a fundamental difference in the nature of the relationships of word-processing abilities across nonword tasks and with PA and VA for students with and without LLD. Specifically, by incorporating participants across the age span who met the criteria for oral language impairment and by controlling lists for word structure, this study was designed to explore the associations/disassociations across oral and literate tasks and with the skills of PA and VA in children with LLD. Thus, this study was designed to clarify whether PA still plays a significant role in nonword reading and spelling in the secondary grades and whether reading and spelling of nonwords presents equal difficulty to students with oral language impairments. It also was designed to help resolve questions about whether nonword repetition ability is significantly associated with nonword reading and nonword spelling in children with LLD at both grade levels.

**Methods**

**Participants**

This study utilized secondary data; the participants were part of a larger study that was being conducted as a beta discrimination trial of the Test of Integrated Language and
Literacy Skills (TILLS) (Nelson, Helm-Estabrooks, Hotz, & Plante, 2007). A stratified sampling approach was used to create groups comparable for chronological age, sex, race/ethnicity, and socioeconomic status based on whether they qualified for free or reduced lunch (these data were not provided by eight parents). A total of 112 1st through 12th grade students served as participants in the current study. Of these, 58 met criteria as having typical language development (TL) and 54 met criteria as having language-learning disabilities (LLD).

The 58 students in the TL group had never been identified as having language or learning disabilities (or any other special education diagnosis other than attention deficit hyperactivity disorder; \( n = 6 \)); they had passed a recent hearing screening; and they did not have deficits in speaking, reading, writing, or social skills. All members of this group achieved a Core Composite standard score of \( \geq 85 \) on the four core subtests (for their age) of Clinical Evaluation of Language Fundamentals, Fourth Edition (CELF-4) (Semel, Wiig, & Secord, 2003).

The 54 students in the LLD group met inclusion and exclusion criteria for language impairments and/or learning disabilities. These students were receiving services for language impairment and/or language-based learning disabilities in public schools or private clinics. The students also obtained a standard score of \( < 85 \) on the Core Language Score Composite of the CELF-4 or on other measures of language and literacy development. With the exception of attention deficit disorders \( (n = 8) \), none of the participants in the LLD group had any other comorbid diagnosis and all had passed a recent hearing screening.
Of the 58 students with TL, 27 were male and 31 female; of the 54 students with LLD, 28 were male and 26 female. The students with TL ranged in age from 6 years (6;0) to 17;9 (mean 11;5); the students with LLD ranged in age from 7;2 to 17;10 (mean 11;4). For this study, the students were additionally divided into elementary (1st through 5th grade) and secondary (6th through 12th grade) levels. Elementary students with TL ranged in age from 6;0 to 11;7 (mean 9;4), and the LLD group ranged from 7;2 to 11;3 (mean 9;6). The TL group of secondary students ranged in age from 12;1 to 17;9 (mean 14;8), and the secondary students with LLD ranged in age from 11;9 to 17;10 (mean 14;4).

In the TL group, 59% of the participants were Caucasian (non-Hispanic), 24% were Hispanic (any race), 12% were African-American, and 5% were Asian. This was comparable to the racial/ethnic composition of the LLD groups in which 57% of the participants were Caucasian (non-Hispanic), 24% were Hispanic (any race), 17% were African-American, and 2% were Asian. The breakdown by age groups is presented in Table 3.1.

Some of the students in both groups came from homes where languages other than English are spoken, but such students were recruited in age strata (within 9 months) paired with others in the opposite group who had the same sex and similar language experience. All participants were identified by speech-language pathologists and other school professionals as speaking English at least as well as any other school language used for academic purposes at school.
Table 3.1

**Participant Demographics**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (yrs;mos)</th>
<th>Gender: % (n)</th>
<th>Race/Ethnicity: % (n)</th>
<th>Free/Reduced Lunch: % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TL (N = 35)</td>
<td>LLD (N = 34)</td>
<td>TL (N = 23)</td>
<td>LLD (N = 20)</td>
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<td></td>
<td>6;0–11;7</td>
<td>7;2–11;3</td>
<td>12;1–17;9</td>
<td>11;9–17;10</td>
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<td>(mean 9;4)</td>
<td>(mean 9;6)</td>
<td>(mean 14;8)</td>
<td>(mean 14;4)</td>
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<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Caucasian</td>
<td>Hispanic</td>
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<td></td>
<td>49% (17)</td>
<td>51% (18)</td>
<td>63% (22)</td>
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<td></td>
<td>53% (18)</td>
<td>47% (16)</td>
<td>59% (20)</td>
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<td>53% (12)</td>
<td>39% (9)</td>
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<td>55% (11)</td>
<td>40% (8)</td>
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<td></td>
<td>African-American</td>
<td>Asian</td>
<td>17% (6)</td>
<td>6% (2)</td>
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<td>23% (8)</td>
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<td>FREE/REDUCED LUNCH: % (n)</td>
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<td>Yes</td>
<td>No</td>
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<td>34% (12)</td>
<td>57% (20)</td>
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<td>38% (13)</td>
<td>53% (18)</td>
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<td>26% (6)</td>
<td>56% (13)</td>
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<td>9% (3)</td>
<td>9% (3)</td>
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<td></td>
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<td>18% (4)</td>
<td>20% (4)</td>
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</tbody>
</table>

**Measures**

This study utilized data from 8 of the 11 subtests of the TILLS-Beta research edition (Nelson et al., 2007). The TILLS is being developed as a standardized, individually administered test of spoken and written language. In order to answer the questions posed by this study, phonemic awareness and vocabulary awareness composite scores were used to gain insights into skills used when attempting the three nonword subtests of Nonword Imitation, Nonword Spelling, and Nonword Reading.

The standards established by the joint committee of the American Educational Research Association, American Psychological Association, and National Council on
Measurement in Education (AERA, APA, & NCME, 1999) have been used to evaluate reliability (inter-scorer, test-retest, and internal consistency) and validity of the TILLS in a series of preliminary studies with more than 800 school-age students.

Construct validity is defined by the joint committee (AERA, APA, & NCME, 1999) as an instrument’s ability to measure a construct for which it was designed. The TILLS is designed to measure language constructs at two language levels (sound/word and sentence/discourse) across four communication modalities (listening, speaking, reading, and writing). This model is consistent with recent research on spoken and written language development (e.g., Bishop & Snowling, 2004; Catts & Kamhi, 2005; Tomblin, 2002). Pilot studies and expert panel review of the TILLS test model have supported its construct and content validity as a measure of language/literacy disability.

The TILLS beta trial, from which the data for the current study were drawn, was designed to measure the validity of the TILLS as a diagnostic test. Selected subtests from the TILLS were used in the current investigation. They are described here, with information about inter-rater reliability and internal consistency from the beta trial. The question of whether the sound/word level subtests met criteria for discriminating LLD from typical performance is one of the primary research questions of the current study. Therefore ability group differences and effect sizes are reported in the results section of the paper.

Stimuli for the three nonword tasks. The stimuli in the Nonword Repetition, Nonword Spelling and Nonword Reading tasks were designed with attention to phoneme choice and word position, length in syllables, phonetic structure, morpheme
inclusion/exclusion, phonotactic probability and neighborhood density, as described in Chapter II. Specifically, the stimulus words for the repetition-only portion were designed to adhere as closely as possible to the guidelines used by Dollaghan and Campbell (1998) in order to ensure low wordlikeness. For the remaining words (to be imitated first and then spelled), phonotactic probability and neighborhood density were held in consideration, but the words were designed to reflect more characteristics of real words. This was done so the items could reflect skills/strategies individuals utilize in decoding/encoding written material using real words. In constructing the nonwords for these subtests, developmental data for reading/spelling were considered, and the stimulus items were designed to reflect these developmental sequences. Specifically, various vowel patterns, consonant blends and diagraphs, as well as both inflectional and derivational morphemes of Anglo-Saxon, Latin, and Greek origins were included on some words, as prior research has shown students with language and learning disabilities often have difficulty with morphemes (Carlisle, 1987; Rice & Wexler, 1996). Using these same criteria, a comparable list of words was then created for the nonword repetition/spelling task which reflected the structure of the nonwords in the reading list.

**Nonword repetition.** The nonword repetition stimulus items were presented via audio CD. A woman’s voice on the CD prompted the participant to “Say ___” (e.g., “Say bup.”). Two practice items were provided. The nonword repetition task included 18 items that were more wordlike (e.g., tyvology). Examinees were prompted to say each word first and then to spell it, as part of the nonword spelling task (described next). These 18 items were followed by 12 additional items that were less wordlike (e.g., dookoneepab) and
used for repetition only. Children’s responses were transcribed by research clinicians on a scoring form that allowed for minor variations in vowel pronunciations, vowel neutralization in unstressed syllables, and varied voicing of k/g and f/v that might have been difficult to distinguish on the CD. The students’ raw scores for the 30 items (correct vs. incorrect) were used as the measure of nonword repetition ability in the current study. Inter-rater reliability for point by point decisions about correct versus incorrect word productions was 99.2%. Cronbach’s alpha for the 30-item nonword repetition task was .85.

Nonword spelling. The nonword spelling task was administered in tandem with the nonword repetition task, using stimuli recorded digitally on the CD. After the presentation of each of the 18 nonword items for repetition, participants heard a second presentation of the word, along with the prompt to “Spell ___” (e.g., “Spell bup.”). The same two practice items used to train the nonword repetition task were used to train the nonword spelling task. Research clinicians were instructed to pause the recording if a student needed more time than allotted on the CD to spell the test word, but they were instructed not to replay the recorded word unless ambient noise interfered with its audibility. Numbered lines were provided in a student test booklet for students to write their responses. Scoring criteria were printed in the examiner’s manual to allow for alternative acceptable spellings, and these were adjusted based on input from research clinicians. The students’ raw scores for the 18 items were used as the measure of nonword spelling ability in the current study. Inter-rater reliability, for rescoring after spelling criteria were set, was measured as 99.2% for point by point agreement about
correct versus incorrect word spellings. Cronbach’s alpha for the 18-item nonword spelling task was measured at .90.

Nonword reading. For the nonword reading task, the items were presented one at a time to the participant using a stimulus book. The participant was told that the words were pretend words and was encouraged to use what he or she knew about reading to read the nonwords. Two practice items were used to prepare the participant for the 22 test items. If the participant did not respond within 5 seconds, he or she was prompted by the examiner to “Just give it a try.” If the participant did not respond after the prompt, the examiner moved on to the next item and scored it as an error. The rescoring of students’ responses on the Nonword Reading subtest showed an item-by-item inter-scorer agreement of 99.9% based on clinician transcription and 97% agreement for a set of audio-recorded responses. Cronbach’s alpha for the Nonword Reading subtest was computed to be .87.

Phonemic Awareness composite. The Phonemic Awareness composite score was computed by combining the scores for phoneme deletion (requiring segmentation) and phoneme reversal (requiring segmentation and synthesis). These were elicited through a task called the “Code Game.”

Phoneme deletion. For this task, the student was instructed to listen to the nonword presented by the examiner, repeat the stimulus and create a new nonword by removing the first sound (bip → ip). There were three practice items and 10 test items. The examiners were instructed to administer the full subtest even if the child had
difficulty during training. Preliminary results of TILLS testing showed inter-rater reliability to be 98.9% for this subtest with a Cronbach’s alpha of .86.

*Phoneme reversal.* For this task, the student was again instructed to listen to the stimulus nonword and then turn the word around and say it backwards (*fom* → *mof*). Three practice items were used to prepare the student for the 10 test items. Examiners were instructed to administer the full subtest even if the child had difficulty during training. Inter-rater reliability was found to be 99.7% for Phoneme Reversal; Cronbach’s alpha for the task was measured at .86.

**Vocabulary Awareness composite.** The Vocabulary Awareness composite was computed by combining scores for the “What Goes Together” (WGT) subtest and the vocabulary portion of the “Acting a Scene” subtest.

*What Goes Together.* The WGT task requires students to pick two out of three words (presented in print as well as orally) and explain how they go together and then select a different pair of words from the same triad and explain how they go together in a different way. Nineteen words in this subtest had single meanings. An example is “kite-airplane-train.” An additional 13 stimuli included words with double meanings, such as “saw-hammer-eyes.” Examinees were asked to demonstrate their awareness of the semantic features of these items by explaining the relationships of one set of words, and also their semantic flexibility, by describing alternative relationships for a second set of words. Analysis of the beta trial data showed interscorer reliability of 96% and Cronbach’s alpha of .90.
**Acting a Scene (vocabulary score).** The other score that was included in the vocabulary composite score was the vocabulary score from the Acting a Scene subtest. The Acting a Scene subtest assesses pragmatic skills and awareness of the vocabulary representing communicative speech acts. In administering this subtest, the examiner asks students to act out what a character would say and how he or she would say it when presented a scenario in print. This makes it possible to assess the student’s awareness of the vocabulary of pragmatics, such as “exaggerating” or “fishing for a compliment.” An example item is: “Rick [or Rita] wants to argue with his/her friend about whose turn it is to go first to play a video game. What do you think Rick/Rita would say?” Students who do not show knowledge of the vocabulary word or idiomatic phrase on the first attempt receive a prescribed prompt and may earn partial credit if they can demonstrate understanding of the key vocabulary after hearing the definition. Interscorer reliability was 90.1% for the vocabulary score on this subtest, and the Cronbach’s alpha for Acting a Scene was .99 in the TILLS beta trial.

