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Language and Speech Predictors of Reading Achievement in Preschool Children with Language Disorders

Juliet K. Haarbauer-Krupa

ACCEPTANCE

This dissertation, LANGUAGE AND SPEECH PREDICTORS OF READING ACHIEVEMENT IN PRESCHOOL CHLDREN WITH LANGUAGE DISORDERS, by JULIET HAARBAUER-KRUPA, by JULIET HAARBAUER-KRUPA, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

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ABSTRACT

LANGUAGE AND SPEECH PREDICTORS OF READING ACHIEVEMENT IN PRESCHOOL CHILDREN WITH LANGUAGE DISORDERS
by
Juliet K. Haarbauer-Krupa

The purpose of this longitudinal study was to examine the relationship between language and reading in children diagnosed with developmental language disorder (DLD) during preschool. An archival data set was available for analysis. Preschool children with DLD who were assessed between 35 and 74 months for preschool language and speech abilities (Rapin, 1996) returned for language, speech and reading testing at age seven years. Children who enrolled in the study were a clinically referred sample, met criteria for average nonverbal intellectual functioning, and demonstrated below average performance on a composite language measure. To evaluate a hypothesis about the contribution of vocabulary, grammar, and speech articulation to reading outcome measures, a series of regression analyses tested models to identify predictors of reading achievement at age seven. Results indicated a strong, positive relationship between language skills assessed at both ages and reading comprehension. School-age language and speech skills explained 25% of the variance in reading comprehension after controlling for word identification skills. Grammar at school age was a significant unique predictor of reading comprehension. Preschool language and speech skills explained 22% of the variance after controlling for word identification skills. Speech articulation was not related to reading outcomes. In contrast, regression analyses suggested that language and

speech skills did not predict word reading abilities. Children who had reading comprehension difficulties had weaker vocabulary, grammar and speech skills compared to children who had average and above comprehension skills. Findings support previous research describing a relationship between language skills and reading comprehension. Language skills measured at preschool can predict reading comprehension difficulties in elementary school for children with DLD. Results highlight the importance of early identification and intervention of language impairment in children to improve areas of vocabulary and grammar critical to reading success.

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Juliet Haarbauer-Krupa

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ABBREVIATIONS

CELF	Clinical Evaluation of Language Function Test
DLD	Developmental Language Disorder
EWOPVT	Expressive One Word Picture Vocabulary Test
IQ	Intellectual Quotient
ITPA	Illinois Test of Psycholinguistic Abilities
LRM	Lexical Restructuring Model
MLU	Mean length of utterance
PA	Phonological Awareness
PAT	Photo Articulation Test
PVVT	Peabody Picture Vocabulary Test
RAN	Rapid Autonomatized Naming
SD	Standard deviation
SDRT	Stanford Diagnostic Reading Test
SES	Socioeconomic status
SLI	Specific Language Impairment
TELD	Test of Early Language Development
WID	Word Identification
WAT	Word Attack

CHAPTER 1: THE PROBLEM

Statement of the Problem

Reading is one process critical for long-term academic success. Skillful reading is unitary, comprised of a complex system of skills and knowledge (Adams, 1990). Efficient readers are able to derive meaning from printed text accurately and efficiently by coordinating foundation skills, shaped through instruction and experience over many years, in phonology, or the sound system of language; semantic and grammatical aspects of language; and orthography, or the visual symbols of language (Scarborough, 2001). Reading achievement is measured by how well children can read words and comprehend connected text.

In typically developing children, there is a strong relationship between learning to read and early language skills (National Institute of Child Health and Human Development, 2005; Share & Stanovich, 1995). Research suggests that oral language skills contribute to reading achievement and in fact can predict reading outcomes (Catts, 1993 Catts, Hogan & Fey, 2003; Cooper, Roth, Speece, & Schatschneider, 2002; Olofsson & Niedersoe, 1999; Scarborough, 2005). Oral language skills in the areas of vocabulary (understanding the meanings of individual words) and grammar (knowledge of language structure and morpho-syntax) in particular are subsystems of language that have been linked to reading. Not only do these language skills show a relationship to reading but they also have predictive value. Even in kindergarten, vocabulary and grammatical measures account for significant variance in reading achievement outcomes

in later elementary school (Catts, Fey, Tomblin, & Zhang, 1999; Scarborough, 1990, 2005; Share & Leikin, 2004; Storch & Whitehurst, 2002; Swank, 1997; Torgensen, Wagner, Rashotte, Burgess, & Hecht, 1997).

Just as oral language as a whole forms the foundation of reading, weakness or disorders in developing language skills place children at risk for difficulties with reading. Numerous studies show that, as a group, children with language disorders acquire vocabulary more slowly, experience more difficulty with morpho-syntactic markers and are not as proficient as their typically developing peers at reading (Watkins, 1997). For this paper, the term *developmental language disorder* (DLD) will describe the population of children with both grammar and vocabulary deficiencies. In addition to a language disorder, a comorbid speech disorder adds to the risk of reading difficulties (Beitchman, Wilson, Brownlie, Waters, and Lancee, 1996). However, not all children with language disorders have difficulty with reading in elementary school. Only about half the children diagnosed with a developmental language disability during preschool proceed through elementary school with reading difficulties (Aram, Ekelman, & Nation, 1984; Catts, Hogan, & Fey, 2003). The question is whether skills in vocabulary and grammar, measured in children with language disorders during preschool, predict who is at risk for problems with reading in elementary school? Theories and empirical research describing the relationship between markers of language disorders and reading provides an avenue for this investigation.

The majority of studies have investigated the language-reading relationship beginning in kindergarten, a time when language performance is more stable than preschool years (Catts, 1993; Catts, Fey, Tomblin, & Zhang, 1999, 2002; Share & Leikin,

2004). Results from these studies reveal a relationship between language and reading, particularly for reading comprehension.

Very few longitudinal studies have examined the language-reading relationship in the DLD population beginning in preschool. A single study series (Bishop & Edmundson, 1987; Bishop & Adams, 1990) examined language and reading in a cohort of preschool children diagnosed as DLD at age 4. Nonverbal intelligence and language variables were entered in a model to predict reading outcomes. Findings revealed a relationship between language at preschool and reading comprehension at age 8. Children whose language disorder persisted after age 5 had difficulties with reading comprehension. Mean length of utterance at preschool predicted reading accuracy but semantic measures (vocabulary and grammar) predicted reading comprehension (Bishop & Adams, 1990). Scarborough and Dobrich (1990) followed four children described as "language delayed" during preschool and then tested their reading ability in second grade. By age 5, all four children exhibited few if any remaining language problems in vocabulary or grammar. When the children were retested in second grade, only one of the four tested at average or above for reading. The remaining three exhibited poor vocabulary skills and below average reading performance.

Scarborough, in a meta-analysis of prediction data from 61 research samples examining kindergarten predictor variables of reading achievement (Scarborough, 1998), found consistently that even after controlling for print variables and differences in phonological awareness, lexical and grammar measures accounted for significant additional variance in reading outcomes (Scarborough, 1998, 2005). The notion of a relationship between vocabulary and grammar on one hand and reading on the other

supports findings from previous studies (Catts et al., 1999; Share & Leikin, 2004; Storch & Whitehurst, 2002) but Scarborough extends this idea by proposing that preschool language skills can predict reading achievement. Further, Scarborough examined preschool language skills as predictors of reading achievement for children who experienced reading difficulties at the end of second grade (Scarborough, 1990, 1991a, 1991b, 2005). The domains of language that predicted reading achievement from preschool differ depending on the age of the children. Between ages 2 and 3, syntactic and speech production abilities predicted reading achievement; between ages 3 and 4, grammar and vocabulary skills predicted reading achievement. At age 5, vocabulary and phonological awareness predicted reading achievement (Scarborough, 1998, 2005).

Subsequent investigations examined the reading performance in the Bishop and Adams (1990) preschool cohort at ages 8 and 15 (Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Outcomes in reading were associated with language performance at age 5 such that children whose language impairment persisted at this time had worse prognosis for reading outcomes. Children whose language disorder persisted had significant difficulties with word recognition and reading comprehension. Children whose language impairment seemed to resolve were similar in their language performance to controls but demonstrated both word reading and reading comprehension problems. Those with the poorest reading outcomes fell further behind their peers in vocabulary skills.

Studies examining language performance beginning at kindergarten also identify the risk for reading difficulties in children with DLD. Language scores show significant but modest correlations with word identification and reading comprehension in a study

examining the language-reading relationship between kindergarten and second grade (Catts, 1993). In this study, language was most closely related to reading comprehension and modest significant correlations were reported with word identification. In another study, which examined reading performance at the end of first grade in children identified as DLD in kindergarten, both word reading in context and reading comprehension were associated with significant differences on all language tasks (Share & Leikin, 2004). Evidence supports a relationship between language and reading in children with DLD and indicates that when these children are diagnosed early, one can predict reading difficulties. What is not known is whether the characteristics of their language disorder (vocabulary and/or grammar) make unique contributions to reading outcomes as measured by Scarborough's meta-analaysis, namely word reading and reading comprehension. Does one aspect of language predict how a child will perform at word reading or reading comprehension? Is it possible to predict reading outcomes from language skills measured in preschool? Understanding the contribution of vocabulary and grammar to word reading and reading comprehension in children diagnosed with language disorders will enhance knowledge of how such characteristics contribute to the risk for reading difficulties.

Although only 5-10% of children who read satisfactorily in the primary grades experience later reading difficulties, 65-75% of those who are identified early in the acquisition process as reading disabled continue to experience difficulties throughout their school career (Scarborough, 2001). Further, children who experience difficulty with reading are at risk for leaving school prior to completion of requirements for graduation. A 10-15% school drop out rate for children who experience reading problems was

reported (Whitehurst & Lonigan, 2001). Children diagnosed with language disorders are at risk for reading difficulties. There is a critical need to identify those most likely to have early reading failure, and to determine whether performance on core characteristics of the disorder at an early age offers predictions for reading performance. It is important to intervene with children who are at risk for reading difficulties as early as possible.

CHAPTER 2: REVIEW OF THE LITERATURE

Literature Review Relative to the Problem

Developmental Language Disorders

The definition of a language disorder during the preschool years has been a subject of considerable inquiry. Some investigators suggest the term *specific language impairment* as descriptive of the disorder. SLI in this context refers specifically to a disorder in the language domain, particularly in the area of morpho-syntax, and excludes children who have mental retardation, middle ear effusion, learning disability, autistic behaviors, or identified neurological deficits or structural malformations (Hall & Aram, 1996; Gray, Plante, Vance, & Hendrickson, 1999). Others use the term developmental language disorder to describe the developmental rather than acquired nature of the symptoms (Hall & Aram, 1996; Rapin, Allen, & Dunn, 1992). This term uses the same exclusion criteria as SLI but is descriptive of a broader perspective of the disorder rather than focusing solely on the grammatical components (Hall & Aram, 1996; Rapin, 1996). Children with DLD show a delay in achieving age expected language milestones, as well as deviance in vocabulary, grammar or both (Rapin et al., 1992, p. 111). Still some researchers use the two terms interchangeably to indicate a language disorder that starts in early childhood (Leonard, 1982, 1989; Johnson et al., 1999; Tallal, 1988). For this paper, the term DLD will refer to the population of children with language disorders.

Regardless of the term used, there is consensus that young children with DLD demonstrate delays in language development (Camarate & Schwartz, 1985; Leonard,

Camarate, Rowen, & Chapman, 1982; Schwartz & Leonard, 1985) and in particular have difficulties with lexical acquisition and grammar skills (Leonard, 1989; Rice, Buhr, & Nemeth, 1990; Watkins, 1997). Children with DLD are a diverse group (Watkins, 1997), varying in the severity of the impairment, defined as the number and type of language domains involved, and including impairments in receptive language, expressive language or both.

