Research Note

A Preliminary Comparison of Reading Subtypes in a Clinical Sample of Children With Specific Language Impairment

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Purpose: The purpose of this preliminary study was to (a) compare the pattern of reading subtypes among a clinical sample of children with specific language impairment (SLI) and children with typical language and (b) evaluate phonological and nonphonological language deficits within each reading impairment subtype.

Method: Participants were 32 children with SLI and 39 children with typical language in Grades 2 through 4. Each child was classified as demonstrating 1 of 4 reading subtypes on the basis of word-level and text-level skills: typical reading, dyslexia, specific reading comprehension impairment, or garden variety reading impairment. In addition, phonological and nonphonological language skills were evaluated.

Results: Children with SLI were more likely to exhibit reading impairments than children with typical language. Children with SLI were more likely to exhibit text-level deficits than children with typical language. Phonological language deficits were observed in children with word-level deficits, and nonphonological language deficits were observed in children with text-level deficits.

Conclusions: The results indicate that the patterns of reading subtypes differ among children with SLI and children with typical language. The findings highlight the importance of simultaneously but separately considering word-level and text-level skills in studies of reading impairment.

Word-level skills and text-level skills differentially contribute to reading outcomes, resulting in four possible reading subtypes (Gough & Tunmer, 1986). Children with typical reading exhibit adequate word- and text-level skills, whereas children with garden variety reading impairment exhibit inadequate word- and text-level skills. It is also possible for word- and text-level skills to be dissociated such that children with dyslexia exhibit inadequate word-level skills but adequate text-level skills, and children with specific reading comprehension impairment exhibit adequate word-level skills but inadequate text-level skills. On average, children with specific language impairment (SLI) struggle with word-level skills (Catts, Adlof, Hogan, & Ellis Weismer, 2005) and text-level skills (Nation, Clarke, Marshall, & Durand, 2004).

Researchers have not, however, sufficiently investigated the specific pattern of reading impairments in children with SLI. Little research has examined word-level and text-level

reading subtypes in the same sample. The novel contribution of the current investigation is that we examined reading subtypes that include both word- and text-level deficits in a single sample of children with SLI. In addition, we replicate previous findings of the linguistic basis of these reading deficits. Systematic replication is crucial for the advancement of social science; replicating prior studies enables a pattern of results to emerge from which scientists can infer real effects (Thompson, 1994). Thus, the twofold purpose of this preliminary study was to (a) compare the pattern of reading subtypes among a clinical sample of children with SLI to children with typical language (TL) and (b) evaluate phonological and nonphonological language deficits within each reading impairment subtype.

Language Basis of Reading Impairments

Research has confirmed the language basis of reading (Catts, Fey, Tomblin, & Zhang, 2002; Mattingly, 1972; Vellutino, Fletcher, Snowling, & Scanlon, 2004). The specific theoretical model that drives our research further postulates that difficulties in particular domains of language lead to differential difficulties with reading (e.g., Bishop & Snowling, 2004; see Figure 1). Phonological aspects of language, such as phonological awareness, underlie the development of

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Figure 1. Expected reading outcomes according to language deficits.

decoding and word recognition (e.g., Adams, 1990; Stahl & Murray, 1994; Wagner & Torgesen, 1987). Thus, children who have difficulties in only phonological processing should display difficulties in only decoding skills (i.e., dyslexia). Nonphonological aspects of language, such as vocabulary knowledge, underlie reading comprehension (e.g., Cutting & Scarborough, 2006; Senechal, Ouellette, & Rodney, 2006). Thus, children who have difficulties only in nonphonological language should display difficulties in only reading comprehension skills (i.e., specific reading comprehension impairment). Finally, this model predicts that children who have difficulties in phonological and nonphonological aspects of language should display difficulties in decoding and reading comprehension (i.e., garden variety reading impairment).

Reading Impairments in Children With SLI

Two limitations of the extant literature obscure the specific nature of reading impairments in children with SLI. First, researchers often define reading impairment using composite scores of word-level and text-level skills (e.g., Bishop & Adams, 1990). This approach masks the separate contributions of word-level and text-level skills to reading difficulties. Second, even when word-level and text-level skills are investigated separately, results typically are reported as group means. This approach obscures individual differences in reading subtypes within the population. Addressing these limitations represents a vital step toward designing effective reading interventions for this population.