**Testing Procedure**

Test data were gathered from students at sites in California, Illinois, Massachusetts, Michigan, Nevada, and Texas by speech-language pathologists with state licensure or certification. These research clinicians were trained by the researchers to gather parental permission and child assent following a protocol approved by a Human Subjects Institutional Review Board. Examiners followed instructions in the examiner’s book, which contained explicit instructions as to how to introduce each task.
All 11 TILLS subtests were administered to each student in a specified randomized order as part of the beta trial. The research clinicians received a cover letter that outlined the testing order that was generated for the students with a randomization algorithm. This meant that the students received the eight tests (phoneme deletion, phoneme reversal, what goes together [2], acting a scene, nonword repetition, nonword spelling, and nonword reading) in different order, but both members of a pair matched for sex, age, race/ethnicity, and SES received the subtests in the same order. The phonemic deletion task always immediately preceded the phoneme reversal task and nonword word repetition and spelling tasks were always administered in tandem, with the repetition of each nonword always preceding spelling of the same item. Testers followed instructions in the examiner’s book, which contained explicit instructions as to how to elicit responses for the specific tasks.

The clinician orally presented the test items on the phoneme deletion and phoneme reversal tasks. A CD containing pronunciations of the stimulus items and intended responses was provided. No repetitions were allowed. The What Goes Together subtests and the Acting a Scene subtest were also presented orally with print available in the stimulus book, which remained visible to the child. The clinicians scored the items on the form provided in the examiner’s book. Nonword stimuli for repetition and spelling were presented via audio CD to ensure consistency in the spoken productions across clinicians. All items were presented using a digitized recording of a woman’s voice. The clinician was instructed to check the sound level on the two practice stimuli to make sure that the volume of the CD player was appropriate and the stimuli were easily audible for the student. The item was repeated only if ambient noise interfered with the presentation. The
clinician phonetically transcribed the student’s repetition response using standard IPA notation in the examiner’s book while the student utilized his/her form to record spelling of each item. The nonword reading stimuli were presented one at a time, and if no response was offered after 5 seconds, the clinician was instructed to prompt the student to try to read the nonword word.

All responses were evaluated using criteria that were modified to allow for acceptable spelling or pronunciation alternatives. The clinician was provided both orthographic and phonetic representations of the stimulus items with acceptable alternative pronunciations for the nonword reading subtest and acceptable alternative spellings for the nonword spelling subtest. Additionally, an audio CD of acceptable pronunciations was made available to the clinician to be used during the scoring process in case clarification was necessary. For this study, nonword repetition, spelling, and reading were scored in binary fashion as correct or incorrect. Any variation that could not be attributed to a consistent developmental speech-sound substitution noted in the participant’s conversational speech was considered incorrect. Errors attributed to consistent developmental speech-sound substitution were scored as correct.

Analysis

Due to the developmental nature of the constrained skills assessed by these tasks (Paris, 2005), it was expected that some of the tasks would show a ceiling effect for the older participants and some (e.g., reading decoding and spelling) would show a floor effect for the younger participants and violate the assumptions of normality. Tests of normality confirmed that results of the phonemic awareness composite for the TL
elementary group as well as nonword repetition and vocabulary awareness for the TL secondary group were not normally distributed. Additionally, results of the nonword spelling and nonword reading for the elementary LLD group violated assumptions of normality. Therefore, the Mann-Whitney test was used to analyze whether or not the two groups of students would perform significantly differently from each other on the eight tasks. Effect size ($r$) was calculated by dividing the $z$-score by the square root of the sample size (Field, 2005) and interpreted as .10 (small effect), .30 (medium effect), and .50 (large effect) (Cohen, 1988).

Kendall’s tau correlations were used to explore the relationships between the two composites of PA and VA and the three specific tasks of nonword repetition, nonword spelling, and nonword reading. Multiple regression analyses were run to determine the influence of PA and VA on the nonword tasks of repetition, spelling, and reading.

The research questions posed by this study were:

1. Are there significant differences in performance between the two groups by ability (TL and LLD) at two grade levels (elementary and secondary) on the five tasks (PA, VA, nonword repetition, nonword spelling, and nonword reading)?

2. Do the relationships among the tasks differ between grade levels and ability?

3. What is the association between PA and VA with the nonword tasks of repetition, spelling, and reading for students with and without LLD?
Results

Data collected on 8 of the 11 subtests of the TILLS during the beta standardization trial and the following analyses were utilized to answer the questions posed by this study.

Performance Between Groups

Mann-Whitney tests were utilized to answer the first question as to whether school-age children at the elementary and secondary grade levels with LLD differ significantly from students with TL in their performance of the sound/word level skills as measured by related tasks of nonword repetition, nonword spelling, and nonword reading, as well as two composite measures of PA and VA (see Table 3.2 for means ranks, z-scores, and effect sizes). Significant differences were found in performance between the two groups by ability, with the TL group out performing the LLD group, at both grade levels on all five tasks. A medium effect was found for VA ($r = .49$) and nonword reading ($r = .47$) at the elementary level and nonword spelling ($r = .47$) at the secondary level; all other comparisons were found to have a large effect size ($r \geq .50$) at both the elementary and secondary levels.

Relationship Among Tasks

Kendall’s tau analysis (a nonparametric correlation measure) was used to explore the relationships between nonword repetition, nonword spelling and nonword reading and the two composite measures of PA and VA. Due to the developmental nature of the constrained skills assessed by these tasks (Paris, 2005), and associated ceiling effects, the
data from some of the tasks violated the assumptions of normality. Nonparametric correlations were run to answer the research question as to whether there is a fundamental difference in the nature of the relationships for the students with and without LLD at the two grade levels. Results are presented in Table 3.3.

Table 3.2

*Differences in Performance Among the Two Ability Groups Across Tasks*

<table>
<thead>
<tr>
<th></th>
<th>Phonemic Awareness</th>
<th>Vocabulary Awareness</th>
<th>NW Repetition</th>
<th>NW Spelling</th>
<th>NW Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL Mean Rank (n = 35)</td>
<td>44.93</td>
<td>44.32</td>
<td>45.04</td>
<td>44.94</td>
<td>44.19</td>
</tr>
<tr>
<td>LLD Mean Rank (n = 34)</td>
<td>24.78</td>
<td>24.68</td>
<td>24.66</td>
<td>24.76</td>
<td>25.54</td>
</tr>
<tr>
<td><em>z</em></td>
<td>4.181</td>
<td>4.098</td>
<td>4.229</td>
<td>4.185</td>
<td>3.868</td>
</tr>
<tr>
<td><em>p</em></td>
<td>&lt; .0001</td>
<td>&lt; .0001</td>
<td>&lt; .0001</td>
<td>&lt; .0001</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Effect size <em>r</em></td>
<td>0.50</td>
<td>0.49</td>
<td>0.51</td>
<td>0.50</td>
<td>0.47</td>
</tr>
</tbody>
</table>

| **Secondary:**       |                    |                      |               |             |            |
| TL Mean Rank (n = 23)| 28.28              | 29.11                | 28.24         | 27.52       | 28.70      |
| LLD Mean Rank (n = 20)| 14.78              | 13.82                | 14.82         | 15.65       | 14.30      |
| *z*                  | 3.532              | 3.983                | 3.509         | 3.107       | 3.765      |
| *p*                  | < .0001            | < .0001              | < .0001       | = .002      | < .0001    |
| Effect size *r*      | 0.54               | 0.61                 | 0.54          | 0.47        | 0.57       |
Table 3.3

**Significant Associations Across Tasks**

<table>
<thead>
<tr>
<th></th>
<th>PA (Sig)</th>
<th>VA (Sig)</th>
<th>NWRep (Sig)</th>
<th>NWSp (Sig)</th>
<th>NWRdg (Sig)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TL-Elementary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic Awareness (PA)</td>
<td>.500**</td>
<td>.106</td>
<td>.533**</td>
<td>.430**</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Awareness (VA)</td>
<td>.303*</td>
<td></td>
<td>.566**</td>
<td>.377**</td>
<td></td>
</tr>
<tr>
<td>Nonword:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Repetition (NWRep)</td>
<td></td>
<td></td>
<td>.341**</td>
<td>.197</td>
<td></td>
</tr>
<tr>
<td>-Spelling (NWSp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.397**</td>
</tr>
<tr>
<td>-Reading (NWRdg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LLD-Elementary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic Awareness (PA)</td>
<td>.264*</td>
<td>.527**</td>
<td>.556**</td>
<td>.630**</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Awareness (VA)</td>
<td>.385**</td>
<td>.408**</td>
<td>.341**</td>
<td></td>
<td></td>
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<tr>
<td>Nonword:</td>
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<td></td>
</tr>
<tr>
<td>-Repetition (NWRep)</td>
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<td></td>
<td>.617**</td>
<td>.473**</td>
<td></td>
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<tr>
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<td></td>
<td>.630**</td>
</tr>
<tr>
<td>-Reading (NWRdg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TL-Secondary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic Awareness (PA)</td>
<td>.590**</td>
<td>.273</td>
<td>.421**</td>
<td>.336*</td>
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</tr>
<tr>
<td>Vocabulary Awareness (VA)</td>
<td>.152</td>
<td>.300</td>
<td>.231</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonword:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Repetition (NWRep)</td>
<td></td>
<td></td>
<td>.553**</td>
<td>.118</td>
<td></td>
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<tr>
<td>-Spelling (NWSp)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.389*</td>
</tr>
<tr>
<td>-Reading (NWRdg)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LLD-Secondary</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemic Awareness (PA)</td>
<td>.574**</td>
<td>.363*</td>
<td>.681**</td>
<td>.561**</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Awareness (VA)</td>
<td>.331*</td>
<td>.515**</td>
<td>.301</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonword:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Repetition (NWRep)</td>
<td></td>
<td></td>
<td>.367*</td>
<td>.275</td>
<td></td>
</tr>
<tr>
<td>-Spelling (NWSpl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.623**</td>
</tr>
</tbody>
</table>

*p < .05. **p < .01.
The relationships among all of the tasks for the students with LLD at the elementary level were found to be significant (see Table 3.3 and Figure 3.1). For the students with TL, all relationships among tasks were significant at the elementary level with the exception of PA with nonword repetition and nonword repetition with reading. For the secondary LLD students, a significant relationship was found among all tasks with the exception of nonword repetition with nonword reading and nonword reading with vocabulary awareness (Table 3.3 and Figure 3.1). Only 5 significant relationships, of the 10 possible, were found among tasks for the TL group at the secondary level: nonword repetition with nonword spelling, nonword spelling with PA, PA with nonword reading, nonword reading with nonword spelling, and PA with VA.

*Figure 3.1. Relationships across tasks for elementary students with TL and LLD.*

Correlations among the tasks were found to be stronger in students with LLD than TL with the exception of PA with VA, VA with nonword spelling, and VA with nonword reading at the elementary level and PA with VA and nonword spelling with nonword repetition at the secondary level.
Figures 3.1 and 3.2 are provided to illustrate the patterns of relationships among the word level tasks and two composite measures by disability (TL and LLD) and age (elementary and secondary). Significant correlations are represented by black arrows; nonsignificant relationships are depicted by gray arrows. The tau statistic and significance are included in the figures to describe all relationships.

**Figure 3.2.** Relationships across tasks for secondary students with TL and LLD.

**Association Between Phonemic Awareness and Vocabulary Awareness With Nonword Tasks**

The number and strength of the relationships between tasks were found to be more numerous and, in general, stronger for students with LLD as compared to those with TL. Although all of the relationships between tasks were found to be significant in the children with LLD at the elementary level, that was not true of the other groups. For the elementary TL group, 8 of the 10 relationships being investigated were found to be significant; only nonword repetition with nonword spelling and nonword repetition with PA were not significant. Similarly, 8 of the 10 relationships were significant for the LLD
secondary group with nonword repetition with nonword reading and nonword reading with VA not significantly related. However, for the secondary TL group, only 5 of the 10 relationships were significant (nonword repetition with nonword spelling, nonword spelling with nonword reading, nonword spelling with PA, nonword reading with PA, and PA with VA).

Finally, the question regarding the association between PA and VA with nonword repetition, nonword spelling, and nonword reading was addressed using multiple linear regression. Six separate simple regressions were run first for the three dependent variables (DV) nonword repetition, nonword spelling, and nonword reading by the two independent variables (IVs) (factors) PA and VA (see Table 3.4 in the column labeled “crude results”). As shown in Table 3.4, the beta values for PA and VA in association with related change in nonword tasks were all statistically significant (at the $p < .0001$ level) when considered individually in the initial models for all three nonword tasks, with one exception. PA as a predictor of nonword repetition by students with TL did not reach a level of statistical significance ($\beta = .253, p = .056$), with the model accounting for very little of the variance (6%). Additionally, when considered alone, PA accounted for more variance than VA in both TL and LLD groups across the three tasks (VA: $\beta = .505$, $p < .0001$), with the exception of TL for nonword repetition.