Research and clinical criteria for DLD differ. Research criteria are more stringent than clinical criteria, so typically the number of children who meet the criteria for DLD in research studies is smaller than those who meet clinical criteria (Kamhi, 1998). Aram, Morris and Hall (1993) explored the congruence between clinical and research identification of DLD in children who were given a clinical diagnosis of a language disorder. Language and speech measures used in this study included the Goldman-Fristoe Test of Auditory Discrimination, Curtiss-Yamada Comprehensive Language Evaluation (Receptive Scale), Expressive One Word Picture Vocabulary Test, Illinois Test Of Psycholinguistic Abilities (Auditory Association and Grammatical Closure), McCarthy Scales of Children's Abilities (Verbal Fluency and Verbal Memory II), Peabody Picture Vocabulary Test (Revised), Photo Articulation Test, Token Test for Children (Part V) and Vineland Adaptive Behavior Scales (Communication Domain). Based on the examination of standardized operational criteria such as the discrepancy between nonverbal IQ and language, language performance cut off scores, and comparison of alternative language measures, the congruence between clinically defined DLD and psychometrically defined DLD ranged from 20 -71% depending upon discrepancy criteria utilized (Aram, Ekelman, & Nation, 1984). No unitary measure provided

complete agreement, a finding supported by subsequent examinations and reviews of the literature (Miller, 1996; Watkins, 1997). Further, many language tests do not have data on predictive validity that accounts for developmental changes, making it difficult to distinguish between children with developmental language impairment and those with typically developing but delayed attainment of skills (McCauley & Swisher, 1984; Plante & Vance, 1994; Bedore & Leonard, 1998).

Characteristics of Children with Developmental Language Disorders

Subsystems of language considered as clinical markers for DLD are primarily in the areas of lexical acquisition and morphology. Much of the research about these characteristics has formed the foundation for current accounts and theories about DLD. According to studies that compare them to age and language equivalent counterparts, children with DLD show differences in grammar and vocabulary development (Watkins, 1997). Differences in lexical skills and grammar contribute to difficulties in listening comprehension of longer units of language such as stories. Specific aspects of grammar, vocabulary and language comprehension are explained in the following sections.

Grammatical characteristics. Morphological impairments are a primary component in the language disorder profile (Bedore & Leonard, 1998; Conti-Ramsden, 2003; Leonard, 1989; Leonard, Eyer, Bedore, & Grela, 1997; Rice, Wexler, & Cleve, 1995; Watkins, 1997). For example, Rice et al. (1995) proposed that problems with finiteness marking for main verb clauses (e.g., past tense (-ed), regular third person, be and do) persist in children with DLD for an extended period of time. In a comparison study between children with DLD and age-matched controls using a grammatical analysis to identify DLD, Bedore and Leonard (1998) examined three different measures: a verb

morpheme composite using a cloze sentence task, a noun morpheme composite using a cloze sentence task, and mean length of utterance (morphemes) based on a spontaneous language sample. Results from their discriminative analysis showed that verb morphology in particular was accurate with the classification of DLD (sensitivity exceeding 85% and specificity 100%). These findings were supported in a study examining both processing (non-word repetition and digit recall) and linguistic markers (noun plurals and past tense) simultaneously (Conti-Ramsden, 2003). In this examination, the linguistic markers of past tense (sensitivity 71%, specificity 91%) and plurals (sensitivity 16%; specificity 100%) were the best predictors of DLD in young children. In children with language disorders, morpho-syntactic characteristics of the disorder are observed regardless of the type of measurement task.

In typical development, the ability to comprehend and produce increasingly complex sentences increases with age as children expand their range and use of grammatical operations. They use longer sentences with more elaborate phrase structure and increased use of clauses (Scott, 2004). Children with DLD are not able to keep up with their age peers in understanding and producing more complex sentences. They demonstrate verb errors and omissions (Grela & Leonard, 2000) and experience difficulty in acquiring more complex forms of language such as clauses that do not conform to subject-verb-object word order (Scott, 2004).

Children with a diagnosed language disorder often have a reduced mean length of utterance (MLU) when compared to their typically developing peers (Dunn, Flax, Sliwinski, & Aram, 1996; Watkins, 1997). While there are controversies about the validity and reliability of MLU to measure grammatical complexity, it is one of the few

measures available to describe grammar and morphology in conversational contexts. When examining spontaneous language performance, Dunn et al. (1996) found that the combination of MLU and percent of structural grammatical errors (the percentage of children's utterances that contained one or more structural errors in morphology or syntax) differentiated children with language disorders from typical controls. Spontaneous language variables measuring syntax and morphological competence relative to age expectations were reliable (96.5%) for clinical diagnosis of language impairment in the study.

Vocabulary and word retrieval. Researchers report that the late onset of lexical acquisition and slower lexical development, particularly during the preschool years, are signs that differentiate children with DLD from typically developing children (Bishop, 1992; Watkins, Kelly, Harbers, & Hollis, 1995; McGregor, Friedman, Reilly, & Newman, 2002). Although some children with delayed expressive vocabulary are at risk for impairment, many are simply delayed but still within the typical range of expressive vocabulary development by 5-6 years of age (Paul, 1996; Rescorla & Schwartz, 1990; Whitehurst, Fischel, Arnold, & Lonigan, 1992). Compared to children with developmental delays, children with DLD persist with slower acquisition of vocabulary.

One contribution to slower lexical development for children with DLD is a difference in fast mapping, or establishing a rapid representation for a new word. Typical children learn a new word after one to two repetitions (Carey, 1978), whereas children with DLD require multiple repetitions to learn a new word (Gray, 2004). As a result, DLD children learn fewer words than their normally developing counterparts (Gray,

2004; McGregor, Newman, Reilly & Capone, 2002; Rice et al., 1990; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, Bode, & Pae, 1994).

Once words are acquired, children with DLD have difficulty with slow mapping, the process of increasing knowledge and meaning of a word for long-term learning (Carey, 1978; McGregor, 2004). Typically developing children begin to build semantic networks, or extended meanings of a word, by understanding a hierarchy of taxonomic relations (superordinate and subordinate categories) as early as age 2 (Clark, 1995; McGregor, 2004). As they acquire more experience with words, expansion and elaboration of meanings increase. Children with DLD have difficulties with two aspects of slow mapping: building semantic networks and acquiring expanded knowledge about a word. One reason for this difficulty may be weak auditory perception skills (Wright et al., 1997). Children with DLD take more time to process information they hear. Another contribution to their difficulty is deficiencies in working memory (Gathercole & Baddeley, 1990). Children with DLD are able to hold less information in verbal working memory than typically developing children.

A difficulty with word retrieval also characterizes children with DLD, demonstrated by an increased frequency of naming errors for known words during object naming, action naming and story retelling compared to typical children (McGregor, 1997). A primary theory of retrieval breakdown for children with DLD is weak semantic activation due to gaps in the lexicon because of a reduced language capacity (McGregor, 1997; McGregor, Newman, Reilly, & Capone, 2002). McGregor, Newman and colleagues (2002) hypothesized the etiology of retrieval errors in children with DLD as a manifestation of slow language development in general and underdeveloped semantic

representations in long-term lexical memory in particular. Preschool children with language disorders produced a higher frequency of errors than their typical, age-matched peers. Two types of errors, semantic and phonological, represent different subsystems of language. Semantic errors occur more frequently than phonological errors in both children with typical language development and those with DLD (McGregor, 1997; McGregor, Friedman et al., 2002; McGregor, Newman et al., 2002). McGregor, Friendman et al. (2002) examined retrieval errors of children with language disorders and compared them to typically developing, age-matched children using naming, description, and drawing tasks. Performance on all three semantic tasks indicated that children with diagnosed language impairment had sparse semantic representations on both naming and drawing tasks. Poor semantic representation was the cause of a high frequency of semantic naming failures. McGregor's hypothesis, that language performance predicts naming performance, was tested by multiple regression using language performance and two non-language variables (years of maternal education and nonverbal IQ) as independent variables, and the number of items correct on naming tasks as dependent variables. Consistent with this McGregor's hypothesis, two language scores accounted for 73% of the variance in naming performance. McGregor et al. posit that the degree of knowledge represented in the semantic lexicon makes words vulnerable to retrieval failure (McGregor, Friedman, et al., 2002). Developmental models portray retrieval as heavily dependent on a lexical storage system with incremental increases in semantic activation and network strength as children achieve vocabulary and grammatical milestones.

Another type of word retrieval error involves the sound form. Although it can be called a phonemic error, for the purposes of this paper the term *phonological error* will be used to describe this type of error. Phonological errors are not considered to be misarticulations of a word which involve speech production, but rather mistakes in expressing the phonological form of the word. Articulation errors are more systematic, such as sound substitutions (b/g; th/s), whereas phonemic errors are a word-specific substitution that does not have a correct sound sequence or is missing sounds to change meaning. Examples of phonemic errors include "be" for bead, "fewdriver" for screwdriver, "bone" for phone, "dirt" for dessert, and "twig" for wig. In her study of word retrieval in preschool children with and without language disorders, McGregor, Newman, et al., (2002) found that children with DLD have a higher frequency of phonemic errors than those children without a diagnosis.

Phonological errors are considered to be the result of word retrieval breakdowns at the level of the lexeme, or sound system of the word. According to Levelt's model of word production, breakdown at the phonological or lexeme level occurs in the final process prior to word production (Levelt, 1999). However, in developing children semantic and phonological processes develop and interact over the course of language acquisition (Storkel & Morrisette, 2002; Morrisette, 1999; Metsala & Walley, 1998). Evidence indicates that the final production of a word is more than simply motor speech output, but rather relies on the lexicon in a bi-directional manner. On the one hand, Storkel and Morrisette (2002) propose that an increase in lexical development results in expansion of the sound system because the activated lexical representation also activates a corresponding phonological form. On the other hand, studies describing the impact of

lexical exposure to changes in speech production demonstrate an improvement in phonological form production when words are frequently produced in naturalistic conversations in the child's environment (Girolametto, Pearce, & Weitzman, 1997). In this study, simply hearing the word more often resulted in increased spoken production of the word. For children with DLD, deficiencies in either the semantic or phonological system or both contribute to difficulties with vocabulary acquisition and word retrieval.

Listening comprehension problems in children with DLD. Children with developmental language impairment have difficulty with listening comprehension. Listening comprehension is assessed by reading short paragraphs to children and asking literal and inferential questions concerning the content of the material. Compared to typical controls, children with DLD show poor performance for their age and have more difficulty with inferential questions than literal questions (Bishop & Adams, 1992; Crais & Chapman, 1987; Weismer, 1985).

Family history of the language disorder. Children with language disorders are more likely to have a family history of speech and language difficulties. Evidence for this includes retrospective family history studies, prospective incidence studies, and case reports. The incidence of language impairment in children with a family history of the disorder ranges from 20-40% (Lahey & Edwards, 1995; Neils & Aram, 1986; Tallal, Ross, & Curtiss, 1989; Tomblin, 1989) compared to the general population estimate of 4% (Choudhury & Benasich, 2003; Tomblin, 1989). Behavioral genetic studies of twins concur with this view of high heritability for language impairments. Monozygotic twins have a higher concordance rate for language-based learning disorders compared to dizygotic (Bishop, North, & Donlan, 1995; Lewis & Thompson, 1992; Tomblin &

Buckwalter, 1994). Dale and colleagues expanded this notion by reporting a relationship between the language skills (vocabulary and grammar) and genetic contribution in 2-year-old children (Dale et al., 1998). For children with language delays in this study, genetic contributions accounted for 25% of the variance in vocabulary scores and 39% of the grammar scores (measured by sentence complexity). The influence of heritability of language disorders extends beyond preschool. Early developmental problems in spoken language predict the persistence of the disorder (Pennington & Lefly, 2001; Tunick & Pennington, 2002).