Word-Level Skills in Children With SLI

Recently, researchers have argued that dyslexia and SLI are distinct disorders (e.g., Bishop & Snowling, 2004; Catts et al., 2005). Catts et al. (2005) presented a compelling argument: Children with SLI with phonological processing deficits were likely to meet the diagnostic criterion for dyslexia on the basis of their word recognition skills; children with SLI with average phonological processing skills were

not. This finding is consistent with the current conceptualization of dyslexia as a disorder characterized by word-level deficits typically resulting from a phonological processing deficit (National Institute of Child Health and Human Development, 2014). Estimates of the rate of dyslexia in children with SLI range from approximately 25% to 80% (Catts, 1993; Catts et al., 2005; Flax et al., 2003; McArthur, Hogben, Edwards, Heath, & Mengler, 2000; Snowling, Bishop, & Stothard, 2000). This wide range may result from researchers examining word-level skills without measuring reading comprehension skills (e.g., Catts et al., 2005), thus classifying children with garden variety reading impairment as children with dyslexia.

Text-Level Skills in Children With SLI

Text-level skills have been much less widely studied than word-level skills. However, Nation et al. (2004) concluded that specific reading comprehension impairment and SLI, similar to dyslexia and SLI, are distinct but often comorbid conditions. Not all children with specific reading comprehension impairment meet diagnostic criteria for SLI; likewise, not all children with SLI exhibit specific reading comprehension impairment. Children with specific reading comprehension impairment tend to exhibit at least subclinical deficits in nonphonological domains of language, such as vocabulary, morphosyntax, figurative language, and grammatical understanding (Adlof & Catts, 2015; Catts, Adlof, & Ellis Weismer, 2006; Nation, Cocksey, Taylor, & Bishop, 2010; Nation et al., 2004). Their performance on phonological measures, however, is unimpaired (e.g., Adlof & Catts, 2015).

Garden Variety Reading Impairment

We use the term *garden variety reading impairment* to describe children with difficulties with both word-level and text-level skills. Theoretically, children with garden variety reading impairment should exhibit difficulties in phonological and nonphonological domains of language (Stanovich, 1988). This pattern of difficulties contrasts with that of children with dyslexia, who should exhibit only phonological language deficits, as well as that of children with specific reading comprehension impairment, who should exhibit only nonphonological language deficits. This theoretical framework has not been specifically investigated in children with SLI, who are up to six times more likely than children with TL to have garden variety reading impairment (Snowling et al., 2000; Tomblin, Zhang, Buckwalter, & Catts, 2000).

In summary, previous research suggests that reading impairments among children with SLI are theoretically expected on the basis of the language basis of reading difficulties, and indeed, reading impairments are common in children with SLI. Even the most conservative estimates of the rate of reading impairment in children with SLI would suggest that approximately half of the children with SLI demonstrate some type of reading impairment. Because effective interventions address specific areas of weakness, there is a vital need to clarify the pattern of reading impairment

subtypes in children with SLI. Toward that end, we addressed two research questions:

1. Does the pattern of reading subtypes among children with SLI differ from children with TL?
2. Do phonological and nonphonological language skills differ among children with different reading subtypes?

Method

Participants

Participants were 71 children in Grades 2 through 4 recruited from public and private schools in Tennessee. All participants had nonverbal intelligence standard scores of 80 or greater on the Test of Nonverbal Intelligence–Fourth Edition (Brown, Sherbenou, & Johnsen, 2010), were monolingual English speakers, and had no reported motor, cognitive, or uncorrected visual impairments. Average maternal education was 15 years for each group (reported for 27 children with SLI and 36 children with TL).