Since the two individual variables had regression coefficients significant at the $p < .0001$ level, both were retained in the final model and forced entry was used. Table 3.4 presents the multivariate regression coefficients (results adjusted for the other independent variable in the model) and statistical significance levels for the variables when both independent variables (PA and VA) were in the models. Model fit was
### Table 3.4

**Summary of Regression Analyses for Variables Predicting Nonword Performance**

<table>
<thead>
<tr>
<th></th>
<th>Crude Standardized Beta</th>
<th>Crude p</th>
<th>Adjusted* Standardized Beta</th>
<th>Adjusted* p</th>
<th>Variance Accounted for by Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NW Repetition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.253</td>
<td>.556</td>
<td>-.077</td>
<td>.621</td>
<td>26%</td>
</tr>
<tr>
<td>VA</td>
<td>.505</td>
<td>&lt;.0001</td>
<td>.556</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>LLD:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.658</td>
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<td>.543</td>
<td>&lt;.0001</td>
<td>46%</td>
</tr>
<tr>
<td>VA</td>
<td>.505</td>
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<td>.212</td>
<td>.089</td>
<td></td>
</tr>
<tr>
<td><strong>NW Spelling</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL:</td>
<td></td>
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<td></td>
</tr>
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<td>.711</td>
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<td>.425</td>
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<td>59%</td>
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<tr>
<td>LLD:</td>
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<tr>
<td>PA</td>
<td>.745</td>
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<td>62%</td>
</tr>
<tr>
<td>VA</td>
<td>.614</td>
<td>&lt;.0001</td>
<td>.298</td>
<td>.005</td>
<td></td>
</tr>
<tr>
<td><strong>NW Reading</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>TL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>.628</td>
<td>&lt;.0001</td>
<td>.442</td>
<td>.002</td>
<td>44%</td>
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<td>LLD:</td>
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<td>PA</td>
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<td>65%</td>
</tr>
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<td>VA</td>
<td>.491</td>
<td>&lt;.0001</td>
<td>.082</td>
<td>.410</td>
<td></td>
</tr>
</tbody>
</table>

*Adjusted model includes IV of PA and VA.

analyzed with an overall regression $F$ statistic. In the nonword repetition tasks, when both variables were entered into the regression analysis, the model accounted for 26% of the variance in the TL group, $F(2, 54) = 9.42, p < .0001$, and 46% of the variance in the LLD group, $F(2, 51) = 22.08, p < .0001$. Both variables together accounted for 59%, $F(2, 54) = 39.21, p < .0001$, of the variance in TL in nonword spelling and 62%, $F(2, 51) = 41.29, p < .0001$ in LLD. In the final model for nonword reading, PA and VA accounted for
44\%, F(2, 54) = 21.21, p < .0001, of the variance for TL and 65\%, F(2, 51) = 46.42, p < .0001, of the variance for LLD.

In the final models, PA was statistically significantly associated (p < .05) with all tasks for both groups by ability with the exception of TL on nonword repetition (\( \beta = -.077, p = .621 \)). VA was found to be statistically significantly associated (p < .05) with all tasks for the TL group and nonword spelling for the LLD group; however, no statistically significant association was found for the LLD group between VA and nonword repetition (\( \beta = .212, p = .089 \)) or VA and nonword reading (\( \beta = .082, p = .410 \)).

**Discussion**

The purpose of this study was to examine relationships in nonword processing skills by school-age children with LLD and TL on three task-specific nonword measures (nonword repetition/imitation, spelling, and reading) and composite measures of PA and VA. Relatively few studies have focused on the skills of children with oral language impairment separate from those of children with a reading impairment or “dyslexia” in studies of literate language. This study additionally differed from previous studies in the inclusion of students from 6–18 years of age in order to add to the limited literature on older students.

Results of the current study indicate a significant difference in performance between the two groups by ability (TL and LLD) for both the elementary and secondary levels on all five tasks. These results corroborate and expand on those of previous studies that point to the difficulty exhibited by children with reading and language disabilities with the foundational skills of phonemic awareness and vocabulary, as well as oral and
literate language tasks (Campbell, 1985; Catts, 1993; Dollaghan & Campbell, 1998; Kamhi et al., 1988). Children with LLD, regardless of age, continue to exhibit a significant deficit compared to their TL peers in all five areas—even those which would be considered developmentally constraint skills, such as PA.

The relationship between nonword repetition and nonword reading in three of the four age by ability groups is consistent with results from previous studies that found the ability to repeat nonwords is not necessarily significantly associated with reading (e.g., Hester & Hodson, 2004). Only the students with LLD at the elementary level exhibited a significant relationship between nonword repetition and nonword reading. Significant correlations were found for PA with the literate language skills of nonword spelling and reading for TL and LLD at both the elementary and secondary level. These findings support and expand those of Stage and Wagner (1992) in their study with kindergarten through 3rd grade students, who found the relationship between nonword spelling and reading decoding to be largely influenced by phonological awareness and working memory, but differ from those of Holmes and Quinn (2009), who found university students did not exhibit deficits in phonemic awareness or phonological memory as compared to good spellers, but instead evidenced orthographic deficits. The discrepancy could be due in part to the unique population studied in Holmes and Quinn’s study—students with unexpectedly poor spelling in relation to their word reading accuracy.

The strength of the relationships varied across the ability groups, with the stronger relationships found, in general, in the LLD groups. Previous studies have found stronger relationships between spelling and reading for students with typical skills than for those with disabilities (Greenberg et al., 1997; Guthrie, 1973). Results of the current study
indicate stronger relationships for the students with LLD than for those in the TL group at both the elementary and secondary levels. The discrepancy in results could be due, in part, to the difference in the stimulus items. The current tasks utilized comparable nonwords for both the spelling and reading tasks, whereas the previous studies compared nonword tasks in one area to true word tasks in the other or utilized two independently designed lists of words or nonwords. Additionally, the children in those studies did not have a primary language-learning deficit.

All of the students at the elementary level in the current study demonstrated significant relationships across all tasks with VA, which is consistent with the literature (e.g., Bowey, 2001; Dollaghan et al., 1995). The only significant relationship found for the TL group at the secondary level for VA was with PA. The LLD group continued to exhibit a significant relationship between VA and PA, nonword repetition, and nonword spelling, which is reflective of the elementary groups.

Results of this study suggest that PA is significantly associated with both nonword reading and nonword spelling. These results support the findings of prior studies (e.g., as summarized by NICHD, 2000) and underscore the influence of PA on literate skills. PA was found to be significantly associated with nonword repetition in both the initial and final models for the LLD group but not the TL. Given the relationship of PA and nonword repetition found in previous studies of young children (e.g., Wesseling & Reitsma, 2001), this was an unexpected finding. Methodology may account for this difference. The cross-sectional design of the current study as compared to the longitudinal model used by Wesseling and Reitsma, as well as the differences in PA tasks, may have
impacted the outcomes. Additionally, there was a wide range of age within the current study (1st–12th) compared to the 1st graders studied by Wesseling and Reitsma.

Past research has linked vocabulary knowledge to nonword repetition ability and literate language skills (e.g., Bowey, 2001; Dollaghan et al., 1995; NICHD, 2000). Results of this current study indicate a significant association between VA and nonword repetition, nonword spelling, and nonword reading in the initial models; however, when both PA and VA are considered together, VA did not account for a significant contribution above that of the PA in the LLD group for the tasks of nonword repetition and nonword reading. This suggests that the LLD group in this study relied heavily on their PA skills rather than drawing on their vocabulary knowledge to aid them in completing these tasks. It should be noted that vocabulary awareness differs from vocabulary size; therefore, the vocabulary task used in this study must be taken into account when considering the associations found for the LLD group.

The use of TILLS database to investigate these study questions proved beneficial but limitations existed. Strengths included the age range of the participants (1st–12th grade), the stratified sampling approach that allowed the creation of two ability groups comparable in terms of age, sex, race/ethnicity, and socioeconomic status. The availability of data across the tasks of nonword repetition, nonword spelling, and nonword reading in which the stimulus items were designed to be low in phonotactic probability and neighborhood density set this study apart from existing research.

On the other hand, generalization of the results of this study is compromised by the relatively small sample size ($n = 112$) which was further divided into two grade levels to analyze relationships across tasks. There were more elementary student in the sample
(TL = 35; LLD = 34) than secondary students (TL = 23; LLD = 20). Due to the small size, the sample could not be divided by grade levels in order to analyze the effect of age on the association between PA and VA with nonword repetition, nonword spelling, and nonword reading. Further research is needed in this area.

The vocabulary composite used in the study was not a finite measure of vocabulary knowledge but rather compilation of tasks that measured both receptive and expressive semantic ability and understanding and use of targeted vocabulary within an authentic context. This complicates comparing results of this study to other studies that used more discrete measures of vocabulary.

In summary, this study sought to explore the relationships in nonword processing skills with PA and VA by school-age children with and without LLD. Students with LLD exhibited significantly more difficulty with skills in PA and VA and significantly poorer ability to repeat, spell, and read complex phonological and morphological nonword structures than their same-age typically developing peers. This study indicates that, although students with TL and LLD show similar patterns of significant correlation among the five subtests in the elementary years, by middle school, the patterns shift and the LLD group continues to demonstrate significant association of literate language skills (reading and spelling) with phoneme awareness tasks, whereas the TL group does not. In general and more specifically, children with LLD demonstrated a stronger relationship between spelling and reading than the TL group. PA appears to be more highly associated with performance on nonword repetition and nonword reading than VA in children with LLD.
The significant cross-task relationships found in both elementary and secondary level LLD groups suggest the importance of interventions that utilize inter-modality processing to facilitate growth in reading, speaking, and spelling for students with LLD. Assessment of PA may remain relevant for students with LLD into the secondary years, but it needs to be interpreted in the context of other strengths and weaknesses and intervention planned accordingly.

Future studies should focus on literate language skills of children with a primary language-learning disability, especially at the secondary level. A clearer understanding of performance by this type of student on these tasks will add to the knowledge base regarding the reciprocal relationship between oral and literate language as it differs in children across the school-age years with typical language as compared to those identified with a primary language-learning disability. This will help shape the underlying theories and paint a clearer picture of the relationship between oral and literate (spelling and reading) language.

References


CHAPTER IV

PAPER THREE: ERROR ANALYSIS OF NONWORD TASK PERFORMANCE FOR ASSESSING WORD STRUCTURE KNOWLEDGE

Literate language abilities comprise many skills, including sound/word level skills for spelling and reading decoding, as well as sentence/discourse level skills for written composition and reading comprehension (Nelson, 2010). Sound/word level skills used in spelling and reading decoding can be considered reciprocal (e.g., Ehri, 2000; Kamhi & Hinton, 2000), in that both involve linguistic processing skills guided by metalinguistic abilities for analyzing the structure of words. This involves the development of multiple abilities extending across the school-age years for associating the phonological and morphological structures of spoken words with their orthographic representations in print.

Apel and Masterson (2001) developed a multilingual model for spelling (encoding) and reading (decoding) assessment and intervention based on their research and work by Bourassa and Treiman (2001). The model incorporates the contributions of five linguistic factors: phonemic awareness, orthographic knowledge for mapping sound patterns onto letter patterns, morphological awareness, semantic knowledge, and mental orthographic images (or mental graphic representations [MGRs]). As students are repeatedly exposed to certain syllables, morphemes, and words, they develop mental images of common orthographic patterns (Ehri, 1980, 2000) that can aid in reading and spelling.
Individuals with language deficits and learning disabilities may have weaknesses in phonology, morphology, and/or semantics (American Speech-Language-Hearing Association [ASHA], 1993) and also in the orthographic system (Cassar, Treiman, Moats, Pollo, & Kessler, 2005). An underlying weakness in phonological awareness may contribute to the difficulty that poor readers have in learning to take advantage of morphological relationships (Ruben, Patterson, & Kantor, 1991). Studies have documented the relationship of morphological awareness to reading and/or spelling in very young students (e.g., Carlisle & Stone, 2005; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005; Wolter, Wood, & D’atko, 2009) and in older students (e.g., Siegel, 2008). In order for students to improve their word-level spelling and reading abilities, they need to develop not only strong phonemic awareness skills and orthographic skills but also morphological skills. Words that students encounter become more challenging as they move into the upper grades, including higher level morphological structures with Latin and Greek roots (Cunningham, 2007).

The present study was designed to investigate patterns of errors involving three types of associations in which students must acquire proficiency in order to read and spell words. The study used nonword tasks that had been developed to assess students’ knowledge of word structure for nonword spelling and nonword reading. The rationale for using nonword items rather than having students read and spell real words was to minimize the influence of students’ previous vocabulary knowledge. However, some of the nonword items incorporated real English morphemes (both inflection and derivational) to permit observation of students’ ability to use knowledge of morphemes in reading or spelling novel words.
The three types of errors that were investigated in this study were categorized as 

*simple phonic* (errors in representing consonant phonemes that could be mapped with single letters), *orthographic* (errors in representing vowels in print contexts and phonemes with digraphs), and *morphemic* (errors in association of morphemes with letter patterns). These three error types relate most closely to the phonemic, orthographic, and morphologic linguistic factors discussed in the literature (Apel & Masterson, 2001; Bourassa & Treiman, 2001).

**Phonemic Awareness and Phonics**

Phonemic awareness includes the ability to segment sounds within words. It is part of the broader construct of phonological awareness. The term *phonics* is used to describe the association of phonemes with graphemes. The simplest phonic associations are between single consonant phonemes (whose pronunciation varies little from word to word) and single letters that consistently represent the same consonant phoneme.

Phonemic awareness is a metalinguistic ability that focuses attention on the individual sounds within words and is a fundamental skill directly contributing to an individual’s ability to decode (read) and encode (spell) words (Bradley & Bryant, 1983; Stanovich & Siegel, 1994; National Institute of Child Health and Human Development [NICHD], 2000). It is a foundational skill on which phonics can develop. Stackhouse (1997) described phonological awareness as developing along a continuum. At the lower end of awareness (entailing tacit knowledge) are skills such as rhyming and syllable segmentation; at the upper end of awareness (entailing explicit knowledge) are skills such as sound manipulation and sound segmenting. Most studies of phonological awareness
have focused on the emergent reader; thus, less is known about phonological awareness in older individuals. Additionally, as children age, cognitive factors (intelligence and working memory) as well as linguistic factors (semantic knowledge) increasingly influence reading ability (Catts & Kamhi, 2005). Hester and Hodson (2004) found phonological awareness to be significantly correlated to reading decoding in third grade students with typical language. Some studies of adults who were diagnosed as children with dyslexia found weak phonological awareness skills even though they now compensated for reading and/or spelling deficits (Felton, Naylor, & Wood, 1990; Paulesu et al., 1996).