Long Term Outcomes for Children with DLD

Young children with an early diagnosis of language impairment are at risk for persistent problems with language. Follow-up studies of changes from childhood through adulthood have provided some important conclusions despite variations in methods, assessments and samples. Important considerations are age at the beginning of the study, the number of language areas involved, and the pattern of language area involvement.

A substantial number of children with DLD at age 5-6 (40-88%) have speech and language impairments that persist throughout their school career (Aram & Hall, 1989; Johnson et al., 1999; Stothard et al., 1998; Rapin, 1996). Several factors contribute to the wide reporting range of persistent deficits. One methodological factor is participant selection. Some studies include children with low non-verbal ability or additional conditions impacting overall development whereas others do not. In many studies, participant selection is based on delayed language development or a clinical referral based on a failed screening rather than standardized measures (Hall & Tomblin, 1978; Johnson et al., 1999; Scarborough & Dobrich, 1990; Shriberg, Tomblin, & McSweeny,

1999). Other studies rely on parent report of delayed language to meet enrollment criteria (Bishop & Edmundson, 1987) or on school placement criteria. The age distribution of the study sample also contributes to the reporting of persistent deficits. There are more investigations that examine children's performance beginning at age 5 and older, when language function is considered more stable (Beitchman et al., 1996; Beitchman et al., 1996 Hall & Tomblin, 1978; Shriberg, Tomblin, & McSweeny, 1999) than at age 4 and younger, when changes in development are more likely to occur (Bishop & Edmundson, 1987; Scarborough & Dobrich, 1990; Stothard et al., 1998).

Researchers following children from the preschool years (ages 3-4) to school age report findings of improvement in language skills by age 5 ½ with individual variability (Bishop & Edmundson, 1987; Stothard et al., 1998). In one study, 44% of children with DLD diagnosed at age 4 had good outcomes, defined as no language score in the impaired range and no more than one score in the below satisfactory age (Bishop & Edmundson, 1987). In contrast, children with persistent language deficits at age 5 demonstrate stability in their profile and are at high risk for long-term language impairment (Stothard et al., 1998). Between ages 3 and 5, there is still a chance for change which can improve longer-term outcomes (Scarborough, 2001). Using a cohort from a previous study (Bishop & Edmundson, 1987), Stothard and colleagues (1998) reported on 68 children who were diagnosed with DLD between ages 3 and 4 and their subsequent follow-ups between ages 5 years, 6 months and the age of 15. An overall index of satisfactory speech-language performance was defined as (a) no score within the impaired range on any of the nine speech and language measures used (less than 3rd percentile) and (b) no more than one score below the satisfactory range of below the 10th

percentile on any of the speech and language measures. For this cohort, 44% (30) were described as persistent language impairment and 56% (38) were considered as "resolved impairment", defined as satisfactory speech and language performance on all measures at age 5 years, 6 months. At age 15, the resolved group achieved similar performance to a control group of children who did not have a history of language disorders on any language measure except sentence repetition, nonword repetition and spoonerisms (a measure of inferential language). The majority of children who remained in the persistent impairment group at age 5 remained there at age 15. The persistent impairment group obtained significantly lower scores than either the controls or general delay group on all speech and language measures. Children diagnosed with DLD between the ages of 3 and 4 have a window of opportunity for skills improvement prior to age 5. If the diagnosis persists at age 5, it is likely to continue throughout the school years.

The severity of the language impairment at the time of initial diagnosis is another factor to consider. Bishop and Edmundson (1987) report a relationship between impairment severity and number of functions (phonological, semantic and syntactic) involved, with more severe impairment characterized by a greater number of areas implicated. Children who entered the study at the age of 4 years who had a single impairment in phonology demonstrated better outcomes at age 5 (78% in the good outcome group) than those with multiple areas of impairment (receptive and expressive skills as well as semantics and grammar, only 14% demonstrated a good outcome). Only 13% of children who displayed only expressive language impairments in vocabulary and grammar had a good outcome (Bishop & Edmundson, 1987).

Initial patterns of language deficits show considerable stability over time beginning at age 5 (Bishop & Edmundson, 1987; Johnson et al., 1999). Between the ages of 3 and 5, children are more likely to show more generalized language deficits in both subsystems of vocabulary and grammar that then become more selective to a single area as development proceeds at age 5 (Scarbourgh & Dobrich, 1990). Children who display impairment in a single subsystem are more likely to improve enough to be considered "resolved". Several researchers concur that children who have both receptive and expressive language impairments tend to persist in this pattern into later childhood (Aram & Nation, 1982; Bishop & Edmundson, 1987; Clegg, Hollis, Mawhood, & Rutter, 2005; Conti-Ramsden, Botting, Simkin, & Knox, 2001; Johnson et al., 1999; Stothard et al., 1998) and into adulthood (Clegg et al., 2005).

Co- morbidity with Speech Disorders

A compounding factor for children with language disorders is the presence of multiple speech sound errors at an early age. Shriberg and colleagues (1999) report an incidence of comorbidity of an articulation disorder in children with DLD as approximately 1.3%. In the same study, there were also children with delayed speech who had a language disorder: approximately 11-15% of the children with persisting speech delay at age 6 demonstrated a language impairment. In a longitudinal study of children between 5 and 12 years of age with language disorders, Beitchman et al. (1996) report that children with only speech impairments at age 5 improved and experienced minimal or no long-term problems with speech or academics. However, children with "pure" language or a mixed speech and language diagnosis at 5 years seemed more resistant to change and were likely to keep this same profile. These findings were

supported by Johnson et al. (1999), who compared outcomes for children grouped by language- or speech-only impairment identified at age 5 and followed until age 19. Those children with speech-only impairments were more likely to resolve their symptoms and have better communication outcomes than children with language impairments. Children with multiple sound production errors during preschool are more likely to persist with differences in speech production in elementary school when compared to children with a single error. Further, children whose impairments only involve speech production (e.g. articulation and phonology) fare better than those whose impairments involve mixed speech and language (Beitchman et al., 1996; Catts, 1993; Shriberg & Kwiatkowski, 1988).

Reading at the Word Level

Children learn to read by mapping their knowledge of phonology, semantics and syntax to printed text, progressing from print awareness to fluent reading and understanding of connected text. Reading is considered to be a linguistic skill based on the fact that written systems are based on language (Catts & Hogan, & Fey, 2003; Muter, Hulme, Snowling, & Stevenson, 2004). Reading orthography requires the alphabetic principle, or knowledge of sound-symbol relationships. Both word reading and reading comprehension are necessary for successful reading. Development of the orthographic processor, allowing for visual interpretation of symbols, that facilitates early word reading is made possible by the guidance of the phonologic processor (Adams, 1990). According to Adams, the child's ability to "sound out" words in print defines their capacity for leaning new words in print. Word decoding requires knowledge of the sounds of words, spelling, word meaning, and pronunciation as well as consideration of

the words in context (Adams, 1990; Catts, Hogan, & Adlof, 2005; Ehri, 1998; Gough & Tunmer, 1986; Snowling & Hulme, 2005). Readers who are "skilled" decoders can read words "quickly, accurately and silently" because they have integrated the use of letter-sound rules in their approach to text (Gough & Tunmer, 1986). The ability to decode the written word depends on a child's skill in understanding the rules for applying sounds to orthography. Reading words becomes more automatic with practice and exposure to print.

Reading words follows a developmental progression as children use a variety of techniques to read words they do not know (Ehri, 1998; Ehri & Snowling, 2004). A first step in the process occurs when children build print awareness and rely on graphic features to recognize words. To help read words that are unknown in print, children apply a decoding strategy, also called word attack, using phonological skills to match sounds to letters, then progressing to pronunciation and blending familiar sound patterns. Beginning readers also use analogies to decode words, recognizing how unfamiliar words are similar in spelling to familiar words. Other ways to read unknown words are to predict the word based on initial letters, sentence context or pictures accompanying the text (Ehri & Snowling, 2004). In these strategies, both grammar and the meaning aspects of language (semantics) contribute to the process. Children become increasingly efficient and build a sight word vocabulary as they gain more experience in reading words. They rely on their language skills as they retrieve sight words from memory, analogize to words already known by sight, and use context cues to help predict words. Reading fluently without decoding each word occurs when children quickly analyze words into orthographic units without phonological conversion (Ehri & McCormick, 1998). This ability to read

decontextualized words is measured by instruments presenting individual words for the child to read, such as the word identification subtest of the *Woodcock Reading Mastery Tests-Revised* (Woodcock, 1987). Word reading accuracy is also measured by tabulating the correct number of words read in a paragraph, the Neal Analysis of Reading Ability-Revised (Neal, 1999).

The relationship between language and word reading is explained by two constructs of language: phonology and semantics. Much of the research supports phonology as the basic core of reading as both a predictive and a concurrent skill. Two components of semantics are vocabulary, the words contained in a lexicon, and grammar, the syntax and morphologic structure of language. The nature of the reading-language relationship changes over development. Storch and Whitehurst (2002) described the influence of combined oral language skills over time. During preschool, oral language skills predicted 48% of the variance in phonological and print awareness. Kindergarten oral language skills accounted for less than 10% of the variance in word reading skills, and by second grade oral language had a negligible effect on word reading.

Phonological Processing

Phonological processing is a subsystem of language that involves the awareness of sound form and the ability to manipulate sounds in word. It involves hearing, isolating and manipulating sounds in spoken language and is a prerequisite for word decoding (Torgensen et al., 1997). In an alphabetic languages such as English, the ability to distinguish and manipulate phonemes is a crucial skill for linking phonemes with their corresponding graphemes. Phonological awareness, a component of phonological processing, is considered the “core” of reading. It is a stable indicator of word recognition

(Adams, 1990; Lonigan, Burgess, & Anthony, 2000; Wagner et al., 1997; Whitehurst & Lonigan, 2001) and training in this skill improves word reading (Brady, Fowler, Stone, & Winbury, 1994). Phonological processing skills show a strong relationship to word reading and deficits are linked to reading difficulties according to the phonology limitation hypothesis (Liberman, Shankweiler, & Liberman, 1989) which describes reduced phonological skills as a core deficit in reading disorders (Morris et al., 1998). These processes are strongly related to the child's ability to sound out words in print and have been found to be highly stable over time (Burgess & Lonigan 1998; Torgensen & Burgess, 1998; Wagner et al., 1997).

Converging areas of research lend support to the relationship between phonological awareness and reading. First, correlation evidence supports the relationship between the two constructs. In a longitudinal study examining the relationship between phonological awareness and word level reading (Wagner et al., 1997), individual differences in phonological processing showed a relationship with word level reading across all grade levels. Wagner et al. offer empirical evidence for the stability of phonological awareness over time, examining phonological sensitivity at kindergarten, first, second, and fourth grades. Results indicated that stable phonological awareness skills predicted word level reading across all grades.