Participants were recruited in two ways: (a) targeted recruitment of children served under categories of speech/language impairment or reading impairment and (b) recruitment of children in general education classrooms of children identified in the previous process. Recruited participants were divided into two groups according to performance on the Core Language Index of the Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003). SLI was operationalized as a standard score below 85 on the Core Language Index of the CELF-4. The SLI group included 32 children whose scores ranged from 40 to 84 ($M = 71.53$; $SD = 9.83$). Children in the SLI group had a mean age of 9;4 (years;months; $SD = 12$ months). The group contained eight second graders, 14 third graders, and 10 fourth graders. TL was operationalized as a standard score greater than 85 on the Core Language Index of the CELF-4. The TL group included 39 children whose scores ranged from 88 to 124 ($M = 106.64$; $SD = 10.24$). Children in the TL group had a mean age of 8;9 ($SD = 12$ months). The TL group contained 15 second graders, 17 third graders, and seven fourth graders. Distribution of grade levels did not differ significantly between groups ($p > .05$).

Procedures

As part of a larger study on the relation of linguistic skills and spelling (Werfel, 2012), participants completed measures of speech, language, reading, and writing. All measures were administered by the first author, who is a speech-language pathologist, or by trained research assistants who were speech-language pathology graduate students. Assessment took place in a quiet room at participating schools. First, the CELF-4 and Test of Nonverbal Intelligence–Fourth Edition were administered to ensure study eligibility. The remaining language and literacy measures were administered in random order for each participant. The mean

number of testing sessions per participant was 3.35, and total testing time was approximately 4 hr. Children's performance on measures of reading (described below) was of interest for the present study.

Measures

Word-Level Reading Measure

Word-level impairment was operationalized as a standard score less than 85 on either subtest of the Test of Word Reading Efficiency–Second Edition (Torgesen, Wagner, & Rashotte, 2012). The Sight Word Efficiency subtest measures how many real words children can read accurately in 45 s. The Phonemic Decoding Efficiency subtest measures how many nonwords children can read accurately in 45 s. Test–retest reliability is .89 to .93.

Text-Level Reading Measure

Text-level impairment was operationalized as a standard score less than 85 on the Passage Comprehension subtest of the Woodcock Reading Mastery Test–Third Edition (Woodcock, 2011). The Passage Comprehension subtest requires children to read passages of increasing length and complexity and verbally fill in a missing word. Test–retest reliability is .86 to .88.

Phonological Language Measure

Phonological language skills were measured using the Phonological Awareness Composite of the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999), which includes two subtests: Elision and Blending Words. On the Elision subtest, children hear a spoken word and then delete a sound segment (e.g., say *powder* without saying /d/ [power]). On the Blending Words subtest, children hear a series of sound segments and then determine the word formed by combining the sounds in order (e.g., what word do these sounds make? /b/ /o/ /n/ [bone]). Test–retest reliability is .70 to .92.

Nonphonological Language Measure

Nonphonological language skills were measured using the Peabody Picture Vocabulary Test–Fourth Edition (PPVT-4; Dunn & Dunn, 2007). The PPVT-4 is a measure of receptive vocabulary. Children hear a target word and are asked to select from a field of four the picture that matches the word. Test–retest reliability is .93.

Classification of Reading Impairment Subtypes

We identified each child's reading subtype according to his or her word-level and text-level performance. Children in either language status group (SLI or TL) could be classified in any of the four reading subtypes. Figure 2 illustrates the classification scheme. We used a cut score of one standard deviation below the mean because it is similar to cut scores used in other studies of reading impairment (e.g., Catts et al., 2005; Tomblin et al., 2000).

Figure 2. Classification of reading subtypes according to word-level and text-level skills. TOWRE-2 = Test of Word Reading Efficiency–Second Edition; WRMT-III = Woodcock Reading Mastery Test–Third Edition.

Reliability

Testing sessions were audio recorded to allow for calculation of reliability of written recording of child responses on tests that required a verbal response. A research assistant listened to the audio-recorded responses for a reliability sample of 30% of participants in each group and wrote child responses on a clean test form. Point-by-point reliability was calculated on each measure for each participant in the reliability sample. Average reliability across all tests was 96.0% for children with TL and 93.9% for children with SLI.