Proficiency in segmenting and blending individual sounds within words is crucial for fluent reading. Children with speech/language disabilities often have difficulty segmenting words into component sounds (for spelling and reading) and then blending the sounds back together (for reading) (Cupples & Iacono, 2000; Johnson et al., 1999). As students learn to read and spell, they demonstrate knowledge of the alphabetic principle when they begin to associate phonemes with letters—simple phonics. Although heavily relied on by beginning readers/spellers, this method of mapping sounds to letters for reading and spelling is inefficient, especially for longer words. Sounding out words involves time, and the lack of correspondence between many sounds and groups of letters in the English language make it an ineffective method on which to rely solely.

The ability to segment and blend sounds within words and associate graphemes with corresponding phonemes is crucial for reading fluency and spelling. Individuals with disabilities often exhibit deficits in these areas. Developmental models of literacy acquisition indicate that, after students show knowledge of the alphabetic principle, they
acquire the orthographic principle (Catts & Kamhi, 2005). At this point, students move from the initial stage of understanding of sound-letter correspondence (simple phonic) into the orthographic stage in which they shift their primary focus from sounds in words to word structure and related patterns of letters that depend on context.

Orthographic Awareness and Mental Orthographic Images

Orthographic awareness involves knowledge of the relationship between sounds (phonemes) and patterns of letters. It develops as students acquire concepts about how letter patterns map onto the syllabic and morphemic structure of words. The use of mental orthographic images formed from repeated exposure to the sound representation, syllable shape, or word shape is necessary in some cases. Phonemic, orthographic or morphological knowledge alone is not enough to read/spell sounds in words due to inconsistent patterns of representation. Long vowel patterns (e.g., make, break, may, they, eight, raise) and representation of the schwa vowel (i.e., cut, of, dove, touch, does) are examples of inconsistencies in depicting sounds in words.

Orthographic awareness incorporates knowledge of simple phonics for associating individual speech sounds (phonemes) with the letters (graphemes) that represent them. It also adds more advanced knowledge for representing some phonemes with digraphs (e.g., sh, ch), knowing about word families in which vowel pronunciation varies with context (e.g., tap, tape), and knowing about families of words with irregular spelling patterns (e.g., light, fight). Mental orthographic images help with these inconsistent patterns of representation.
Nonwords have been used extensively in studies to explore the orthographic constructs of spelling and reading. Campbell (1985) analyzed spelling performance in 9- to 11-year-olds on a task that targeted medial vowels and final consonant sounds by presenting a true word as a prime for the nonword (*sense* for *gens*). Cassar et al. (2005) designed nonwords for spelling that contained difficult orthographic patterns for beginning spellers such as consonant clusters and reduced vowels in unstressed syllables. In addition, they designed pairs of four-letter nonwords to test the participants’ knowledge of allowable consonant and vowel patterns. Carney and Martin (2003) used a nonword reading task to compare students with dyslexia to chronological age and reading age matched controls to investigate the relative contributions of phonological and orthographic awareness. They found that, although in general the students with dyslexia relied on analogy of orthographic information for decoding, all of the groups additionally used some phonological skills to help read the words. In their study of university students who were unexpectedly poor spellers given their reading ability, Holmes and Quinn (2009) found that while these individuals had more difficulty than good spellers with pronouncing long, difficult to spell nonwords, there was no difference between the groups on shorter words. Holmes and Quinn interpreted these findings as difficulty at the orthographic level. These results supported the findings of Masterson, Laxon, Lovejoy, and Morris (2007) who also studied university students with good reading combined with poor spelling abilities. Masterson et al. concluded that the spelling deficits were due to weak orthographic representations and not due to poorer phonological ability.

Orthographic knowledge of which sound(s) each letter or letter combination/pattern represents is crucial for reading (decoding) and spelling (encoding) of words.
Once the relationships/patterns are learned and the mental orthographic images formed, the individual should be able to apply the knowledge analogically to the spelling and decoding of unknown words.

**Morphological Awareness and Mental Morphological Images**

Morphological awareness is involved in both reading and spelling. It is closely related to phonological awareness and is defined as “awareness of and access to the meaning and structure of morphemes in relation to words” (McBride-Chang et al., 2005, p. 417). Through experiences with both oral and written language, mental representations of morphemes develop (Ehri & Wilce, 1982; Taft, 2003). These mental pictures are crucial to spelling and reading due to the variation/exceptions found in the English language. Often phonemic, orthographic, or morphological knowledge alone is insufficient for the task (Apel & Masterson, 2001).

Morphemes are constructed from phonemes, so morphemic knowledge is not fully independent from phonemic knowledge. Morphemes also have meaning, so morphemic knowledge is not fully independent from vocabulary knowledge. A morpheme is considered to be the smallest meaningful unit of language having a differential function (Nicolosi, Harryman, & Kresheck, 2004). A free morpheme can stand alone to designate meaning, whereas a bound morpheme must be joined to another morpheme (unrelated). Inflectional morphemes are added to the root word to inflect the word in order to fill a syntactic role in a specific sentence, such as to indicate number (*cat/cats*), person (*walk/walks*), tense (*talk/talked*), or comparative form (*long/longer/longest*). In English, although all inflectional morphemes occur as suffixes, derivational morphemes may
appear either as prefixes or suffixes and are used to derive a new word with a related but slightly different meaning, possibly even a different part of speech \((\text{sad/sadly})\).

Inflectional suffixes make up a small closed set that develop during the pre-school years and are refined in the school-age years, whereas derivational prefixes \((\text{un-, dis-, non-, ir-})\) and suffixes \((-\text{ology, -tion})\) are learned more slowly, extending over the school-age years (Nagy, Diakidoy, & Anderson, 1991). By 3rd grade, approximately 80% of the words in textbooks are multimorphoric (Carlisle, 2004).

The English language comprises morphemic elements that arise from Anglo-Saxon, Latin, and Greek origin. Beck, McKeown, and Kucan (2002) categorized words into a three-tiered etymological system. Words of Anglo-Saxon origin comprise Tier 1. These words are used frequently in ordinary situations and the base words are generally considered to be free morphemes. They can be combined into compound words (e.g., \textit{hotdog}) or joined with a prefix or suffix (e.g., \textit{unhappy, happiness}). Tier 2 contains words that make use of multiple Latin roots and affixes, allowing them to form an array of associated words (e.g., \textit{erupt, disruption}). Words with Latin etymology are used in more formal settings and found in literature and textbooks. The Greek influence is found in the words of Tier 3. Vocabulary words in this tier tend to be low-frequency words that are used in specific disciplines by scholars and scientists. Many combine two roots or roots and affixes (e.g., \textit{microphone, phonology}).

McBride-Chang et al. (2005) studied the acquisition of morphological awareness. They developed tasks to measure morpheme identification and morphological structure awareness in kindergarten and 2nd grade students and found the results to be statistically significantly correlated with scores on subtests that involve reading of real words (Word
Identification) and nonwords (Word Attack) from the Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001). They also found significant correlations for the morphological awareness tasks and the Elision (phoneme/morpheme deletion) and Nonword Repetition subtests on The Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). Wolter et al. (2009), in their study of 1st grade students with typical language, also found evidence of morphological awareness at a young age; this knowledge contributed unique variance to reading and spelling measures above that accounted for by phonological awareness. Carlisle and Stone (2005), in their study of 39 2nd and 3rd graders and 33 5th and 6th graders, found that morphemic structure might influence the acquisition of word-reading skill as early as 2nd or 3rd grade.

Older students also show relationships between morphemic awareness and reading and spelling abilities. Siegel (2008) studied a group of 1,238 6th graders with and without dyslexia. She used tasks that contained real as well as pseudo words to assess language (morphological awareness and syntactic awareness), reading (decoding, fluency and comprehension), phonological processing (as measured by phoneme and syllable deletion), and spelling (words and nonwords from standardized measures). Students with dyslexia scored significantly lower than students without dyslexia on the morphological awareness tasks. Additionally, for both groups, morphological awareness was more highly correlated with reading and spelling than phonological awareness. Results of multiple regression analysis indicated that morphological awareness contributed significant independent variance to reading and spelling over and above the contributions of phonological and syntactic awareness.
Prior research has shown students with language-learning disabilities often have difficulty with morphemes (Carlisle, 1987; Rice & Wexler, 1996). Carlisle studied the abilities of 9th graders with learning disabilities (LD) to extend knowledge of morphemes to support their spelling ability. She found that students with LD relied on whole word and grapheme-phoneme correspondence to spell words but had difficulty considering the morphological structure when spelling as compared to younger students with typical language. Carlisle attributed students’ difficulty with morphological knowledge and spelling of suffixes to lack of exposure to the orthographic patterns for affixes as a secondary result of their poor reading skills.

In summary, knowledge of morphemes is crucial for successful spelling and decoding/comprehension of words. Beginning readers, as well as proficient readers, utilize morphological structure in reading and spelling. Deficits in morphological awareness negatively impact reading and spelling performance.

**Are Reading and Spelling Part of the Same Construct?**

Phonemic awareness and phonics, orthographic awareness and mental orthographic images, morphological awareness and mental morphemic images all provide critical foundational skills for reading and spelling. In the early stages of learning to decode, reading involves matching letter symbols to speech sounds and then blending the sounds into the word. Soon, however, students must be able to recognize groups of letters as orthographic patterns and to read syllable by syllable and morpheme by morpheme rather than sound by sound. Orthographic awareness and imaging is what makes it possible for students to know how to pronounce vowels in new words and to recognize
letter patterns such as “sh,” “tch,” and, later, “ph,” as single phonemes rather than two separate sounds. Morphemic awareness and imaging is what makes it possible to read familiar word parts, such as –ing, -ed, and –tion. Skilled readers are able to use a “direct route” (Catts & Kamhi, 2005) for recognizing the meaning of words in print without sounding them out either sound by sound or syllable by syllable. When they encounter an unfamiliar word, they are able to apply analogical processes (along with contextual cues) to recognize real words.

Ehri (1994) proposed a model for capturing the developmental advances in word recognition skills. She called the early method of sounding out words reading by invention. This method is most closely aligned with phonemic awareness and beginning phonics. As words become familiar, readers add the method of sight word recognition to their repertoire. When readers develop the ability to access their store of words in memory, they can begin to read more efficiently and no longer have to pronounce individual sounds and blend them, although they may revert to that method when they encounter completely new words. Sight word recognition requires a level of orthographic awareness that goes beyond phonics. It involves Apel and Masterson’s (2001) concept of mental orthographic images. Ehri’s third strategy, called analogy, involves applying knowledge of familiar words and structure to novel words. This level incorporates prior knowledge of phonics and orthographic patterns, and adds knowledge of morphemic word components. Knowledge of phonics, orthographic patterns, and morpheme components all play essential roles in these additive reading strategies. It is likely that similar strategies operate as students acquire the ability to spell novel words (e.g., Ehri, 2000, Kamhi & Hinton, 2000).
Reading and spelling differ, however, in that reading involves interpreting a "closed" set of stimulus items (words on the page, represented with letter patterns) that can be recognized by applying a strategic mixture of word structure knowledge. When words are in context, sentence and discourse cues and world knowledge, as well as word knowledge, can be called on to assist in decoding unfamiliar words. On the other hand, spelling unfamiliar words, even in meaningful contexts, involves an "open" set of letter patterns that must be retrieved from memory, likely by applying a similar, but reciprocal, strategic mixture of skills. Within the spelling task, there are two different abilities to consider: the ability to generate the spelling of the word, and the ability to recognize if the word is spelled correctly. The speller must use his or her knowledge of phonics at the phoneme–grapheme level, knowledge of how orthographic patterns map onto syllables, and awareness of morphemes to select letters to represent sounds and sound segments. Not only does the speller have to make choices between multiple ways to represent a sound (e.g., "ee," "ea," "y," "e+C+e") or unit ("-tion," "-sion;" "-ment," "-mint"), the speller also must know what choices are allowable or preferred in specific word positions (e.g., "ch" versus "tch").

Kamhi and Hinton (2000) suggested a "Simple View of Spelling" that shows how spelling and reading are related. This model is based on evidence that good readers tend to be good spellers and poor readers tend to be poor spellers. On the other hand, the relationships may not be as predictable as this simple model would suggest. Studies comparing the reading and spelling abilities of individuals with and without disabilities generally have shown only a moderate correlation between the two types of tasks (e.g., Greenberg, Ehri, & Perin, 1997; Scarborough, 1998; Shanahan, 1984).
Studies of elementary students (Guthrie, 1973) and adults with reading disabilities (Greenberg et al., 1997) have shown correlations between spelling and reading in readers without disabilities to be more strongly associated than in readers with disabilities. It should be noted that the reading and spelling tasks in these studies differed. Guthrie used several word, nonword, and letter reading tasks and compared performance to identification of the correct spelling for nonwords and letters/consonant cluster from a field of four. Greenberg et al. utilized sight word reading along with the Word Identification and Word Attack subtests of the *Woodcock Reading Mastery Test-Revised* (WRMT-R) (Woodcock, 1987). They compared reading performance on these measures to performance on three other tasks: (a) identifying the most wordlike member of a pair of nonwords, (b) a paired tasked assessing knowledge of positional constraints for letters, and (c) performance on an informal reading inventory (Bear, Truex, & Barone, 1989) containing words of various length and phonemic, orthographic, and morphological complexity (*bed*—*fortunate*). Tattersall (Chapter III) studied the performance of children across grades 1–12 with and without LLD using similarly constructed lists of nonwords for spelling and reading. She found a stronger correlation between the two tasks for children with LLD than for children with TL.