Even before formal reading instruction commences, predictive relationships are apparent. Phonological awareness in kindergarten has strong predictive ability for reading success in elementary school, and is particularly related to reading during the first two years of formal instruction when children are learning to decode words (Adams, 1990; Kirby, Parrila, & Pfeiffer, 2003; Swank, 1997). A substantial amount of variance in both

concurrent and subsequent reading achievement is accounted for by measures of phonological awareness, even when controlling for such factors as IQ, family income, vocabulary knowledge, and verbal memory (Bryant, McLean, Bradley, & Crossland, 1990; Swank, 1994; Torgensen, Wagner, & Rashotte, 1994).

In addition to a direct relationship between the phonologic pathways to word reading, indirect effects on word reading occur through phonological awareness. When the effects of phonological awareness are controlled for, the influence of vocabulary and grammar on word recognition only accounts for about 1% of the variance in word recognition in first grade (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004). Composite scores of oral language measured in kindergarten were significant predictors of phonological awareness in second grade (Cooper et al., 2002). Further, a stronger relationship was observed between phonological awareness and receptive vocabulary than was the case with expressive vocabulary. Children with a diagnosis of a language disorder may have selective deficits in phonology or semantics. Because oral language precedes phonological awareness, a weakness or disorder in this skill will place children at risk for problems with developing phonological awareness as well as with the phonologic and semantic pathways.

Semantics

There are two pathways to reading at the word level: a phonologic pathway and a semantic pathway (Snowling & Hayiou-Thomas, 2006). In a theory proposed by these researchers known as the Triangle Theory, phonology encompasses the sound form aspects of language and semantics includes vocabulary and grammar. Grammar exerts an influence on reading through the semantic pathway by providing linguistic context to

enhance meaning (Snowling & Hayiou-Thomas, 2006). When vocabulary and grammar alone are investigated as predictors of reading, both show strong relationships to word reading and account for a significant portion of the variance in word reading skills in first grade for typically developing readers (Swank, 1997). A two-path model known as the triangle model (Figure 1) illustrates concepts and relationships within the dual pathway (Snowling & Hayiou-Thomas, 2006).

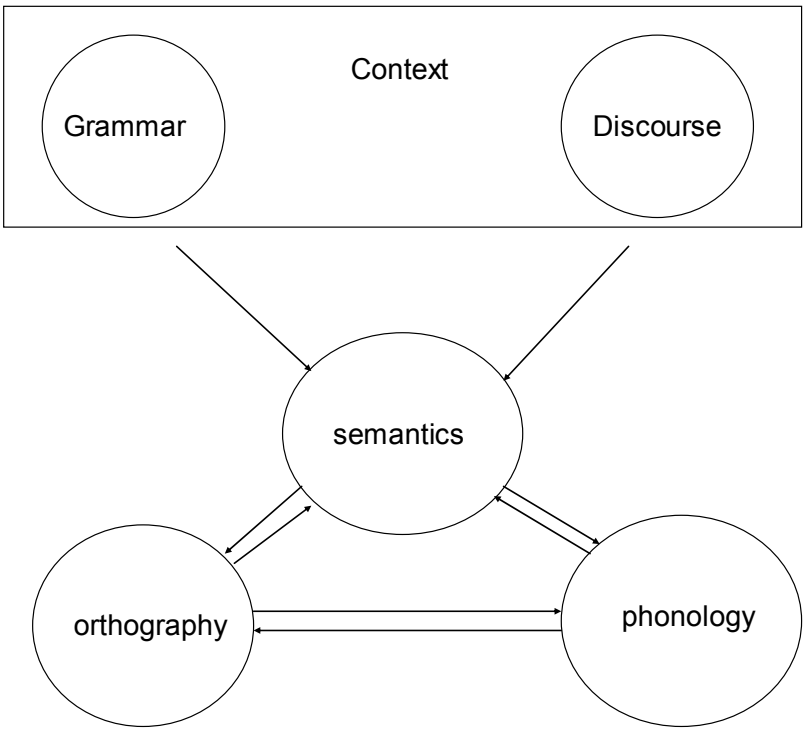

Figure 1. The Triangle model of reading (after Plaut, McClellland, Seidenberg, & Patterson, 1996) from Snowling & Hayiou-Thomas, 2006, p. 112.

According to this model, reading is the outcome of a process that involves interactions between the sounds of words, word meaning, and word spellings (Snowling & Hulme, 2005). When a child begins to read, a phonologic pathway dependent on the acquisition of phonological awareness skills is established. Once a child has acquired the alphabetic principle encompassing knowledge of both the visual and sound aspects of

letters, this pathway links words in print to sounds. The alphabetic principle is a mechanism for beginning decoding and understanding of novel words as children become more skilled in reading. The semantic pathway assists the child with early decoding by providing access to the word meaning. Semantic knowledge helps with both decoding word reading and later interpretation of text.

Reading is accessing the lexicon via print (McGregor, 2004). Lexical knowledge consists of both phonological and semantic representations, which provides for two routes to the word identification skills needed for reading (Levelt, Roelofs, & Meyers, 1999). One route is the link between phonological representations and orthographic patterns of words in print. A child with a smaller vocabulary has a reduced pool of well-rehearsed phonological representations and therefore few words to map onto printed words. A child with a larger vocabulary has more depth in their semantic networks to link to phonology.

A second route to word identification is through vocabulary knowledge. More efficient encoding, organizing and retrieval of the phonological representations of words occurs when there is more detail about words in the lexicon (McGregor, Friedman et al., 2002; Ouellette, 2006). In a study investigating typically developing children's semantic representations by comparing picture naming with picture drawing, semantic naming errors were associated with limited semantic knowledge and the degree of naming errors was associated with limited semantic knowledge rather than a correct name (McGregor, Friedman et al., 2002). Children who have larger expressive vocabularies will retrieve phonological information more efficiently and therefore will be more skilled with word identification tasks in reading. During word reading, recognition of words can be

facilitated not only by a child's semantic knowledge, but also by the language of the text. Semantic priming effects assist word recognition and are greater for children than adults (McGregor, 2004). Children can compensate for deficits in spelling-sound correspondence by using their lexical knowledge of words to achieve word identification (Plaut & Booth, 2000; Stanovich, Nathan, West, & Vala-Rossi, 1985; Stanovich, West, & Freeman, 1981).

Receptive and expressive vocabularies contribute differently to word reading. Wise, Sevcik, Morris, Lovett, & Wolf (2007) used structural equation modeling to model the relationships between concurrent vocabulary (receptive and expressive) and listening comprehension skills on one hand and word identification on the other in second and third grade children who met the criteria for reading disabilities. Two significant findings about the relationship between reading and vocabulary were reported. One is that both receptive and expressive vocabulary contributed significantly to pre-reading skills (phonology and print awareness). A second finding identified a separate but significant independent pathway between receptive and expressive vocabulary on one hand and pre-reading phonological skills on the other. Although a stronger relationship between receptive vocabulary knowledge and phonological awareness was reported, expressive vocabulary knowledge was a better predictor of word identification skills. Listening comprehension and expressive vocabulary skills were both significant predictors of word identification skills in this age group. The Wise et al. study supports the notion of distinctive contributions to the reading process for receptive and expressive vocabulary. Receptive vocabulary is the primary foundation for building phonological awareness

skills, whereas expressive vocabulary knowledge is a better predictor of word decoding skills.

The lexical restructuring model (LRM) explains the relationship between lexical knowledge and phonological representation during development. The production of sounds occurs as a process utilizing vocabulary growth and performance constraints (Metsala & Walley, 1998). Assumptions from this model describe the development of phonological awareness as a change from the holistic perception of the word to one more segmented in terms of phonemes. This process is accomplished via lexical expansion, during which the semantic system interacts with the sound system. According to this model, vocabulary growth and word frequency influence a child's phonological perception. Words learned early in life and used frequently are more easily recognized because they moved earlier from a holistic form to a more phonologically segmented one. This model also accounts for the contribution of vocabulary growth to the phonological awareness needed for reading. Restructuring of words into phonological segments proceeds with vocabulary growth, which forces children to pay more attention to the sound system. The more words a child knows, the more he is likely to pay attention to the sound patterns of the word. If lexical representations do not become segmentalized in a developmentally appropriate manner or time frame, children will experience difficulty with accessing phonemes and applying this knowledge to decipher the alphabetic code necessary for reading (McGinnis, 2005).

In addition to vocabulary knowledge, rapid automatized naming (RAN), the ability to say words quickly without error, contributes to word reading. RAN correlates significantly with word reading (McBride-Chang, Manis, & Wagner, 1996) and makes an

independent contribution to word identification beyond phonological awareness and print knowledge (Bowers, 1995; Bowers & Wolf, 1993; Felton & Brown, 1990; Wolf, Bowers, & Biddle, 2000). When measured in kindergarten, RAN is predictive of decoding abilities in first, second, and third grades (Parrila, Kirby, & McQuarrie, 2004; Wolf, 1997). RAN is highly correlated with expressive vocabulary in kindergarten and first grade (Kirby & Parrila, 1999). Individual differences in RAN and vocabulary were related to individual differences in word reading (Wagner et al., 1997). When children have weak oral language skills, naming speed is slower (Gathercole, Willis, Emslie, & Baddeley, 1992; Swanson, Trainin, Neocoechea, & Hammill, 2003; Wolf & Obregon, 1992).

Grammar exerts its influence on word reading via the semantic pathway (Snowling & Hayiou-Thomas, 2006). The contribution of grammar can be explained by the construct of morphology, a word structure centered on morphemes and combinations of morphemes and reading processes. The effect of morphological awareness on word pronunciation is both phonological and semantic. For example, a single phoneme, (s), changes the singular “dog” to the plural “dogs”. This inflection suffix is considered semantically “active” (Carlisle, 2004). The plural word is stored as a semantic unit. Morphological awareness influences word decoding skills by altering the pronunciation of words in a regular predictable fashion. During early elementary school, morphological awareness accounted for between 4 and 5% of decoding variance when the effects of phonological awareness and vocabulary were controlled for (Carlisle, 1995; Shankweiler et al., 1995). Another measure of grammar competency, MLU, when measured during

preschool, predicted 48% of the variance in word reading accuracy at age 8 for children with DLD (Bishop & Adams, 1990).

Reading at the Word Level and Language Disorders

Children with DLD may have single deficits or a combination of deficits in phonology, grammar or vocabulary, and they may develop phonological awareness more slowly than their typical peers (Briscoe, Bishop, & Norbury, 2001; Catts, 1993; Catts, Hogan & Fey, 2003). A deficit in oral language places children at risk for developing problems with the phonologic as well as semantic pathways that build reading skills. There are theoretical explanations for why children with DLD are at risk for difficulty with word reading. Some researchers propose that reading is a language skill and word reading is the translation of print into language (Catts, Hogan, & Fey, 2003). This premise implies a continuation of oral language skills to reading. Others argue that children are vulnerable to the disruption of both pathways (semantic and phonologic) that contribute to word recognition (Snowling & Hulme, 2005). Disruption of the semantic pathway occurs due to slow lexical growth, differences in grammar development, and poor recognition of the morpho-syntactic markers that contribute to word meaning. A less robust vocabulary constrains phonological awareness and processing.

Children with DLD can demonstrate difficulties with word reading as early as first grade. Catts (1993) examined a group of children (n=56) with speech-language impairments diagnosed in kindergarten by assessing first grade word reading. The performance of children with impairments differed significantly from that of their age peers. When vocabulary was entered first into the model, it accounted for a significant amount of the variance in word identification and word attack. When phonological

processing and RAN were entered first followed by vocabulary, a negligible amount of the variance in word identification or word attack was explained by vocabulary.

Children identified in kindergarten as language impaired performed significantly lower on word attack and word identification in second and fourth grade than did the non-impaired control children (Catts et al., 2002). Further, difficulties with phonological processing were observed in the language impaired group in kindergarten, lending support to other findings that children with DLD have difficulty in pre-reading constructs related to print (Boudreau & Hedberg, 1999).