Results

As a group, children with SLI scored significantly lower than children with TL on all measures of reading (see Table 1). Cohen's *d* effect sizes indicate large group differences.

Table 1. Performance on reading measures by group.

Measure	SLI, <i>M</i> (<i>SD</i>)	TL, <i>M</i> (<i>SD</i>)	<i>t</i>	<i>p</i>	<i>d</i>
TOWRE-2 SWE	81.19 (15.05)	99.97 (16.59)	5.07	<.001	1.19
TOWRE-2 PDE	77.50 (14.68)	93.66 (16.18)	4.47	<.001	1.05
WRMT-III PC	80.88 (10.87)	106.08 (15.85)	7.92	<.001	1.85

Note. SLI = specific language impairment; TL = typical language; TOWRE-2 SWE = Test of Word Reading Efficiency–Second Edition, Sight Word Efficiency subtest (Torgesen et al., 2012); TOWRE-2 PDE = Test of Word Reading Efficiency–Second Edition, Phonemic Decoding Efficiency subtest; WRMT-III PC = Woodcock Reading Mastery Test–Third Edition, Passage Comprehension subtest (Woodcock, 2011).

Pattern of Reading Subtypes Across Language Groups

Figure 3 illustrates the pattern of reading impairment subtypes in each group. The majority of children with TL demonstrated typical reading skills. Dyslexia was the most common type of reading impairment observed in the TL group, affecting 26% of children with TL. Comprehension deficits in children with TL were rare; only 3% of children with TL demonstrated specific reading comprehension impairment, and only 5% demonstrated garden variety reading impairment.

The pattern of reading impairment subtypes in children with SLI differed from that of children with TL. Only 16% of children with SLI demonstrated typical reading skills. Of the children with SLI who demonstrated typical reading skills, the average decoding standard score was 94, and the average reading comprehension standard score was 97, both in the low average range. Garden variety reading impairment was the most common type of reading impairment observed in the SLI group, affecting 50% of children with SLI. Specific reading comprehension impairment affected 9% of children with SLI. Similar to children with TL, 25% of children with SLI demonstrated dyslexia.

Logistic regression was used to determine the relative odds of typical reading, dyslexia, and garden variety reading impairment in each group. No statistical analysis was performed for specific reading comprehension impairment because we found only one instance of specific reading comprehension impairment in the TL group. Table 2 displays logistic regression results. The odds ratio for typical reading approached 0, indicating that children with SLI were far less likely than children with TL to demonstrate typical reading skills. Participants in each group had roughly equivalent odds of having dyslexia. Children with SLI, however, had approximately 18 times greater odds than children with TL of having garden variety reading impairment.

Phonological and Nonphonological Language Performance Across Reading Subtypes

Finally, we used a one-way analysis of variance to compare phonological (phonological awareness) and nonphonological (vocabulary) language skills across the four reading subtypes. There were main effects of group for both phonological, $F(3, 67) = 15.06, p < .001$, and nonphonological, $F(3, 67) = 6.92, p < .001$, language skills. Follow-up Tukey tests indicated that phonological skills were lower in the dyslexia and garden variety reading impairment groups than in the typical reading group ($p < .01$ and $.001$, respectively; $d = 1.18$ and 1.83 , respectively); there was no difference in phonological language skills between typical reading and specific reading comprehension impairment. In addition, follow-up Tukey tests indicated that nonphonological skills were lower in the specific reading comprehension impairment and garden variety reading impairment groups than in the typical reading group ($p < .05$ and $.01$, respectively; $d = 1.61$ and 1.37); there was no difference in nonphonological language skills between the typical reading and dyslexia groups.

Figure 3. Patterns of reading subtypes by group.

Discussion

The purpose of this study was twofold. First, we aimed to compare the pattern of reading subtypes within children with SLI and children with TL. The novel contribution of this study was that we compared the pattern of word-level and text-level reading subtypes in a single sample of children. Our findings indicated that the two groups of children exhibit different patterns of reading performance and that children with SLI are much more likely than children with TL to exhibit reading difficulties. Second, we aimed to evaluate the theoretical model that phonological language deficits should lead to decoding difficulties and that nonphonological language deficits should lead to comprehension difficulties. Our findings supported the proposed theoretical model; further, our findings replicated and consolidated previous research (e.g., Catts et al., 2005; Nation et al., 2004).