The current review of the literature revealed only one other study that used comparable lists of nonword items for investigating relationships of reading and spelling. Snowling, Nation, Moxham, Gallagher, and Frith (1997) used the same nonword list for both reading and spelling tasks in their study of university students with and without dyslexia. Results indicated significant differences in reading, but not spelling, between the two groups. However, effort (as measured by time to complete task) was not assessed,
and a number of sound representations were considered correct when scoring the results of the spelling task, which may have positively affected the performance of the students with dyslexia.

Ehri (2000) described reading and spelling as two sides of the same coin; she reviewed the literature and cited evidence that both tasks rely on the same foundational knowledge sources, follow a similar course of development, and are highly interwoven. However, Ehri also pointed out that spelling places more complex demands on retrieving information in memory. Why, then, did the participants in the study by Snowling et al. (1997) with dyslexia perform relatively better on the spelling task compared to typically developing college-age peers, so that their spelling skills were not significantly different, although their reading skills were? Were there other factors besides time and multiple correct representations that played a role? More research is needed to explore the complex relationship between reading and spelling in various clinical populations using closely matched tasks.

**Error Patterns Across Tasks and Groups by Disability**

As discussed here, spelling and reading are supported by multiple foundational skills including knowledge of phonics, orthographic patterns, and morphology (Apel & Masterson, 2001). Errors at the phonemic level may include deletion of a sound/letter or syllable or reversal of sounds in the word. Orthographic errors include difficulty with phonics rules/patterns resulting in misspelling or mispronunciation of diagraphs and vowels and difficulty with syllabification. Additionally, for spelling real words, errors in positional constraints may be evident (e.g., *quite* → *kwite*). Morphological errors involve
difficulty with grammatical morphemes (e.g., *talked* → *talkt* or *talk-ed*) or with
modifications associated with adding a derivational morpheme (e.g., *happiness* →
*happyness*) for or with root/base pattern representation (*pleasure* → *plesure*).

The literature reflects discrepancies regarding interpretation of the type of errors
found in the reading and spelling in younger students with dyslexia compared to normal
readers. Carney and Martin (2003), for example, studied the performance of students with
dyslexia (mean age 11;3) in comparison with chronological age controls (mean age 11;3)
and reading age matched controls (mean age 7;11) on real and nonword reading tasks.
Their results indicated that students with dyslexia displayed errors that were qualitatively
different from errors made by the control group. The students with dyslexia performed
similarly on nonword reading tasks involving derivatives of regularly pronounced
keyword (e.g., *food*) but exhibited significantly more difficulty on nonwords derived from
irregularly pronounced keywords (e.g., *wool*). On the other hand, Cassar et al. (2005)
compared spelling performance of students with and without dyslexia on real and
nonword spelling tasks and found that the spellings of older students with dyslexia were
similar to those of the younger typical students.

**Dyslexia and Specific Language Impairment**

Most of the literature regarding spelling and reading deficits has focused on
students labeled as having "dyslexia," which also may be called specific reading
impairment or specific learning disability (SLD), with no mention of their oral language
abilities. As previously noted, studies have shown that children with dyslexia use both
phonological and orthographic skills to decode words (Carney & Martin, 2003; Siegel,
Additionally, although they exhibit less morphological awareness than typical peers, morphological awareness contributes significantly to reading and spelling performance (Siegel, 2008). Spelling and reading are not as strongly associated in individuals with dyslexia when compared to peers without dyslexia (Greenberg et al., 1997; Guthrie, 1973; Snowling et al., 1997). Discrepancies exist as to whether the spelling errors exhibited by children with dyslexia qualitatively differ from the errors made by children without dyslexia. (Carney & Martin, 2003; Cassar et al., 2005).

Children with spoken language disorders demonstrate difficulty with foundational skilled necessary for spelling and reading including phonological awareness (e.g., Cupples & Iacono, 2000; Johnson et al., 1999) and morphology (Carlisle, 1987; Rice & Wexler, 1996). Kamhi and Catts (1986) and Kamhi, Catts, Mauer, Apel, and Gentry (1988) studied students with spoken language-impairment (LI), also called specific language impairment (SLI), and students with reading impairment (RI) and found that the groups performed at a comparable level to each other on many of the measures. This raised questions as to the possibility of different variants of language disability. Other studies (e.g., Bishop & Snowling, 2004; Catts, Adlof, Hogan, & Ellis Weismer, 2005) have concluded that dyslexia and SLI are more accurately classified as distinct but potentially comorbid language-based disorders.

Research is needed to document types and patterns of errors in the literate language skills in those classified with a primary language-based disability as compared to students with typical development. This type of information is crucial to understanding the associations and dissociations of the skills of spelling and reading across clinical populations.
Purpose of the Study

The purpose of this study was to investigate the three types of errors—simple phonic, orthographic, and morphological—in the two tasks of nonword spelling and nonword reading in school-age students either with LLD or TL. The goal was to determine if the type/quantity of errors differ across tasks by ability groups and age groups. By incorporating participants across the age span who met the criteria for oral language impairment and controlling lists for word structure, this study was designed to examine profiles or patterns of errors within and across the groups of children as they performed tasks of nonword reading and nonword spelling. A better understanding of error patterns across groups, ages and tasks can contribute to the design of assessment tools and clinical intervention methods to identify individuals at risk for language and literacy deficits and inform intervention strategies.

A primary research question was whether patterns of error are similar across tasks when students with typical language (TL) and language-learning disabilities (LLD) spell and read two sets of nonword items that have comparable word structure. A secondary question was whether relationships differ between groups at elementary and secondary age/grade levels. Data were analyzed to describe patterns of performance for groups by disability (TL and LLD) and age/grade level (elementary and secondary) as well as between tasks (nonword spelling and reading) for the three dependent variables (phonic errors, orthographic errors, and morphemic errors). Profile analysis was used to compare patterns of errors between groups and across tasks.

Specifically, the research questions posed by this study were:
1. When spelling, do children with LLD demonstrate a significant difference in overall accuracy and error pattern (i.e., different relationships of the three types of errors) than children with TL? Does accuracy and error pattern differ significantly between elementary and secondary students?

2. When reading, do children with LLD demonstrate a significant difference in overall accuracy and error pattern than children with TL? Does accuracy and error pattern differ significantly between elementary and secondary students?

3. When comparing nonword spelling and nonword reading, do the patterns of error differ between the two tasks for children with and without LLD at the elementary and secondary levels?

Methods

Participants

This study analyzed secondary data gathered from 111 school-age students who participated in a larger study of a beta research version of a new Test of Integrated Language and Literacy Skills (TILLS) (Nelson, Helm-Estabrooks, Hotz, & Plante, 2007). Fifty-three students were identified as meeting inclusion and exclusion criteria as having language impairments and/or learning disabilities (LLD). The other 58 participants meet criteria as having typical language development (TL). A stratified sampling approach was used to create groups comparable in chronological age, sex, race/ethnicity, and socioeconomic status based on whether they qualified for free or reduced lunch.
The students in the LLD group met criteria for having normal hearing as confirmed by an audiometric screening and are receiving services for language impairment and/or learning disabilities in public schools or private clinics. Most of the students obtained a standard score of < 85 on the Core Language Score Composite of the Clinical Evaluation of Language Fundamentals, Fourth Edition (CELF-4) (Semel, Wiig, & Secord, 2003) (n = 36). A portion of them (n = 17) met the criterion of receiving services for LLD based on other measures of language and literacy development, but they scored at 85 or above on the Core Language Score of the CELF-4. The rationale for this is that the CELF-4 measures spoken language proficiency only, and the research team was interested in the performance of students whose language difficulties involve their reading or written language, not just listening and speaking. With the exception of attention deficit disorders (n = 8), none of the participants had any other diagnosis comorbid to their identification as having difficulty with spoken and/or written language.

None of the 58 students in the typical language (TL) group had ever been identified as having language or learning disabilities (nor having any special education diagnosis other than attention deficit hyperactivity disorder; n = 6). That is, they did not have deficits in speaking, reading, writing, or social skills. They also had passed a recent (within 12 months) hearing screening test. All were administered the CELF-4 as part of the larger study and were confirmed to achieve a standard score of ≥ 85 on the Core Composite.

Of the 58 students with TL, 27 were male and 31 female; of the 53 students with LLD, 28 were male and 25 female. The students with TL ranged in age from 6 years (6;0) to 17;9 (mean age 11;5); the students with LLD ranged in age from 7;2 to 17;10 (mean
age 11;4). For this study, the students were additionally divided into elementary (1st through 5th grade) and secondary (6th through 12th grade) levels. Elementary students with TL ($n = 35$) ranged in age from 6;0 to 11;7 (mean age 9;4), and the LLD group ($n = 33$) ranged from 7;2 to 11;3 (mean age 9;6). The TL group of secondary students ($n = 23$) ranged in age from 12;1 to 17;9 (mean age 14;8), and the secondary students with LLD ($n = 20$) ranged in age from 11;9 to 17;10 (mean age 14;4).

In the TL group, 59% of the participants were Caucasian (non-Hispanic), 24% were Hispanic (any race), 12% were African-American, and 5% Asian. This was comparable to the LLD groups in which 59% of the participants were Caucasian (non-Hispanic), 24% were Hispanic (any race), 14% were African-American, and 3% Asian. The distribution by age groups is presented in Table 4.1.

### Table 4.1

**Participant Demographics**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Elementary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TL ($N = 35$)</td>
<td>LLD ($N = 33$)</td>
</tr>
<tr>
<td>AGE (yrs;mos)</td>
<td>6;0–11;7 (mean 9;4)</td>
<td>7;2–11;3 (mean 9;6)</td>
</tr>
<tr>
<td>GENDER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>49% (17)</td>
<td>55% (18)</td>
</tr>
<tr>
<td>Female</td>
<td>51% (18)</td>
<td>45% (15)</td>
</tr>
<tr>
<td>RACE/ETHNICITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>63% (22)</td>
<td>61% (20)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>14% (5)</td>
<td>15% (5)</td>
</tr>
<tr>
<td>African-American</td>
<td>17% (6)</td>
<td>21% (7)</td>
</tr>
<tr>
<td>Asian</td>
<td>6% (2)</td>
<td>3% (1)</td>
</tr>
<tr>
<td>FREE/REDUCED LUNCH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>34% (12)</td>
<td>36% (12)</td>
</tr>
<tr>
<td>No</td>
<td>57% (20)</td>
<td>55% (18)</td>
</tr>
</tbody>
</table>
Some of the students in both groups came from homes where languages other than English were spoken, but such students were recruited in age strata (within 9 months) to correspond with others in the opposite group who had the same sex and similar language experience. All participants were identified by speech-language pathologists and other school professionals as speaking English at least as well as any other school language.

Measures

This study utilized data from two of the 11 subtests of the TILLS-beta research edition (Nelson et al., 2007), which were gathered as part of the larger the beta discrimination trial. The scores used in this study came from 16 stimuli in the Nonword Word Spelling task and a comparable set of 16 stimuli in the Nonword Word Reading task. The nonword items were not identical but were designed to include parallel features, with attention to length in syllables, phonotactic probability, and neighborhood density. In order to take into account skills/strategies individuals utilize in decoding/encoding written material, developmental data for reading/spelling were additionally considered, and the stimulus items were designed to reflect these developmental sequences. Specifically, various developmental vowel patterns, consonant blends, and diagraphs were included. Inflectional and derivational morphemes of Anglo-Saxon, Latin, and Greek origins were included in many of the nonwords. The nonwords in the list for spelling each had a comparable nonword in the list used for reading, and the same number of opportunities for correct phonic, orthographic, and morphemic representations allowed for direct comparisons to be made across tasks (see Appendix A).
Testing Procedure

The data were gathered at sites in California, Illinois, Massachusetts, Michigan, Nevada, North Carolina, and Texas by speech-language pathologists with state licensure or certification. These research clinicians were trained by the researcher team to gather parental permission and child assent using procedures approved by a Human Subjects Institutional Review Board, and were given instructions for an assigned random order in which to administer all 11 subtests of the TILLS. Thus, the nonword reading and spelling tasks came at random points in the delivery, and systematic order effects were controlled. Examiners received training in human subjects’ protections and followed instructions in the examiner’s book, which contained explicit instructions as to how to introduce the nonword repetition and spelling tasks to the student.

Nonword spelling. Nonword stimuli for spelling were presented via audio compact disk (CD) to ensure consistency in the spoken productions across clinicians. All items were presented using a digitized recording of a woman’s voice. The clinician was instructed to check the sound level on the two practice stimuli to make sure that the volume of the CD player was appropriate and the stimuli were easily audible for the student. An item was repeated only if ambient noise interfered with the presentation. The student first responded to a prompt to “Say” the nonword (scored separately as a nonword repetition task), and then the voice on the CD repeated the stimuli item, with the prompt to “Spell ____.” Students wrote the words on numbered lines within a student response booklet. Examiners were told to pause the CD if the student needed more time to spell the word than provided on the disk.
Nonword reading. The nonword reading stimuli were presented in a stimulus book by uncovering words one at a time on the list for the student to read. If no response was offered after 5 seconds, the clinician was instructed to prompt the student to try to read the word. Responses were transcribed in the examiner's notebook using standard IPA notation relative to scoring guidelines that identified alternative correct pronunciations and provided opportunities to cross out omitted word components, to write in additions or substitutions, and to indicate transpositions.