A developmental language disorder disrupts the phonologic and semantic pathways to reading. Effects from this disruption lead to difficulties with word reading which can appear as early as first grade. If a child's language skills improve, word-reading skills are more likely to approximate age peers but remain at the lower end of the spectrum. Long term follow-up studies reveal an "illusionary recovery" as word reading difficulties are noted many years later (Scarborough, 2005; Catts, Adlof, & Weismer, 2006).

The Contribution of Speech Production to Reading

Although theories and empirical evidence support the contribution of speech production to word reading, the role of speech production has not always been at the forefront of reading research. In recent years, the relationship between speech production and reading has been studied by investigating its influence on phonological awareness and reading achievement. According to Liberman's theory, the relationship between speech production and language contributes to reading through phonological awareness

(Liberman, 1997). Two primary models of the contribution of speech production to reading, explained below, support this assumption.

Support for contributions of the sound system aspect of word production to phonological awareness needed for reading are explained by the phonological distinctiveness hypothesis, which proposes that the sound system provides the "distinctiveness between lexical representations and its neighbors" (Elbro, 1996, p.467). This theory explains the phonetic detail of the word as contributing to the completeness of the lexical representation and ease of access of the word form. Children who experience articulation inaccuracies have diminished phonological awareness due to their reduced capacity to produce accurate phonological segments. The severity of children's articulation difficulties was an accurate predictor of their performance on phonological perception and sensitivity tasks (Bird, Bishop, & Freeman, 1995) and word-level reading tasks (Carroll, Snowling, Hulme, & Stevenson, 2003; Larrivee & Catts, 1999; McDowell, Lonigan, & Goldstein, 2007; Nathan, Stackhouse, Goulandris, & Snowling, 2004). Due to the nature of the relationship between sound production and phonological awareness, children whose sound production limitations persist into school continue to experience difficulties with the phonological awareness required for reading. Researchers examining the articulation skills and reading for children between the ages of 5 and 7 with moderate to severe disorders in speech production found that 43% of the variance in word identification was attributed to the child's speech production composite score. Further, children who demonstrate multiple articulation errors, indicating a more severe disorder in expressive phonology, had relatively poor reading outcomes (Larrivee & Catts, 1999).

A recent examination of vocabulary and speech production in preschool children (McDowell et al., 2007) offers support for the theories described above and for Liberman's theory of speech perception. These investigators studied 718 children between the ages of 24 and 72 months by administering standardized tests of vocabulary, phonological awareness and speech sound accuracy (articulation), and used multiple regression analysis to predict contributions to phonological awareness. Results indicated that an increase in speech sound accuracy led to greater changes in phonological awareness as age increased. Children whose poor speech production accuracy persisted had difficulty with phonological awareness. These findings supported previous studies reporting a relationship between accuracy of speech production and strength of the phonological awareness skills needed for reading (Carroll et al., 2003; Dowell, Lonigan, & Goldstein, 2007. Further, McDowell and colleagues report that speech sound accuracy predicted unique variance in word reading when holding phonological awareness constant and that vocabulary predicted unique variance in phonological awareness when accounting for speech sound accuracy. These findings support both the phonologic distinctiveness hypothesis and the lexical restructuring model (McDowell et al., 2007).

Other empirical support for the role of articulation quality in the development of phonological sensitivity was examined longitudinally by following a single phoneme (/r/) that three-year-old children typically mispronounce (Thomas & Senechal, 2004). Results from this study revealed that production of /r/ at age 3 predicted phonemic sensitivity for /r/ at age 3 and 5, even when controlling for vocabulary, letter knowledge and phoneme sensitivity for a control phoneme that the children were able to produce accurately. Further, children who mispronounced /r/ at age 3 had difficulty with phonemic sensitivity

for this sound at age 8, after the articulation improved. The authors of this study posit that these results support the assumption that articulation and phonemic sensitivity depend on a common underlying phonemic representation, and that if production is altered at a young age, the effects on phonemic sensitivity linger beyond the time of improvement.

Speech articulation has also shown a direct relationship with word reading measures. Measures of articulation show a significant relationship with word identification and word attack (Lewis, Freebairn, Hansen, Iyengar, & Taylor, 2004). Children who make consistent errors of articulation are at greater risk for reading difficulties.

Reading Comprehension

The Simple View of Reading

The *simple view of reading* describes the process of learning to read as word recognition and understanding printed language utilizing two processes: decoding words and reading comprehension (Gough & Tunmer, 1986). In this view, decoding of printed words is the first step in the reading process. Successful readers are able to easily decode words and answer questions about the content of connected text. There is a strong relationship between word recognition and comprehension, but is it not perfect. Some individuals who perform well in one area perform poorly in the other (Nation, 2005). Evidence that word decoding and language skills are necessary but not, when occurring one without the other, sufficient, comes from three types of investigations: those describing the process of word decoding, those predicting comprehension differences, and those describing characteristics of children with reading comprehension deficits. In

addition, measurement factors complicate any attempt to determine whether word reading or language account for more of the variation in comprehension skills.

Empirical support for the simple view of reading comes from several sources. Some studies have demonstrated that, although word recognition and listening comprehension are independent skills, together they are highly correlated with reading comprehension (Hoover & Gough, 1990). In an investigation examining language skills and reading acquisition longitudinally, Catts and colleagues (1999) found that participants' performance on measures of word recognition and listening comprehension explained about 75% of the variance in reading comprehension as measured in second, fourth and eighth grades.

In the same longitudinal study, Catts et al. (1999) report a developmental aspect of skill contribution by explaining both unique and shared variance for word recognition and listening comprehension across grade levels for reading comprehension. Although word recognition and listening comprehension combined contributed a large proportion of the shared variance at each grade level, the unique variance for each skill changed over time. In second grade, word recognition accounted for the majority of the unique variance (27%) in reading comprehension but this contribution diminished to 2% by eighth grade. The contribution of listening comprehension skills increased from second grade (9%) to eighth grade (36%), confirming previous reports (Kamhi & Catts, 2005) of a developmental progression for reading comprehension. Further studies support the independence of word recognition and comprehension with evidence that some children with comprehension difficulties perform comparably to typical children on word recognition and phonological tasks (Catts et al., 2006; Cain, Oakhill, & Bryant, 2004;

Nation, Adams, Bowyer-Crane, & Snowling, 1999; Nation & Snowling, 1998; Stothard & Hulme, 1992). The simple view proposes that word recognition is necessary but not sufficient for reading comprehension. Evidence from reading studies supports the view that these skills may be independent.

Word Reading and Reading Comprehension

Two constructs of word reading relate to reading comprehension and can place constraints on comprehension, particularly early in the reading process. The first is word reading accuracy or word recognition, which is the child's ability to read single words without error. For successful readers, independent word reading accuracy is about 98%. Reading can become frustrating if word reading accuracy falls to 90% or lower (Ehri & Snowling, 2004). Juel (1988) examined high- and low-performing readers from first to third grade, and found that high performers read between 91 and 97% of the words, whereas low performers read only between 71 and 83 % of the words. The second aspect of word reading is reading fluency, which describes the speed of word reading. Readers who read text with sufficient fluency show greater comprehension (Ehri & Snowling, 2004). Both word reading accuracy and fluency are necessary for successful comprehension of written passages.

When children read connected text, their attention is focused on constructing meaning from the passage and integrating it into their existing repertoire of knowledge. This process continues without interruption when words are read accurately and fluently. The most efficient way to read words in text is through sight reading (Ehri & Snowling, 2004). When children use other means to read words in connected text, such as decoding, reading by analogy, or trying to predict a word, their process of comprehension slows,

and their attention is held up momentarily as they direct resources to a specific word (Ehri & Snowling, 2004). The more word recognition consumes attention, the fewer resources are available for comprehension (LaBerge & Samuels, 1974). Development of efficient word reading skills frees up attention resources to focus on comprehension and learning from text.

As children progress through school, reading comprehension becomes more dependent on language, particularly vocabulary and knowledge about text structures and grammar. Efficient linguistic processing is important to integrate ideas expressed in connected text within and across paragraphs. In school, children are exposed to a variety of text formats (e.g. biographies, science texts) that provide an expanded reference for passage structure. As children become more experienced with reading, they rely less on word reading, using their language skills to recognize words in context. They also gain more practice with reading and exposure to a variety of text formats. Better readers read more, while those struggling with comprehension read less (National Reading Panel, 2000; Stanovich & Cunningham, 1992; Stanovich & West, 1989).

Evidence of reading comprehension improvement from investigations examining the effects of phonological awareness and word decoding intervention is mixed, especially when compared to reported improvement in decoding skills. Some studies report improvements in comprehension (Rachotte, MacPhee, & Torgensen, 2001; Torgensen et al., 2001), whereas others do not (Lovett et al., 1994). Intervention efforts demonstrate that improvement in word reading is one aspect that may predict improved reading comprehension performance but not the only one.

Language Skills and Reading Comprehension

Scarborough describes the developmental nature of reading as "multifaceted", highlighting the contribution of word recognition and language skills to reading comprehension (Scarborough, 2001). Vocabulary and grammar in particular predict reading comprehension, and develop the base for background knowledge (Scarborough, 2001; Muter et al., 2004). Scarborough (2001) calls these language components "strands": As reading develops, these "strands" become increasingly "strategic" as word recognition becomes increasingly "automatic". Further findings support the contribution of language above and beyond word recognition skills. Reports from a longitudinal study (Muter et al., 2004) that followed children for two years from school entry (4 years, 9 months) showed that reading comprehension requires both vocabulary and grammar skills. These skills were important predictors even when word decoding and phonological awareness were controlled for. Further, reading comprehension becomes increasingly dependent on language children age and emphasis on decoding decreases (Gough, Tummer, & Peterson, 1996; Muter et al., 2004).

Grammar provides constraints for reading words in text. Morphological processing, which requires both the syntactic and semantic components of words, accounts for a significant unique portion of the variance in reading comprehension. A study of third and fifth graders demonstrated the developmental nature of this relationship (Carlisle, 2000). In third grade, morphological awareness contributed 43% of the variance in reading comprehension, whereas in fifth grade it explained 53% of the variance.

A reciprocal relationship exists between vocabulary and reading comprehension (McGregor, 2004). Breadth and depth of semantic knowledge play a roles in reading

comprehension in addition to word recognition. In a study that matched children on decoding skill level, oral vocabulary differentiated children with good and poor reading comprehension (Nation & Snowling, 1998). In addition, a principle known as the *Matthew effect* proposes that reading enhances lexical-semantic knowledge (Stanovich, 1986). Reading texts is the principle means of learning vocabulary during the school years (Steinberg, 1987). Further, growth of vocabulary is an important determinant of reading comprehension skills (National Reading Panel, 2000).

In addition to vocabulary and grammar, other higher-level language skills play a role in reading comprehension, in particular, inference generation and understanding figurative language (Nation, 2005). These higher-level skills are dependent on vocabulary and grammar knowledge. Children skilled in reading comprehension are better at making inferences about what they read than children with poor comprehension. They also have a greater command of figurative language. Comprehension monitoring, a metacognitive control process or strategy that skilled readers use to track their understanding of written material, is another aspect of reading comprehension. Comprehension monitoring relies on strong language skills to determine text understanding.