The first purpose of the study was to compare the pattern of reading subtypes in children with SLI and children with TL. The majority of children with SLI met criteria for reading impairment, whereas the majority of children with TL demonstrated typical reading skills. In addition, children with SLI demonstrated a different pattern of reading impairment subtypes than children with TL. For

children with TL, dyslexia was the most common reading impairment subtype, and reading comprehension deficits with or without concomitant decoding deficits were rare. Children with SLI, however, were likely to demonstrate reading comprehension deficits, with or without concomitant decoding deficits. These reading comprehension deficits contributed to the much higher rate of reading impairment in children with SLI than in children with TL.

The second purpose of this study was to evaluate a theoretical model that specifies the relation of difficulties in phonological and nonphonological domains of language with difficulties in word-level and text-level reading skills. On the basis of previous research with dyslexia and specific reading comprehension impairment, we theorized that children with difficulties in phonological aspects of language would exhibit difficulties in word-level decoding skills and that children who exhibit difficulties in nonphonological aspects of language would exhibit difficulties in text-level reading comprehension skills. We further postulated that children with difficulties in phonological and nonphonological domains of language would exhibit difficulties in decoding and comprehension skills. Our data support this theoretical model. Children with dyslexia had lower phonological awareness skills than typical readers; however, vocabulary skills did not differ between children with dyslexia and typical readers. Likewise, children with specific reading comprehension impairment had lower vocabulary skills than typical readers, but phonological awareness skills did not differ between children with specific reading comprehension impairment and typical readers. Finally, children with garden variety reading impairment exhibited lower phonological awareness and vocabulary skills than typical readers.

Implications

These findings have important implications for researchers and practitioners. For researchers, our findings highlight the importance of simultaneously but separately considering word-level and text-level skills in studies of reading impairment. Measuring only the reading skill of interest in a particular study (e.g., decoding) may contribute to the disparate estimates of reading subtypes seen in the literature. For practitioners, first our findings highlight the importance of screening for language impairments in young children and supporting reading acquisition in children with SLI. At school entry, SLI is largely unidentified (Tomblin et al., 1997). Because children with SLI are incredibly likely to exhibit a reading impairment related to phonological and/or nonphonological language skills, early identification and treatment of language difficulties is vital to preventing reading impairments in children with SLI. Thus, professionals should (a) conduct language screenings at school entry and (b) closely monitor and scaffold the acquisition of literacy and preliteracy skills in children identified with SLI. Second, our findings highlight the importance of measuring nonphonological language skills of children with reading comprehension deficits. Children with SLI were likely to exhibit reading comprehension deficits, either in

Table 2. Logistic regression for reading outcomes ($\alpha = .16$).

Outcome	β	p	Odds ratio
Typical reading	-2.38	<.001	0.09
Dyslexia	-0.03	.95	0.97
Garden variety reading impairment	2.92	<.001	18.50

Note. Group was coded as specific language impairment = 1, typical language = 0.

isolation or in combination with decoding deficits. Conversely, children with TL were unlikely to exhibit reading comprehension deficits; fewer than 10% of children with TL had below-average reading comprehension scores. Therefore, we propose that language assessment should become a component of standard testing protocols for children with reading comprehension deficits; these children likely experience oral language deficits as well.

Limitations and Future Directions

This study characterizes the pattern of reading impairments in a preliminary clinical sample of children with SLI who received speech-language and/or reading services in their schools. Given that SLI is largely unrecognized in the school-age population (Tomblin et al., 1997), the pattern of reading impairments in a population-based sample of children with SLI may be slightly different than reported here. Future studies should aim to refine understanding of the pattern of reading subtypes in children with SLI recruited via population-based sampling. Additionally, future work should include sample sizes large enough to include in-depth considerations of the complex relations of phonological and nonphonological language abilities to reading subtypes. Population-based research with a large sample size is a vital next step in addressing the research questions posed herein.

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