Scoring of Responses

A complex scoring system was designed to code the number of errors on simple phonic, orthographic, and morphemic components of each word on each task (see Appendix A). The same number of opportunities for correct/incorrect scores for phonic, orthographic, and morphemic components was available in both the spelling and reading tasks, but there were varied opportunities for each word component. The total number of correct possible representations for each component on both subtests was as follows: 39 for phonic, 20 for orthographic, and 14 for morphemic. Due to the difference in number of opportunities to elicit responses in the three types of errors, a percentage correct score (total possible-errors/total possible) was calculated for each category. This made it possible to compare the three types of errors within tasks as well as between tasks.

All written transcriptions were evaluated using criteria that were modified to allow for acceptable spelling or pronunciation alternatives. For example, on the spelling task, the nonword “smeeb” could be spelled “smeeb” or “smeab”; on the reading task, the nonword “nopiphonia” could be pronounced “nopIfoniə” or “napIfoniə.” The scoring
method analyzed the major types of errors as simple phonic (errors in association of consonant phonemes with single letters), orthographic (errors in association of vowels and consonants with context-determined letter patterns or digraphs), or morphemic (errors in association of morphemes with letter patterns). Errors were classified into one of these three categories. Any variation that could not be attributed to a consistent developmental speech-sound or dialectic substitution as evidenced in conversational speech was considered an error.

Errors in representation (spelling or reading) for each of the stimulus words for each of the participants were coded and totaled. It was expected that younger students and students with LLD would have more errors across all three categories, but especially at the morpheme level. Errors in letter formation on the spelling task were scored using guidelines suggested by K. Apel (personal communication, May 19, 2009). If the grapheme (letter) produced in error did not result in a letter change (e.g., backwards “c”) or if it could be differentiated in the child’s handwriting (e.g., “z” written backwards that was differentiated from an “s” by straight vs. curved lines), it was scored as correct. Any letter formation that could be confused with another letter (e.g., “b” for “d”) was scored as incorrect.

Coding reliability was evaluated by independently recoding a random sample of equal numbers of responses from participants with TL and LLD. On the repetition task, interscorer reliability was found to be 99% on phonic and 100% on morphemic scoring; 99% on phonic, 98% on orthographic, and 100% on morphemic coding in the spelling task; and 99% on phonic, orthographic, and morphemic scoring on the reading task.
Analysis

Profile analyses were used to construct a pattern of performance for participants across the two ability groups (TL and LLD) on the three dependent variables (phonic errors, orthographic errors, and morphemic errors) for the two tasks (nonword reading and nonword spelling) from data generated based on the scoring protocol. These analyses assessed within and between group differences in the quantity and types of errors—simple phonic, orthographic, and morphemic—separately for nonword spelling and nonword reading. Profile analysis is a multivariate test that is an extension of a repeated measures multiple analysis of variance (MANOVA).

Using profile analysis, one can answer questions concerning each of the three aspects: parallelism, levels, and flatness. First, are the profiles parallel? This question tests interactions for within-subject factors (e.g., within spelling or reading by ability and within spelling or reading by age level). Second, it addresses the question, is there a difference between levels of performance between groups? With significant differences between levels, pairwise comparisons examine differences between factor levels using a Bonferroni adjustment to control for Type 1 error. Finally, when age and ability are combined, are the mean scores of the three types of errors different across the tasks of spelling and reading (flatness)?

Due to SPSS misreporting eta squared ($\eta^2$) values (e.g., Levine & Hullett, 2002), eta square was hand calculated and used to interpret effect size. Because $\eta^2$ is equivalent to $R^2$ in multiple linear regression, it can be interpreted as the proportion of variance
accounted for by a variable. Typical benchmark standards were used: .01 = small effect, .06 = moderate effect, and .14 = large effect (Cohen, 1988).

In order to address whether the patterns of error differed across the tasks of nonword spelling and nonword reading for children with TL and children with LLD, dependent $t$ tests were performed. Effect sizes (Cohen’s $d$) were examined for the pairs showing significant differences in the percentage correct means in order to describe the degree to which the three types of errors—phonic, orthographic, morphemic differed across the tasks of nonword spelling and nonword spelling within each of the ability groups. Cohen’s $d$ provides a standardized unit of measure in terms of the number of standard deviations between group performances. Cohen (1988) suggested that this type of effect size be interpreted as small ($d = .2$), medium ($d = .5$), and large ($d = .8$).

**Results**

Data collected on the Nonword Spelling and Nonword Reading subtests of the TILLS during the beta standardization trial were used to answer the questions posed by this study. Descriptive statistics were calculated first. Means and standard deviations of 111 children with and without LLD at two grade levels for phonic, orthographic, and morphemic performance within the tasks of nonword spelling and nonword reading are shown in Table 4.2.
Table 4.2

Performance Among Groups by Age and Ability Across Nonword Reading and Spelling Tasks Shown as Mean Percent Correct (and Standard Deviations) for Word Components

<table>
<thead>
<tr>
<th></th>
<th>Elementary (TL: ( n = 35 ); LLD: ( n = 33 ))</th>
<th></th>
<th>Secondary (TL: ( n = 23 ); LLD: ( n = 20 ))</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spelling</td>
<td>Reading</td>
<td>Spelling</td>
<td>Reading</td>
</tr>
<tr>
<td>TL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonic</td>
<td>93.77</td>
<td>95.60</td>
<td>96.54</td>
<td>97.21</td>
</tr>
<tr>
<td></td>
<td>(7.60)</td>
<td>(7.66)</td>
<td>(3.99)</td>
<td>(4.70)</td>
</tr>
<tr>
<td>Orthographic</td>
<td>76.00</td>
<td>81.86</td>
<td>81.86</td>
<td>88.91</td>
</tr>
<tr>
<td></td>
<td>(18.26)</td>
<td>(14.30)</td>
<td>(12.30)</td>
<td>(9.04)</td>
</tr>
<tr>
<td>Morphemic</td>
<td>72.65</td>
<td>84.90</td>
<td>90.37</td>
<td>94.10</td>
</tr>
<tr>
<td></td>
<td>(17.11)</td>
<td>(17.13)</td>
<td>(8.51)</td>
<td>(7.96)</td>
</tr>
<tr>
<td>LLD:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonic</td>
<td>81.51</td>
<td>83.37</td>
<td>88.85</td>
<td>93.59</td>
</tr>
<tr>
<td></td>
<td>(16.73)</td>
<td>(23.26)</td>
<td>(8.54)</td>
<td>(8.26)</td>
</tr>
<tr>
<td>Orthographic</td>
<td>57.42</td>
<td>62.58</td>
<td>71.50</td>
<td>75.00</td>
</tr>
<tr>
<td></td>
<td>(25.07)</td>
<td>(27.56)</td>
<td>(16.87)</td>
<td>(16.70)</td>
</tr>
<tr>
<td>Morphemic</td>
<td>54.55</td>
<td>65.80</td>
<td>75.00</td>
<td>84.65</td>
</tr>
<tr>
<td></td>
<td>(24.08)</td>
<td>(24.92)</td>
<td>(21.05)</td>
<td>(13.94)</td>
</tr>
</tbody>
</table>

Performance Within and Between Groups on Spelling of Nonwords

To answer the question as to whether children with LLD exhibit different patterns (profiles) of errors (i.e., different relationships between the three types of errors) in the tasks of nonword spelling and reading than their TL peers, statistical analyses for parallelism and level were evaluated for the two ability groups at two ages, first for
spelling and then for reading. For spelling, tests for parallelism indicated a significant interaction with a small effect size for error pattern \times ability (LLD and TL), $F(2, 107) = 3.960, p = .022, \varepsilon^2 = .018$ and a significant interaction with a moderate effect size for error pattern \times age (elementary and secondary), $F(2, 107) = 11.504, p < .001, \varepsilon^2 = .058$.

These results indicate significant differences within profiles for the TL and LLD groups and significant differences within profiles for the two age/grade groups (elementary and secondary) on the spelling error subscale. Figure 4.1 illustrates the differences in parallelism of both ability and age groups, as well as the differences of spelling error distributions within each group.

Figure 4.1. Performance on spelling error subscale by age and ability.
For spelling, analysis of levels indicated significant differences with large effect sizes between the two ability groups (TL and LLD), $F(1, 109) = 28.436, p < .001, \varepsilon^2 < .184$ and age (elementary and secondary), $F(1, 108) = 17.691, p < .001, \varepsilon^2 < .114$.

Pairwise comparisons of the estimated marginal means (EMM) for percent correct items specified that the TL group (EMM = .862) exhibited significantly fewer errors (a greater percentage correct) when compared to children with LLD (EMM = .712). Additionally, the secondary age group (EMM = .848) exhibited significantly fewer errors when compared to the elementary age group on the spelling task (EMM = .727) (see Table 4.3).

Table 4.3

Pairwise Comparison Statistics for Spelling Errors by Ability and Age

<table>
<thead>
<tr>
<th>Spelling</th>
<th>Mean Difference</th>
<th>SE</th>
<th>$p$</th>
<th>95% Confidence Interval for Difference(*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL LLD</td>
<td>.149(*)</td>
<td>.028</td>
<td>0.000</td>
<td>0.094 - 0.205</td>
</tr>
<tr>
<td>Elem Secondary</td>
<td>-.121(*)</td>
<td>.029</td>
<td>0.000</td>
<td>-.178 - -.064</td>
</tr>
</tbody>
</table>

Results also indicated significant differences in flatness, with large effect size, across items within the spelling task, $F(2, 107) = 98.588, p < .001, \varepsilon^2 = .455$. This indicates that when age and ability combined, mean scores of the three types of errors differed (were not flat) across the spelling task (see Figure 4.1). As shown in Table 4.4, the phonic errors (EMM = .901) were significantly lower when compared to both orthographic (EMM = .731) and morphemic errors (EMM = .729).
Table 4.4

Pairwise Comparison Statistics for Spelling Errors

<table>
<thead>
<tr>
<th>Spelling</th>
<th>Orthographic</th>
<th>Phonic</th>
<th>Orthographic</th>
<th>Morphemic</th>
<th>Morphemic</th>
<th>Phonic</th>
<th>Orthographic</th>
<th>Morphemic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Difference</td>
<td>Std. Error</td>
<td>Sig.(a)</td>
<td>Upper Bound</td>
<td>Lower Bound</td>
<td>Mean Difference</td>
<td>Std. Error</td>
<td>Sig.(a)</td>
</tr>
<tr>
<td>Phonic</td>
<td>.172(*)</td>
<td>0.013</td>
<td>0.000</td>
<td>0.140</td>
<td>0.204</td>
<td>.170(*)</td>
<td>0.015</td>
<td>0.000</td>
</tr>
<tr>
<td>Morphemic</td>
<td>-0.002</td>
<td>1.000</td>
<td>1.000</td>
<td>-0.206</td>
<td>-0.135</td>
<td>-0.002</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Orthographic</td>
<td>-0.170(*)</td>
<td>0.013</td>
<td>0.000</td>
<td>-0.204</td>
<td>-0.140</td>
<td>-0.170(*)</td>
<td>0.015</td>
<td>0.000</td>
</tr>
<tr>
<td>Morphemic</td>
<td>0.002</td>
<td>1.000</td>
<td>1.000</td>
<td>-0.030</td>
<td>0.034</td>
<td>0.002</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Performance Within and Between Groups on Reading of Nonwords

As was seen with performance between the groups on the task of spelling nonwords, tests for parallelism for reading nonwords indicated significant interactions with small effect sizes for both error pattern x ability group (TL and LLD), $F(2, 107) = 7.362, p = .001, \varepsilon^2 = .033$, and error pattern x age group (elementary and secondary), $F(2, 107) = 6.408, p = .002, \varepsilon^2 = .027$. These results indicate differences within the profiles for TL and LLD groups and elementary and secondary groups on the reading task. Figure 4.2 illustrates the parallelism of ability and age, as well as the differences in phonic, orthographic, and morphemic reading errors distributions within each group.
Results indicated significant differences (levels) between ability groups (TL and LLD), $F(1, 108) = 21.643, p < .001, \varepsilon^2 < .154$, with a large effect size, and also between elementary and secondary age groups, $F(1, 108) = 10.089, p = .002, \varepsilon^2 < .072$ with a moderate effect size. Pairwise comparisons of the estimated marginal means (EMM) for percent correct items specified significant differences between the TL and LLD groups as well as the elementary and secondary groups on the reading task. As seen in Table 4.5, the children with TL (EMM = .908) exhibited significantly lower error rates (a greater percentage correct) when compared to children with LLD (EMM = .770). The secondary age group (EMM = .887) exhibited significantly lower error rates when compared to the elementary age group (EMM = .791).
As noted for spelling, flatness was also found to be significant for reading, $F(2, 107) = 86.515, p < .001, \varepsilon^2 = .410$, indicating that, when performance was combined for ability and age groups, mean scores for the three types of errors differed (i.e., were not flat) across the reading task (see Figure 4.2). Eta squared values suggest a large effect size for differences in the error types. Results of pairwise analysis of the reading errors for the combined ability and age groups indicated that there were significantly more orthographic errors (EMM = .770) than morphemic errors (EMM = .832) and phonic errors (EMM = .924). In addition, morphemic errors were significantly more frequent than phonic errors (see Table 4.6).
Table 4.6