Scarborough proposes that the prediction of reading skills from language is dependent on the age when language is measured (Scarborough, 1998, 2005). There are very few studies that measure language in preschool. By examining children who later developed reading difficulties retrospectively in a meta-analysis, Scarborough identified trends in age of language testing (Scarborough, 2005). At the youngest ages tested (between 2.5 and 3 years), syntactic and speech production abilities distinguished those who had reading problems. Grammar and vocabulary measured between the ages of 3

and 4 and vocabulary and phonological awareness measured at age 5 differentiated the groups. The age at which language is measured may determine what aspect of language relates to reading difficulties.

Reading Comprehension Difficulties

The simple view and Scarborough's model define two pathways for reading problems: difficulties with word recognition accuracy, and fluency or difficulties with language. According to Perfetti's *verbal efficiency hypothesis* (Perfetti, 1985), reading comprehension is compromised when decoding is deficient. This theory was based on study results showing that children with reading comprehension problems were slower at reading words and nonwords than age matched peers (Perfetti & Hogaboam, 1975). Stanovich proposes that children with weak word reading skills compensate by using connected text to help identify a word. Context cues provide less precise information about words than phonological or analogy cues, and require more time to decipher, slowing the reading comprehension process (Stanovich, 1980). Slow or inefficient word decoding is one source of reading comprehension difficulties, although not all children who have reading comprehension problems experience word recognition problems, particularly in the early elementary years.

Some researchers argue that oral language measures can account for reading comprehension abilities and that reading comprehension difficulties are really oral language comprehension problems *(Catts et al., 2005; Nation, 2005). Comprehension deficits have also been associated with weaknesses in oral language skills, particularly vocabulary and grammar (Cain, Oakhill, Barnes, & Bryant, 2001; Nation et al., 1999; Nation & Snowling, 1998). In two recent studies examining the concurrent and

retrospective language abilities of children with identified reading comprehension deficits, Catts et al. (2006) identified 57 children with reading comprehension problems in eighth grade. They defined a reading comprehension problem as a scoring below the 25th percentile on a composite reading comprehension test battery and above the 40th percentile in word recognition, and a word decoding problem as performance below the 25th percentile in word recognition and above the 40th percentile in reading comprehension. In the first of the two studies, the two groups of children with reading comprehension problems and a "typical reader" group (between 40th and 84th percentiles) were compared on measures of language comprehension (vocabulary, grammatical understanding and discourse comprehension), reading achievement (word recognition and reading comprehension) and phonological awareness. Results showed significant differences between the groups in vocabulary and grammatical understanding. Children described as "poor comprehenders" demonstrated concurrent deficits in reading and language comprehension but not in word decoding. Children described as "poor decoders" showed the opposite pattern, with deficient performance in word recognition but not in language comprehension. Based on assessment of concurrent language and reading skills, children demonstrating comprehension difficulties in eighth grade had at least mild deficits in semantic and syntactic processing, scoring as a group in the 20th percentile for receptive vocabulary and 30th percentile in grammatical understanding.

In the second study examining the same eighth grade children, Catts and colleagues (2006) examined performance on language comprehension and phonological measures retrospectively in second and fourth grades. They predicted that the subgroup differences observed in eighth grade would be observed in earlier grades. Because

reading comprehension is so heavily dependent on word recognition during the early reading process, the investigators predicted a different pattern. They expected that children identified as poor decoders during eighth grade would score lower on reading comprehension measures, while children identified as poor comprehenders in eighth grade (who had strengths in word recognition) would score higher on comprehension measures in second and fourth grade than in eighth grade. Surprisingly, poor comprehenders demonstrated weak performance across all grades on language measures, although only about 31% met the criteria for language impairment during the early grades. Children identified with reading difficulties in grades 2, 4 and 8 had deficits in listening comprehension, but not necessarily in word decoding. In second grade, approximately 50% of the identified poor readers had deficits in listening comprehension. In grades 4 and 8, this number increased to 60%.

There is considerable evidence to support the view that poor comprehenders have a weakness in oral language. Poor performance on vocabulary and grammar measures characterized poor comprehenders as a group, with a substantial number meeting the criteria for language impairment (Nation & Snowling, 2004). Several studies provide evidence of vocabulary weakness contributing to poor comprehension (Nation & Snowling, 2004; Nation & Snowling, 1998; Stothard & Hulme, 1992).

Reading Comprehension Testing Methods

Assessment of reading comprehension skills is a complex issue involving constructs of language and word reading, although both word recognition skills and oral language skills make unique contributions to reading comprehension regardless of the test measure used (Cutting & Scarborough, 2006). Differences in the predictive power of

these aspects for reading comprehension skills may be a result of how comprehension is measured. It is assumed that all tests measure the construct in a similar fashion. However, recent investigations identified differences in the influence of word reading and language depending on the type of test used to assess comprehension. Reading comprehension tests vary in length of passage presented, modality of passage reading (oral or silent), answer format (cloze, picture selection, multiple choice, or retell) and dependence on word recognition skills (Keenan, Betjemann, & Olson, 2008). For example, in a study comparing four comprehension tests (Gray et al., 1999), the Oral Reading Test, Qualitative Reading Inventory, Peabody Individual Achievement Test, and Woodcock-Johnson Passage Comprehension Test, modest correlations between measures were reported with some more highly dependent on word recognition than others (Keenan et al., 2008). In measures that used a single sentence presentation of the passage, read silently and answered by a cloze format or picture selection, word decoding accounted for most of the unique variance in reading comprehension. Measures utilizing silent or oral reading of passages with multiple-choice questions had a stronger relationship with language than cloze-type tests (Francis, Fletcher, Catts, & Tomblin, 2005; Cutting & Scarborough, 2006).

Age differences also influence how children perform on comprehension tests. Although it is recognized that age differences exist in the contribution of word reading to comprehension, this notion is not accounted for consistently across assessment measures (Keenan et al., 2008). Developmental differences are larger for measures dependent on word reading (e.g. cloze and multiple-choice tests) than for tests administering a passage for comprehension followed by questions. In particular, if children are young or poor

readers, tests using sentence length passages with a cloze format response are more likely to account for word recognition performance than comprehension (Keenan et al., 2008).

Reading Outcomes for Children with Developmental Language Problems

Numerous studies show that, as a group, children with language disorders are not as proficient as their typically developing peers at reading and its component processes (Glogowska, Roulstone, Peters, & Enderby, 2006; Share & Leikin, 2004; Stothard et al., 1998; Scarborough & Dobrich, 1990; Snowling et al., 2000; Watkins, 1997). It seems likely that children with reduced pre-requisite skills for reading will indeed experience reading difficulties. However, not all children with language disorders have difficulty with reading in elementary school. Only about 50-60% of children diagnosed with a developmental language disability during preschool proceed through elementary school with reading difficulties (Aram, Ekelman, & Nation, 1984; Catts et al., 1999; Catts Hogan, & Fey, 2003; McArthur, Hogben, Edwards, Heath, & Mengler, 2000). Although there is increased risk for reading problems, considerable variability in both language and reading performance is reported by several researchers, particularly in the early phase of reading (Bishop & Adams, 1990; Catts, 1993; Catts et al., 2002; McArthur et al., 2000; Share & Leikin, 2004; Snowling et al., 2000; Stothard et al., 1998).

Investigations examining the reading skills of children with language impairment use diverse testing protocols, and a wide range of methods to recruit participants, group participants for analysis, and distinguish the effects of the language impairment from the more general consequences of intellectual functioning. Children and their families who participate in these studies are usually recruited from clinical referrals (Bishop & Adams, 1990; Scarborough & Dobrich, 1990; Stothard et al., 1998) that may contain a greater

number of the most severe cases (Catts et al., 2002). Other studies administer screening assessments to a larger sample of children to identify children whose language performance is below 1 standard deviation (SD) of the mean (Catts et al., 2002; Share & Leikin, 2004; Simkin & Conti-Ramsden, 2006). Children may then be grouped on the basis of language subtypes such as receptive or expressive involvement (Simkin & Conti-Ramsden, 2006), or on the basis of intellectual functioning (Bishop & Adams, 1990; Catts et al., 2002; Snowling et al., 2000). Studies reporting reading outcomes are likely to include measures to assess vocabulary and grammatical function of this population either directly through individual measures or in a composite test. Some studies examine a broader range of language function, including measures spontaneous speech or narrative abilities (Catts et al., 2002) or phonological awareness (Share & Leikin, 2004; Catts et al., 2002; Snowling et al., 2000; Stothard et al., 1998).

The consensus among researchers is that children described as having developmental language impairment show intellectual functioning within normal limits, defined as at or above an intelligence quotient (IQ) of 85. Some studies create groups based on intellectual functioning using entry level IQ scores, above or below a nonverbal IQ of 85 (Bishop & Adams, 1990; Catts et al., 2002; Snowling et al., 2000; Stothard et al., 1998) while others match intellectual level achieved in the study to a control group (Share & Leikin, 2004). Still others only examine those children with language impairment who show intellectual functioning within normal limits (above 80 or 85 IQ) at the beginning of the study (Simkin & Conti-Ramsden, 2006).

Aspects of the Language Disorder Related to Reading Outcomes

Several aspects of language disorders relate to reading achievement outcomes. Severe language disorders, defined as having more than one area (e.g. vocabulary and grammar) or both receptive and expressive involvement, create a higher risk for reading difficulties (Bishop & Adams, 1990; Beitchman et al., 1996; DeThorne et al., 2006). Very few reports about reading outcomes relative to severity of impairment in preschool are available. Studies more commonly describe children as "persistent", indicating that the language disorder continues, or as "resolved", indicating that the children no longer meet the criteria for language disorder (Bishop & Adams, 1990; Stothard et al., 1998; Snowling et al., 2000). Children demonstrating both expressive and receptive problems identified at age 11 have more severe literacy difficulties than those who demonstrate only one problem area, and they experience difficulties with both word reading and reading comprehension (Simkin & Conti-Ramsden, 2006). Conversely, children with milder problems such as a single domain of language involved, or performance within normal range by age 5, have better reading outcomes, and may perform within normal limits (within 1 SD of the mean) on measures of isolated word reading (Bishop & Adams, 1990; DeThorne et al., 2006). Mild impairments were described as a profile at the time of diagnosis in preschool consisting of language comprehension and vocabulary within normal limits and deficits in expressive phonology and grammar only (Bishop & Adams, 1990) or resolved language difficulties (DeThorne et al., 2006). In addition to severity, a second compounding factor for language disorders is the presence of a speech articulation disorder, which increases the severity of the problem. In such cases, children demonstrate

difficulties with word reading even at the beginning of the process (DeThorne et al., 2006; Beitchman et al., 1996).

Language area of involvement (e.g. vocabulary or grammar) is another factor that determines the extent of reading impairment. Although deficiencies in one or more language domains is part of the profile of DLD, vocabulary and grammar in particular contribute significantly to reading outcomes in children in this population (Catts et al., 2002; Snowling et al., 2000; Bishop & Adams, 1990, Scarborough & Dobrich, 1990). In many studies, correlation analyses and multiple language measures combining both areas into a composite score are often used, making it difficult to determine the effect of a specific domain on reading outcomes (Bishop & Adams, 1990; Catts, 1993; Catts et al., 2002; Share & Leiken, 2004; Wise et al., 2007).

Some researchers speculate that grammar plays a more important role in predicting reading outcomes than other aspects of language (Bishop & Adams, 1990; Catts et al., 2002). Using specific language measures to show the relationship to later reading, Bishop and Adams (1990) first investigated children who received a clinical diagnosis of a language impairment at 4 years of age and followed these children until age 8½. Measures used in this study assessed receptive vocabulary, expressive vocabulary and grammar at age 4. At age 8½, participants with DLD had poor reading comprehension scores at age 8½ compared to normal controls. Regression analysis was used to analyze the contribution of syntax and vocabulary to later reading skills, but these variables were not entered into the same equations. Since MLU was the strongest predictor during the initial analysis, measures from vocabulary scores were adjusted for this variable for subsequent stepwise selections. Based on this procedure, MLU at age 4

predicted 48% of the variance in reading accuracy and 61% of the variance in reading comprehension at age 8½. After adjusting for MLU, vocabulary and semantics predicted an additional 56% of the variance in reading comprehension at age 8½.