Pairwise Comparison Statistics for Reading Errors

<table>
<thead>
<tr>
<th>Reading</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>Sig.(a)</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Orthographic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonic</td>
<td>.153(*)</td>
<td>0.012</td>
<td>0.000</td>
<td>0.124</td>
</tr>
<tr>
<td>Morphemic</td>
<td>.101(*)</td>
<td>0.011</td>
<td>0.000</td>
<td>0.074</td>
</tr>
<tr>
<td>Orthographic</td>
<td>Phonic</td>
<td>-.153(*)</td>
<td>0.012</td>
<td>-0.183</td>
</tr>
<tr>
<td>Morphemic</td>
<td>-.052(*)</td>
<td>0.013</td>
<td>0.000</td>
<td>-0.083</td>
</tr>
<tr>
<td>Morphemic</td>
<td>Phonic</td>
<td>-.101(*)</td>
<td>0.011</td>
<td>-0.128</td>
</tr>
<tr>
<td></td>
<td>Orthographic</td>
<td>.052(*)</td>
<td>0.013</td>
<td>0.022</td>
</tr>
</tbody>
</table>

Comparison of Patterns Across Tasks of Nonword Reading and Spelling

In order to address the final question regarding whether the patterns of error differed across the tasks of nonword spelling and nonword reading for children with TL and children with LLD, dependent t tests were performed (see Table 4.2 for mean percent correct and standard deviations). For the TL group at the elementary level, significant differences in performance across tasks were found for orthographic correctness in spelling (M = 76.00, SE = 3.09), which was significantly lower than for reading (M = 81.86, SE = 2.42, t(34) = 2.41, p = .02, d = .36), as well as for morphemic correctness in spelling (M = 72.65, SE = 2.89), which also was significantly lower than for reading (M = 84.90, SE = 2.90, t(34) = 4.17, p < .0001, d = .72). The means for the percentage correct in phonic errors were not significantly different across tasks for the elementary
students with TL. There were no significant differences found in the degree to which the three types of errors differed across the spelling and reading tasks for students with TL at the secondary level.

The children with LLD at the elementary level exhibited no significant differences in orthographic and phonic errors across the spelling and reading tasks. A significant difference in performance across tasks was found for morphemic correctness, which showed significantly lower percentages of morpheme units correct in spelling ($M = 54.55, SE = 4.19$) than in reading ($M = 65.80, SE = 4.34, t(32) = 3.84, p = .001, d = .46$).

Although the LLD group at the secondary level did not exhibit a significant difference in performance on orthographic correctness across tasks, results indicated a significant difference in phonic correctness, showing significantly lower proportions of phonics elements correct in spelling ($M = 88.85, SE = 1.91$) than in reading ($M = 93.59, SE = 1.85, t(19) = 2.73, p = <.013, d = .56$). Secondary students with LLD also showed significantly lower proportions of morphemic units correct in spelling ($M = 75.00, SE = 4.71$) than in reading ($M = 84.65, SE = 3.12, t(19) = 3.18, p = .005, d = .54$).

To summarize, 12 contrasts of performance by the TL and LLD groups at the elementary and secondary grades in phonic, orthographic, and morphemic accuracy across the tasks of nonword spelling and nonword reading were analyzed. For the TL group, performance in reading was found to be significantly better than in spelling only at the elementary level for orthographic (small effect size) and morphemic (medium effect size) performance. The LLD group demonstrated a significant difference in performance in favor of reading to spelling tasks in morphemic accuracy at the elementary level with small effect size and in phonic and morphemic accuracy at the secondary level with
medium effect size. Their percentage of orthographic correctness did not differ across the reading and spelling tasks at either age level.

**Discussion**

The purpose of this study was to investigate whether patterns of errors representing difficulties with phonic, orthographic, and morphemic word structure knowledge differ within and across nonword spelling and nonword reading tasks and between two groups of students with and without LLD at the elementary and secondary grade levels. The three types of errors that were investigated in this study were categorized as simple phonic, orthographic, and morphemic. These are three of the linguistic factors discussed in the literature as contributing to spelling and reading accuracy (Apel & Masterson, 2001; Bourassa & Treiman, 2001).

The current study differed from previous studies in several ways. It compared children with primary oral language based disorder to children with typical language. Also, by covering the full age range, 1st–12th grades, it included older students for which little research exists. The focus on three linguistic components—phonic, orthographic, and morphemic—in one study and across the tasks of spelling and reading using comparable lists of nonwords set the study apart from previous research in another way.

**Error Profiles Within Tasks**

Although it is well documented in the literature that children with TL outperform children with LLD and dyslexia in reading and spelling (e.g., Catts & Kamhi, 2005), it is
less clear whether this difference is simply quantitative in nature or qualitative as well for children with disabilities (Carney & Martin, 2003; Cassar et al., 2005). The present study found significant differences within the spelling and reading profiles (pattern of phonic, orthographic, and morphemic errors) of children with TL as compared to LLD as well as within the profiles for elementary as compared to secondary level students. These results support and expand on those of Carney and Martin (2003) by suggesting the difference between school-age children with and without LLD is qualitative rather than simply quantitative. Data from the current study revealed a different profile for secondary LLD as compared to primary TL. Although the elementary TL group showed statistically significant differences in orthographic and morphemic accuracy, the secondary level LLD group continued to have statistically significant differences in proficiency between tasks in both phonic and morphemic accuracy (in favor of reading) but not for orthographic skill. These findings for children with LLD contrast with those of Cassar et al. (2005), who determined the difference in spelling ability for children with and without dyslexia to be developmental in nature. Although the profiles of older students with LLD and younger ones with TL may differ across phonic, orthographic, and morphemic ability, further analysis of specific errors and a more complete inventory of possible patterns would be necessary to confirm the degree to which errors within each of the three areas differ in type as well as in dimension.

In the present study, all groups regardless of ability or age had significantly more difficulty with orthographic knowledge than phonic. These results support and expand on those of Holmes and Quinn (2009) and Masterson et al. (2007), who studied skills in
university students. In the current study, not only were orthographic deficits found in the LLD groups, but the TL groups also demonstrated a relative weakness in this area.

**Comparison of Error Profiles Across Tasks**

A relatively small body of literature exists investigating the connection between spelling (encoding) and reading (decoding) skills of children with a primary oral language diagnosis across the school age years. Studies using children labeled as "dyslexic" have found that the association between reading and spelling skills in that population are not as highly correlated as in children with typical ability (Greenberg et al., 1997; Guthrie, 1973). However, the study of school age children with LLD that is reported in Chapter III of this dissertation found the opposite for children with a primary disorder of spoken language; that is, the children with LLD were found to have a stronger correlation between their performance on the spelling and reading tasks than their age matched peers. This relationship was based on simple scores (items scored as correct or incorrect). The current study utilized a complex scoring method to analyze phonics, orthographic, and morphemic structure across the tasks of nonword spelling and nonword reading. It showed no significant difference at the elementary level between tasks for either ability group in phonic performance. However, the children with TL exhibited significantly more orthographic and morphemic errors in spelling than in reading of nonwords, whereas the LLD group only showed a significant difference with morphemic structure in favor of reading performance.

This discrepancy across tasks could represent a simple developmental delay for the students with LLD. For both groups, this study (although cross sectional and not
longitudinal in design) suggests that improvements in word component skills in reading occur before the same components improve in spelling. The pattern was not the same for all word components, however. Although both groups appeared to display better proficiency in reading than in spelling of morphemic units, they differed in orthographic skill. As previously noted, orthographic knowledge appears to be a relative area of weakness for both the TL and LLD groups; however, the TL group had significantly better accuracy in orthographic correctness in reading over spelling, but the LLD group displayed similar performance in orthographic skills across tasks. This also could represent a developmental lag, but because the components are not equally delayed, a conclusion of qualitative differences between groups appears justified.

At the secondary level, performance in the three linguistic components was found to be consistent for the TL group across the spelling and reading tasks; that is, performance in reading was reflective of that in spelling for phonemic, orthographic, and morphemic accuracy. However, the children with LLD at the secondary level exhibited significant differences across the tasks of spelling and reading. In nonword reading, they had significantly fewer errors in phonics and morphemes than in spelling. Thus, at the secondary level for students with LLD, differences in spelling and reading ability that are not evident using a simple scoring system (such as the one used in paper two of this dissertation) are captured when the complex scoring system developed for this study was utilized. These results further highlight the need for continued research into the relationship of the underlying skills needed for success in spelling and reading. They also suggest that error analysis may offer clinicians information about weak areas that should be targeted in intervention.
Conclusions

The TILLS database provided a stratified sample of participants for this study that allowed the creation of two ability groups comparable in terms of age, sex, race/ethnicity, and socioeconomic status that spanned the school age years, grades 1–12. Use of this database proved to be beneficial; however, limitations existed. The nonword lists for this study utilized a subset of 16 comparable items from the Nonword Spelling and Nonword Reading Subtests of the TILLS. The availability of data across the tasks of nonword spelling and nonword reading in which the stimulus items were designed to be low in phonotactic probability and neighborhood density set this study apart from others. The ability to extract detailed information regarding the linguistic factors supporting spelling and reading ability (phonic, orthographic, and morphemic) from these data was crucial. It should be noted, however, that although the lists were comparable in structure they provided only a small sample of all possible phonic, orthographic, and morphemic units rather than offering a comprehensive assessment of these areas.

Generalization of the results of this study is compromised by the small sample size ($n = 111$), especially when it was further divided into two grade levels. Although the number of participants based on ability was closely matched in number at the two grade levels, there were not uniform numbers of participants across the two levels. Distribution of participants by grade levels varied from 68 at the elementary level to 43 at the secondary level. Further, although the two groups had students who were matched for age (within 9 months), there were fewer students at the lower and upper ends of the age range, so that the mean age of the elementary students (9;5) was fairly close to that of the
secondary students (11;5). Further research is needed with more students in the early and later grades. Longitudinal research is also needed.

Even with these limitations, this study added valuable information regarding differing profiles of students with and without LLD at the elementary and secondary levels in nonword spelling and nonword reading tasks. Results point to inconsistent skills across spelling and reading tasks for both children with TL and LLD at the elementary level. Both groups exhibited more difficulty with morphological and orthographic ability than with phonics. Given these results, the connection between morphological knowledge and fluent reading as well as vocabulary knowledge, and the need to be able to spell/read multimorphonic words by 3rd grade (Carlisle, 2004), explicit instruction in morphemic structure would appear to benefit both ability groups. Orthographic representation was the most difficult for both ability groups and at both age levels, accounting for the most errors as compared to morphemic and phonic in the reading task. This finding is not surprising given the complexity of the English language, with many exceptions to phonics rules and alternative ways to represent sounds that necessitate comprehensive orthographic knowledge. It points to the need for ongoing instruction for all students in this area from elementary through secondary school to help them detect the orthographic patterns that are there and that may be intertwined with morphological derivation.

Instruction in phonemic awareness and simple phonics often ends around 3rd grade as students move from the “learning to read” stage to the “reading to learn” stage. Results of the present study point to lower levels of phonic proficiency for LLD as compared to TL and inconsistent phonic skills across tasks of spelling and reading in
secondary students with LLD. This finding highlights the continued need for explicit instruction in this area for children with a language-based literacy disorder.

Finally, in answer to the question as to whether spelling and reading are simply two sides of a coin, the results of this study indicate that it depends—on age and ability. For secondary students with TL, performance in word components in spelling is reflected in reading. That is, not only do the profiles of errors mirror one another across tasks, but the proficiency levels across tasks do not differ significantly. For the other groups, TL at the elementary level and LLD at both age levels, statistically significant differences were evident in the profiles between tasks. It should be noted, however, that the general profile of fewer phonic errors as compared to orthographic and morphemic errors was found across both tasks by all groups. This finding does support Ehri’s (2000) conclusions that the tasks are highly interwoven. Significant differences in proficiency in favor of reading over spelling within the three areas (phonic, orthographic, and morphemic) for the TL elementary and both LLD groups showed that spelling is a more demanding task in terms of retrieving information from memory (open-ended task); reading, on the other hand, involves a closed set with less demands. The better performance by all groups (ability and age) in all areas across tasks in favor of reading clearly illustrates this point.

Recommendations

This study leaves unanswered questions. Results indicate a qualitative difference in profiles for the children with and without LLD. Further research is needed, however, to analyze the characteristics of the errors that students make in the areas of phonics,
orthography, and morphology across the tasks of reading and spelling. Is the nature of the errors typical of that found in children with TL? In which specific areas are children with LLD at the secondary level still exhibiting difficulty with the developmentally constraint skill of simple phonics, which leads them to be less accurate in both tasks than TL elementary students? Is there a phonological basis or a deficit in the mental representation in the errors found in orthographic and morphological form? Qualitative analyses of the phonic, orthographic, and morphemic errors are needed to gain a better understanding of the underlying nature of the errors for children with LLD. Such information may help to paint a detailed picture of common deficits which has the potential for practical implications in the design of assessment tools, instructional methods, and clinical interventions for individuals at risk for language and literacy deficits.

References


CHAPTER V

DISCUSSION

The purpose of this final chapter is to review the central purpose of the dissertation, and to summarize and integrate the results of the three related studies presented in Chapters II–IV. The findings will then be related back to the central purpose and to the previous literature, and implications for further research and clinical practice presented.

Central Purpose

The central purpose of this dissertation was to investigate word-structure knowledge displayed in speaking, spelling and reading tasks in children with TL and children with LLD across 1st–12th grade. Individuals with language deficits may present with impairment in varied combinations of the five systems of language—phonology, morphology, syntax, semantics, and pragmatics across the four modalities of language use—listening, speaking, reading, and writing (ASHA, 1993). Deficits impacting word learning, spelling, and fluent reading are frequently observed in children with LLD (e.g., Catt, Fey, Tomblin, & Zhang, 2002) and may involve abilities at the sound/word level involving phonology, morphology, and semantic factors, as well as alphabetic and orthographic ones (e.g., Carlisle, 1987; Edwards, Beckman, & Munson, 2004; McBride-Chang, Wagner, Muse, Chow, & Shu, 2005; Rice & Wexler, 1996).
In order to study word learning, spelling and reading in children with and without disabilities, nonwords have been used extensively in previous research. Because nonwords separate word meaning from word structure, tasks using nonwords may hold the key to a better understanding of the underlying deficits in sound/word level structure that individuals with language disabilities exhibit. However, design of nonword tasks and nonword items varies greatly across studies of speaking, spelling, and reading, making it difficult to compare results.

The three studies in this dissertation controlled aspects of nonword structure and modes of stimulus presentation and response to investigate abilities for a wider age range of students than included in many previous studies, and for equal numbers of students with and without LLD. The first study evaluated the ability of two types of nonwords—those with true inflectional and derivational morphemes, and those without—to differentiate between students with and without a language disorder. Based on the results of this first study, a combined list of the nonwords was then incorporated into the second study, which investigated the relationships of nonword processing performance across three tasks of nonword repetition, nonword spelling, and nonword reading. The second study also investigated the association of underlying skills of vocabulary awareness and phonemic awareness on these three tasks. The strong relationship found between spelling and reading for both children with and without LLD in the second study was further scrutinized for specific linguistic based errors in the third study. It involved comparison of profiles of patterns for phonic, orthographic, and morphemic errors across groups by disability as well as elementary and secondary grade level. Thus, each succeeding study built on findings of previous ones to add information about how word-structure
knowledge is demonstrated on tasks requiring nonword speaking, spelling, and reading by children with TL and with LLD across the full range of the school-age years.

Summary of Findings

Study One Summary

The first study investigated nonword repetition (imitation) using two sets of nonwords. Both sets were designed to be low in phonotactic probability and neighborhood density, but they differed in the inclusion of true morphemes. The inclusion of morphemes in the nonwords of one set increased their wordlikeness, but this feature allowed the researcher to explore the morphemic as well as phonemic knowledge. Although the literature supports the use of nonword repetition tasks for differentiating children with and without developmental language-learning disabilities, the impact of word structure on the performance of children with LLD is less clear.

Controversy exists as to whether the performance of children with LLD is influenced by wordlikeness. Previous studies have revealed inconsistent evidence regarding the effect of wordlikeness in children with LLD. Some studies have shown children with LLD to benefit from wordlikeness (e.g., Archibald & Gathercole, 2006; Coady, Evans, & Kluender, in press; Munson, Edwards, & Beckman, 2005), whereas other studies indicate that children with LLD do not benefit from increased wordlike structure (e.g., Marton, 2006; Masterson, Laxon, Carnegie, Wright, & Horslen, 2005; Munson, Kurtz, & Windsor, 2005).
Results of the current study revealed that all students, regardless of ability, were able to utilize the support provided by the inclusion of the true morphemes to significantly improve their performance over that on the nonwords without morphemes. On the other hand, the most significant difference found in performance between ability groups was at the high school level (grades 9–12) on the list of nonwords with morphemes; these findings suggest that morphological deficits continue to significantly impact ability into adolescence.

In general, across the grade levels, a larger effect size was found between groups on the list without morphemes. However, when the results were plotted for students earning each score, within this small data set, more anomalies were noted for the list of nonwords without morphemes than for the words with morphemes. Examination of the results from the ROC analyses confirmed that, in this small study, both types of nonwords as well as the combined list perform in the “good” range for distinguishing between children with and without LLD. Effect size and ROC results for the two lists of nonwords combined suggested that it might be slightly better than either of the two lists used separately.

**Study Two Summary**

One of the advantages of the three-paper dissertation model is to be able to incorporate the findings of one study into the next. Since the results from the first study pointed to the value of using a combined list of nonwords to discriminate between children with TL and children with LLD, nonwords with and without morphemes were used for the repetition task in the second study. The relationships in nonword processing
skills by school-age children with language/learning disabilities (LLD) and typical language (TL) on three task-specific nonword measures (nonword repetition, spelling, and reading) and composite measures of phonemic awareness (PA) and vocabulary awareness (VA) were examined in the second study. As was predicted, significant differences were found in performance between the two groups by ability, with the TL group out performing the LLD group, at both grade levels on all five tasks. Effect sizes were calculated, and a very large effect size was found for all tasks at both the elementary and secondary levels.

Addressing questions about relationships between tasks, study two revealed that significant correlation coefficients were more numerous and, in general, stronger for bivariate task comparisons for students with LLD compared to students with TL. These results differed from previous studies that found stronger relationships between spelling and reading for students with typical skills than for students with reading disabilities (Greenberg, Ehri, & Perin, 1997; Guthrie, 1973). The discrepancy in results could be due, in part, to the difference in the stimulus items. The current tasks utilized comparable nonwords for both the spelling and reading tasks, whereas the previous studies had compared nonword tasks in reading to true word tasks in spelling (Greenberg et al., 1997) or had utilized two independently designed lists of words or nonwords for reading and spelling tasks (Guthrie, 1973). Additionally, the children in those studies were identified on the basis of reading deficits and were not identified as having a primary language-learning deficit.

Past research has linked vocabulary knowledge to nonword repetition ability and literate language skills (e.g., Bowey, 2001; Dollaghan, Biber, & Campbell, 1995; NICHD,
Results of study two indicated a significant association between vocabulary awareness and nonword repetition, nonword spelling, and nonword reading in the initial models; however, when both phonemic awareness and vocabulary awareness were considered together, vocabulary awareness did not account for a significant contribution to variance beyond that accounted for by phonemic awareness in the LLD group for the tasks of nonword repetition and nonword reading. For the LLD group in this study, the developmentally constrained skill of phonemic awareness appeared to be more highly associated than vocabulary awareness was with performance on nonword repetition and nonword reading.

**Study Three Summary**

The final study involved a fine-grained error analysis to describe the types of errors (phonemic, orthographic, and morphemic) that students with and without LLD demonstrate on nonword spelling and nonword reading tasks. Although it is well documented in the literature that children with TL out perform children with LLD and dyslexia in reading and spelling (e.g., Catts & Kamhi, 2005), it is less clear whether this difference is simply quantitative in nature or qualitative, as well, for children with disabilities (Carney & Martin, 2003; Cassar, Treiman, Moats, Pollo, & Kessler, 2005).

Study three found statistically significant differences within the spelling and reading profiles (pattern of phonic, orthographic, and morphemic errors) of children with TL as compared to LLD, the profiles for elementary as compared to secondary level students and the profile for secondary LLD as compared to primary TL. These results support and expand on those of Carney and Martin (2003) by suggesting the difference
between school age children with and without LLD is qualitative rather than simply quantitative. Although the LLD group has more difficulty in simple phonics, both groups have more difficulty with orthographic and morphemic knowledge.

**Discussion**

Detailed discussions related to the findings of each individual study were included within the discussion sections in Chapters II–IV of this dissertation. This discussion will center on the collective findings of the three studies.

Phonemic awareness, a crucial foundational skill for oral language, has been found to be closely associated with success in literate language tasks. The mapping of sounds and letters requires segmentation of the sounds within a word and association with their alphabetic counterparts. At the phoneme level, the students with LLD demonstrated less proficiency than their TL peers with phonemic awareness as demonstrated by the nonword task of repetition in the first study, and by the tasks of repetition, spelling, and reading, as well as phonemic awareness per se, in the second study. The relationships between the three tasks in the second study were, in general, stronger for children with LLD. The third study revealed that children with LLD, regardless of age, continued to exhibit more errors than the TL elementary students in simple phonics, which relies extensively on phonemic awareness.

Although it well established that students with LLD have deficits in morphological knowledge (Carlisle, 1987; Rice & Wexler, 1996), results of the first study support the view that students with a primary language-learning disability do utilize their underlying word structure knowledge to better their performance. Both groups of students
performed better on the list of nonwords with morphemes than on the list of nonwords without morphemes. However, error analysis of literate tasks in the final study, as well as data from the first study, showed morphemic knowledge in children with LLD to lag behind that of their TL peers into adolescence.

Relationships between the tasks of nonword spelling and nonword reading were more highly associated in children with LLD in the second study; however, comparison of errors across tasks in the third study found similar differences in errors between tasks in the elementary groups but more significant differences in the children with LLD than the children with TL at the secondary level. The LLD group at the secondary level exhibited significant differences in phonemic and morphemic correctness in favor of reading over spelling, whereas no significant differences in percent correct of the three error types was found across the tasks for their TL peers.

The children with and without LLD at the elementary and secondary level exhibited similar general trends in the profiles of spelling and reading errors. All students were most proficient with phonic knowledge; they showed more difficulty with orthographic and morphemic knowledge. Although significant differences in proficiency in favor of reading over spelling within the three areas (phonic, orthographic, and morphemic) for the TL elementary and both LLD groups were found in study three, examination of the findings from studies two and three support previous findings as to the intertwined nature of the two tasks.
Conclusions

This set of studies sought to add to the literature regarding word-structure knowledge displayed in speaking, spelling and reading tasks in children with TL and children with LLD across 1st–12th grade. Several conclusions can be drawn from the results.

- Results indicated that a relatively short measure (12 items) containing nonwords of low phonotactic probability without morphemes was equally effective as a same length measure of nonwords with true morphemes in distinguishing between children with and without LLD in a sample of school age children.

- The deficits in PA and morphology found in the children with LLD negatively impacted their performance on the oral task. Underlying PA deficits provide a faulty foundation on which to build phonic skills needed for literate tasks of spelling and reading.

- Although students with TL and LLD show similar patterns of significant correlation among nonword repetition, spelling, and reading with PA and VA in the elementary years, by middle school the patterns shift and the LLD group continues to demonstrate significant association of literate language skills (reading and spelling) with phoneme awareness tasks whereas the TL group does not. PA appears to be more highly associated with performance on nonword repetition and nonword reading than vocabulary awareness in children with LLD.
Using the simple scoring method in study two, children with LLD demonstrated a stronger relationship between spelling and reading than the TL group. However, the complex scoring system utilized in study three indicated significant difference in phonic and morphemic skills across nonword spelling and reading for children with LLD at the secondary level. This supports a conclusion of qualitative differences between groups.

The goal of this set of studies was to add to the current literature regarding word-structure knowledge across the tasks of speaking, spelling and reading in school age children with TL and children with LLD. The individual studies add to the inconsistent literature in the areas of impact of wordlikeness on children with LLD and whether errors exhibited by children with disabilities differ in nature or simply degree. Findings serve to expand literature by focusing on children with LLD and comparing performance by children in K–12th grade on closely related tasks of oral and literate language.

**Clinical Implications**

The significant cross task relationships found in both elementary and secondary level LLD groups support recommendations for interventions that utilize inter-modality processing to facilitate growth in reading, speaking, and spelling for students with LLD. Assessment of phonemic awareness may remain relevant for students with LLD into the secondary years, but decisions whether to target phonemic awareness directly need to be made in the context of other strengths and weaknesses. Results of these studies point to the importance of explicit instruction throughout grades K–12 for children with LLD in
the areas of phonics and morphemic structure as well as instruction for all students in orthographic structure to facilitate strong spelling and reading abilities.

**Recommendations for Further Research**

Although this set of studies addresses some of the inconsistencies and gaps in the literature, continued research into the relationship of foundational skills necessary for oral and literate language is needed. Future studies should compare and contrast the literate language skills of children with a primary language-learning disability to those with typical language, especially at the secondary level.

Findings from studies employing nonword stimulus items are valuable for investigating word-structure knowledge displayed in speaking, spelling and reading tasks. However, researchers need to carefully analyze their results in relationship to the structure of the specific nonword items to make results of studies easier to compare.

Further research is needed to analyze the strength of the relationship between oral and written tasks and characteristics of the errors that children with LLD make in repetition, spelling, and reading. In which specific areas are children with LLD at the secondary level still exhibiting difficulty with the constraint skill of simple phonics which leads them to be less accurate in speaking, spelling, and reading than younger TL students? Although the profiles for nonword spelling and nonword reading in older students with LLD and younger ones with TL may differ across phonic, orthographic and morphemic ability, further analysis of specific errors and a more complete inventory of possible patterns would be necessary to determine whether the errors within each of the three areas differ in type as well as in dimension. Such information may help to shape the
underlying theories and paint a detailed picture of common deficits, which has the potential for practical implications in the design of assessment tools, instructional methods, and clinical interventions for individuals at risk for language and literacy deficits.

References


Appendix A

Human Subjects Institutional Review Board
Letter of Approval
Date: April 2, 2009

To: Nickola Nelson, Principal Investigator
   Amy Curtis, Co-Principal Investigator
   Michele Anderson, Student Investigator for dissertation
   Barbara Johnson Howes, Student Investigator
   Patricia Tattersall, Student Investigator
   Joyce Irvine, Student Investigator
   Michelle Magalski, Student Investigator
   Shannon Lester, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 06-12-23

This letter will serve as confirmation that the change to your research project “TILLS-Beta Trial” requested in your memo dated 4/2/2009 (site specific consent document and information form for Krause Speech & Language Services) has been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: January 26, 2010