Other researchers propose that vocabulary makes a critical contribution to reading outcomes (McGregor, 2004). When vocabulary delays and deficits in lexical acquisition occur prior to reading, many children have difficulty with reading comprehension (Scarborough, 1990). Children with language disorders who had the lowest outcomes in reading comprehension scores demonstrated a decline in vocabulary from 5 to 15 years (Snowling et al., 2000). For children with language disorders who have deficit skills in one or both of these areas, it is likely that grammar and vocabulary play an important role somewhere in the reading process, particularly in reading comprehension (Bishop & Adams, 1990; Share & Leikin, 2004). However, it is unclear which domain plays the larger role in word reading and reading comprehension. Based on a study by Share and Leikin (2004) examining reading outcomes at the end of first grade, both areas play a greater role in reading comprehension (42% of the variance, and larger effect sizes) than in word reading (29% of the variance).

Another factor affecting reading outcomes is the persistence of a language disorder to the age when reading instruction begins, usually between ages 5 and 6. Children who are identified or continue with a language problem at this age are more likely to have reading difficulties (Aram, Ekelman, & Nation, 1984; Beitchman et al., 1996; Bishop & Adams, 1990; Catts et al., 2002; Catts, Hogan, & Fey, 2003; Snowling et al., 2000; Stothard et al., 1998). Children who have a history of language disorders in their family are more likely to continue to have language difficulties beyond age 5, which

makes family history a variable to consider when examining outcomes (Lahey & Edwards, 1995; Neils & Aram, 1986; Tallal et al., 1989; Tomblin, 1989). Resolution of the language disorder, demonstrated by language test scores within 1 SD of the mean for language measures, increases the likelihood that children with DLD will achieve reading scores within the normal range between ages 6 and 8 (Bishop & Adams, 1990; Catts et al., 2002; Stothard et al., 1998). Longitudinal studies examining children with a diagnosis of DLD during preschool which followed them for several years report age related results based on improvement in or persistence of the language disorder. Children whose language skills improved between preschool and kindergarten had word identification scores and reading comprehension scores within 1 SD of the mean but tended to be on the lower end for reading comprehension (Stothard et al., 1998; Snowling et al., 2000). Children whose language disorder persisted after age 5 had difficulty with word identification in first grade that was even more apparent at age 15. Even children who performed as well as their age peers in language at age 15 continued to demonstrate difficulty with word reading, particularly decoding of nonwords (Stothard et al., 1998; Snowling et al., 2000). Simkin and Conti-Ramsden (2006) describe reading skills based on grouping children with language disorders at age 11 into three groups: resolved language impairment, expressive only language impairment, and combined expressive and receptive language impairment. All three subgroups had some children who appeared to have difficulties with reading at age 11, with the resolved group showing the least (25% with single word reading and 29% with reading comprehension difficulties) and the group with both receptive and expressive deficits showing the most (88% with both word reading and reading comprehension problems).

Many researchers describe the notion of an "illusionary recovery" from a language disorder to describe children who demonstrate reading difficulties later in elementary school that appear to be the result of an early language disorder diagnosis (Scarborough, 2001; Scarborough & Dobrich, 1990; Catts et al., 2006). This term describes those children who seemingly recover from their language impairment by the beginning of school entry. Even some children with DLD who score at grade level for word recognition skills early in elementary school begin to show deficits in word reading accuracy and comprehension in connected text between 8 and 15 years of age (Snowling et al., 2000). Many children with DLD showed improved language skills, staying within 1 SD of the mean on early measures of word reading, but at a later age demonstrated simultaneous difficulties in reading comprehension and word reading accuracy in connected text (Catts et al., 2006; Simkin & Conti-Ramsden, 2006). Symptoms of language impairment emerged when demands for using language to read connected text were increased.

Attainment of language skills once reading instruction is started is another factor to consider in reading outcomes. Language skill levels at the time of school entry were associated with significant differences in both word reading and reading comprehension (Share & Leikin, 2004). Concurrent language skill attainment in second and fourth grades predicted reading difficulties better than changes in language skills from kindergarten (Catts et al., 2002). In this study, children who achieved higher levels of language skills had better reading outcomes than those who demonstrated significant improvement.

In addition to language, researchers who have investigated the impact of early speech impairment on reading suggest that a significant speech production problem may make the development of skills required for success in reading more difficult to achieve or demonstrate (Bird et al., 1995; Foley & Pollatsek, 1999; Smith, 2001). Much of the research on the relationship between speech production and reading describes children who have multiple speech production errors, as evidenced by specific patterns of errors with phonological processes, e.g. consistently producing the /t/ sound for the /k/ sound, as when a child calls a "cat" a "cat". Children with phonological speech production disorders are vulnerable to difficulties in phonological processing skills and subsequent literacy development (Bishop et al., 1995; Dodd et al., 1995; Webster & Plante, 1992). In a study of children between the ages of 3 and 7 with moderate to severe speech sound production problems, Lewis and colleagues (2004) report correlations between measures of articulation and phonology on one hand and measures of reading achievement (word attack, r = .45; word identification, r = .60; and passage comprehension, r =.54) on the other.

In summary, the majority of studies of children with DLD examine reading outcomes for children diagnosed in kindergarten or first grade. As a group, children with language disorders have more difficulty with reading words and understanding what they read compared with typically developing children, but within the DLD group there is wide individual variation. Longitudinal studies that show early difficulties with reading can begin with word recognition (Catts, 1993; Catts et al., 2002; Catts et al., 2003). Children who have difficulty with word recognition in kindergarten and first grade are more likely to have difficulty with reading comprehension. However, even children with

DLD who have adequate word recognition performance in first grade can have reading comprehension difficulties. Longitudinal studies examining reading comprehension in later elementary grades identify significantly different language profiles of children experiencing difficulties with reading comprehension. Low language performance on both grammar and vocabulary measures characterized this group (Nation, Stackhouse, et al., 2004). The nature of their language problems significantly influences reading outcomes. One of the issues related to reading problems is the severity of the language disorder. Severity is defined by range of language test scores or by the number of language areas (e.g. vocabulary, grammar or both) that are considered below average (Bishop & Edmundson, 1987). Other factors related to severity of reading problems include the persistence of language problems (Bishop & Adams, 1990; Catts et al., 2002; Snowling et al., 2000; Stothard et al., 1998), the number of language areas involved (Bishop & Adams, 1990; Catts, 1993; Share & Leikin, 2004), and co-morbidity of speech articulation disorder (Beitchman et al., 1996; Nathan et al., 2004).

There are fewer longitudinal studies examining reading outcomes for children diagnosed with DLD in preschool. Those that describe outcomes report that children who had preschool deficits in multiple language areas tended to be DLD at 5 and also had worse reading outcomes. Bishop and Adams (1990) found that children whose DLD persisted at 5 years showed problems in reading comprehension at age 8, but many of these children displayed adequate performance on word recognition in connected text. Indeed, even children with a preschool diagnosis of DLD who had age–appropriate language skills at age 5 performed within age expectations in reading, but demonstrated comprehension problems later in elementary school, at age 8 (Snowling et al., 2000;

Stothard et al., 1998). In addition to the influence of preschool language measures, performance IQ appeared to be a "protective factor" for early language disorders, with higher performance IQ abilities related to better reading outcomes (Snowling et al., 2000; Snowling & Hulme, 2005). Children whose speech difficulties persist into elementary school and those who have a comorbid speech problem are also more likely to experience reading difficulties than those who do not have a speech disorder (Beitchman et al., 1996; Nathan et al., 2004). There is consensus that children with language difficulties in preschool are at risk for reading difficulties. No studies to date have examined children indentified as DLD in preschool with average IQ and comorbid speech difficulties. Examination of a population with homogenous intellectual functioning at the time of diagnosis will provide a model for systematic investigation of factors related to the language disorder (e.g. severity, area of involvement and comorbid speech disorder) that contribute to risk for reading problems.

CHAPTER 3: METHODOLOGY

Study Questions and Hypothesis

The goal of this study is to further explore reading outcomes of children diagnosed with DLD in preschool who had a nonverbal IQ score at or above average ($\geq$ 80). Children were selected from a large multi-site study conducted in 1996 examining language and speech of preschool children who were referred for communications difficulties that were not due to hearing loss or identified neurological condition (Morris et al., 1996). Once enrolled in the study, children were classified into two groups based on the presence of social communication skill deficits (autism) and language deficits. Further division within the areas of autism and language deficit by level of intellection functioning (above and below a nonverbal IQ of 80) created four groups. The children with DLD for the current study did not display social communication deficits and had a nonverbal IQ of 80 or above (Morris et al., 1996). The focus of previous reports on this study was to describe the language and speech characteristics of the children with DLD compared to the other groups. Children with DLD as a group showed relatively even deficits across receptive and expressive skills at preschool with all scores falling slightly less than 1SD below norms on an overall language measure, with greater impairment in functional language skills than in vocabulary and grammar (Fein et al., 1996).

The current study focused on the group of DLD children who returned at age 7 for further evaluation that included language, speech, and reading assessments. The following research questions are the focus of this investigation:

1. What is the relationship between language and speech skills measured in preschool and language skills measured at age 7 for children diagnosed as DLD at preschool?

Hypothesis: Past research indicates that children's speech and language abilities are relatively stable over time. Therefore, children's speech and language performance at preschool is expected to be correlated with their performance at age seven.

2. What is the relationship between vocabulary, grammar, speech articulation and reading achievement at age 7 for children who are diagnosed as DLD in preschool?

Hypothesis: Deficits in language place children at risk for problems with developing semantic and phonologic pathways that build word-reading skills (Snowling & Hayiou-Thomas, 2006). Children who make consistent articulation errors have diminished capacity to produce phonological segments which directly affects the ability to read words (Carroll et al., 2003; Lonigan et al., 2000; McDowell et al., 2007). Therefore, vocabulary, grammar and speech articulation abilities are expected to relate to word reading skills. Previous research has consistently found that vocabulary and grammar contribute strongly to reading comprehension performance (Catts, 1993; Cain, et al., 2001; Muter et al., 2004; Nation et al., 1999; Nation & Snowling, 1998; Scarborough, 2001). It is expected that there will be a strong relationship between vocabulary, grammar and reading comprehension skills at age 7.

3. Do speech and language skills measured in preschool predict reading achievement at age 7?

Hypothesis: Previous research shows that language skills measured between the ages of 5 and 6 have a relationship to reading outcomes (Catts, 1993; Wise et al., 2007). Scarborough proposes that at a younger age, preschool language skills can predict reading outcomes for children and, in fact, vocabulary and grammar measured between the ages of 3 and 4 are specific areas of language capable of predicting later reading performance (Scarborough, 1998, 2001). Since vocabulary and grammar show a relationship to reading achievement outcomes in the school age population, a similar relationship between preschool language skills and reading achievement measured at school age is expected. In addition, research shows the role of articulation quality in the development of phonological skills needed for reading (Carroll et al., 2003; Lonigan et al., 2000; McDowell et al., 2007; Thomas & Senechal, 2004). Based on these findings, speech articulation quality at preschool will show a relationship with word reading skills.

4. Does language predict reading comprehension when controlling for word identification skills?

Hypothesis: The simple view of reading proposes that word reading is necessary but not sufficient for reading comprehension (Gough & Tunmer, 1986). Language skills are the additional component required for successful reading comprehension. Based on this view, language will account for additional variance in reading comprehension when controlling for word identification.

5. Does number of language areas impaired predict reading achievement at school age?

Hypothesis: Bishop and Edmundson (1987) report that preschool children who have a single area of language involved at the time of their initial diagnosis had better outcomes in language performance than children who had multiple areas of impairment. It is hypothesized that children who have more severe language problems that persist until age 7 will be at the greatest risk for reading difficulties in elementary school.

Methods

Participants

Study Recruitment

At preschool, participants were selected from a multi-site study of children who met the inclusion/exclusion criteria for the Autism and Language Disorders Nosology Project between the years 1985 and 1990 (Rapin, 1996). Professionals (speech-language pathologists, psychologists, neurologists, pediatricians, and psychiatrists with expertise in speech and language) referred to the study children whom they considered to be language impaired (Aram, Morris, & Hall, 1993). The methods of clinical diagnosis showed significant variation, with physicians relying primarily on clinical judgment, while speech-language pathologists and psychologists relied on some form of objective measure to supplement clinical judgment (Aram et al., 1993).

Recruitment occurred at six geographically separated sites that differed in the type of children recruited and socioeconomic factors. Since the primary goal of the recruitment was to ensure an "adequate number of children in the low base rate conditions", neither random nor consecutive sampling occurred at any of the sites (Rapin, 1996). Cleveland, Ohio; Manhasset, New York; and Bronx, New York were three sites

that primarily recruited children with language disorders. The Cleveland site recruited inner city children from the Cleveland Speech and Hearing Center and from speech pathologists in the greater Cleveland area. Children were seen for testing at the Cleveland Speech and Hearing Center. In Manhassset, all children recruited were students at a specialized preschool affiliated with North Shore Community Hospital, and were evaluated at the school. At the Bronx site, there were two sources of study referrals: the Therapeutic Nursery in the Division of Psychiatry at the Albert Einstein College of Medicine and the medical center practice of a pediatric neurologist. For the Boston and Trenton sites, children were recruited from specialized classes and schools for children with autism in the greater Boston, Rhode Island, and Connecticut areas, and throughout the state of New Jersey, respectively. Testing for the majority of these children occurred at the school. There were no significant differences between children recruited from the Boston and Trenton sites, or between those from the Cleveland and Manhasset sites. Children from the Bronx site, which recruited participants from all clinical groups, differed from all the other sites in the type of children recruited and socioecomic status (SES) ($F=33.1$, $p < .001$). The Bronx site recruited more children classified as high IQ autistic disorder because of their access to the therapeutic preschool which only enrolls children with autism and language disorders. The Bronx site was also one of the sites with a higher proportion of families in the above average SES level.

Initially children met the five general inclusion criteria: (a) a clinical diagnosis of developmental language disorder by a speech pathologist, psychologist or physician; (b) age between 3 and 5.11 years; (c) English as the only language spoken in the household; (d) hearing at 20dB or better binaurally at 1000 and 2000 Hz, or 25 dB or better at 500

and 4000 Hz; and (e) no known and defined brain lesions, frequent uncontrolled seizures, gross sensorimotor deficits, or high dosages of anti-epileptic or psychotropic medications. Of the original 633 children who met these criteria, 36 were excluded because of incomplete core data, and 41 dropped out of the study following enrollment. The remaining 556 children were placed in one of four clinical groups.

Study Enrollment

Once enrolled in the study, the 556 participants were classified into four clinical groups: high functioning autistic disorder (nonverbal intelligence quotient [NVIQ] $\geq$ 80), low functioning autistic group (NVIQ $\leq$ 80), nonautistic with low nonverbal IQ (NVIQ $\leq$ 80), and developmental language disorder (NVIQ $\geq$ 80).

The developmental language disorder group is the one used for the current study. Placement in the DLD group was based on three criteria: (a) a lack of autistic features on the Wing Autistic Disorder Interview Checklist (WADIC) or no diagnosis of Pervasive Developmental Disorder (PDD) from a psychiatrist; (b) a nonverbal IQ equivalent $\geq$ 80 on either the abstract-visual reasoning subtest of the Stanford-Binet Intelligence Scale-Revised or the Bayley Scales of Infant Development; and (c) a significant deficiency in language measures. This last criteria was defined as either a score on the Test of Early Language Development (TELD) (Hresko, Reid, & Hammill, 1981) 15 points (1 SD) below the mean of the child's nonverbal IQ score, or a mean length of utterance (MLU) score that was 1 SD below the mean for the child's chronological age (based on the criteria in Aram et al., 1993, and Morris et al., 1996). All children in the DLD sample (N=264) had a clinical diagnosis of developmental language disorder from a speech pathologist or neurologist. The mean nonverbal IQ for this group was 102.3 (SD 17.1). In

the DLD sample, 74% were males, 26% were females. Based on Hollingshead levels of socioeconomic status (Hollingshead, 1975), 10% were in the lowest income group, 18% were in the second lowest income group, 34% were in the middle-income group, 23% were in the upper middle group and 15% were in the high-income group. Racial representation was as follows: Caucasian, 75%; Black, 20%; Hispanic, 2%; and other, 4%. Education levels for fathers were 43% college graduates and 48 % high school graduates. For mothers, 39 % were college graduates and 55% were high school graduates.

Current Study

Seventy-one of the children returned for testing at age 7 years. These children primarily came from the Cleveland (39.70%), Bronx/Manhasset (39.70%) and Boston (19.20%) sites.

Table 1 provides a description of the demographic characteristics of the 71 participants. Participants represented a normal distribution across all income categories. The average onset of first words was 18 months. At initial enrollment, the mean age for participants was 4.15 years. The average age for participants returning for assessment at school age was 7.24 years. Males represented the majority in the gender distribution.

Education levels for fathers in the study group were 44% college graduates and 44% high school graduates. Forty-five percent of the mothers in the group were college graduates and 48% attained a high school education.

A history of language disorders for both immediate (parents and siblings) and extended (grandparent, aunts, uncles and cousins) family was identified by parent report

on the history questionnaire. Forty-nine participants (62.8%) had a family history of a language disorder in either the immediate or extended family.

Table 1. *Participant Demographics (N=71)*

Gender				
Males	71.6%			
Females	28.4%			
Socioeconomic Status (% in each category)				
I (High)	18.9%			
II	20.3%			
III (Middle)	29.7%			
IV	23.0%			
V (low)	6.8%			
Race				
Caucasian	71.6%			
African American	23.0%			
Hispanic	5.4%			
	Mean	SD	Variance	Range
Age (in months)				
Preschool	49.85	11.16	124.57	35-74
School age	86.83	2.29	5.26	83-93
Age in months for onset of first words	18.28	8.27	68.32	6-36
Age in months for onset of word combinations	27.10	9.29	86.25	8-48

Measures

The following measures were administered:

Language measures

Peabody Picture Vocabulary Test – Revised (PPVT-R): The PPVT-R (Dunn & Dunn, 1981) is a standard measure that evaluates single receptive vocabulary by offering children a four choice picture array from which they select one picture when the label is spoken by the examiner. Norms for children ages 2 and above provide standard scores using a mean of 100 and standard deviation of 15.

Expressive One Word Picture Vocabulary Test (EOWPVT) (Gardner, 1989): A measure of expressive lexicon and confrontation naming, the EOWPVT presents a picture for the child to label. Norms are for children over age 2, providing standard score equivalent using a mean of 100 and standard deviation of 15.

Illinois Test of Psycholinguistic Abilities (ITPA) grammatic closure subtest: The ITPA (Kirk, McCarthy & Kirk, 1968 consists of 24-pictured items. For each item, the examiner speaks two sentences, a stem sentence followed by a sentence with the final word omitted. Children are required to supply the missing word which deviates morphologically from the stem sentence. An example might be, "Here is a dog. Here are two ____ (dogs)". Pictures depict both sentences. Standard scores are provided with a mean of 100, standard deviation of 15.

Clinical Evaluation of Language Functions (CELF)-revised sentence formulation subtest: For the CELF (Semel, Wiig, & Secord, 1989), children listen to sentences and then select the picture that represents the spoken sentence. Standard scores begin at age 5 and have a mean of 10, standard deviation of 3.

Test of Early Language Development (TELD): The TELD (Hresko et al., 1981) is a composite measure of receptive, expressive, semantic and grammar skills designed for children between the ages of 2 years, 5 months and 7 years, 11 months. Children receive one point for every item scored correctly to calculate a total raw score. Raw scores are converted to standard scores with a mean of 100, standard deviation of 15.

Speech Measures

Photo Articulation Test (PAT): The PAT (Pendergast, Dickey, Selmar, & Soder, 1984) measures the phonetic and phonemic sound production characteristics of single word responses in a picture naming task. The child is asked to name presented color pictures and the evaluator records speech production to assess errors of articulation. Norms are available for children ages 3 to 12 for tongue, lip and vowel sounds as well as a total score. Raw scores are converted to standard age scores using the age norms available in the manual. Validity obtained by comparing scores to two other articulation tests was .82 to .97 and reliability is .99. Standard scores at preschool are calculated with a mean of 100, standard deviation of 15. At school age, percentile scores are used in the calculations.

Reading Achievement Measures

Woodcock Reading Master Tests-Revised (WRMT-R): Two subtests of the WRMT-R (Woodcock, 1987) were administered as measures of single word reading achievement. For both subtests, raw scores, indicating the number correct, and standard scores were available. These subtests are normed to a mean of 100 and standard deviation of 15. A .94 mean internal consistency reliability was obtained by split-half reliability. The word identification subtest assesses children's ability to accurately read and

pronounce printed English words ranging from high to low frequency of occurrence. The word attack subtest assesses children's ability to read pronounceable nonwords that vary in complexity and number of syllables.

Stanford Diagnostic Reading Test (SDRT) reading comprehension subtest: The reading comprehension subtest of the SDRT (Karlsen, Madden, & Gardner, 1976) has two sections. The first section measures a child's ability to read sentence length connected text and respond to a question about the content using a cloze technique. Children who are successful with these items proceed to the next section where they read short passages and answer both literal and interpretive comprehension questions. Standard scores are calculated in stanines. A stanine of 4 is considered average. Stanines below 4 are considered below average.

Procedures

Questionnaires encompassing medical, developmental, family history, behavioral, cultural and socio-economic domains were mailed to the families in advance of their initial visit to the testing center. After referral to the study, each child was seen at either a diagnostic center or at the child's school for administration of the standardized measures at preschool. These included the TELD, PPVT, OWPVT, ITPA and PAT. At this time, all children participated in a comprehensive neurological examination which included assessment of oral motor functioning.

At age 7, parents of children in the original study were notified by mail about additional testing. Seventy-one children returned to their center for a follow-up visit. At this time, measures were administered, including the PPVT, OWPVT, CELF, PAT, and subtests of the WRMT-R. Children who scored higher than a raw score of 10 on the word

identification subtest were given the SDRT. For those scoring lower than 10, the reading comprehension test was not administered since it was assumed they did not have enough word reading skills to read connected text. This occurred for 13 children who were given the lowest stanine (1) for reading comprehension for the cloze portion of the measure. There were 33 children with reading comprehension scores for the cloze section of the SDRT. An additional 13 (17%) of the scores were added based on word identification scores for a total of 46 participants.

Following approval from the Institutional Review Board, participants for the current study were mined from original data sets using SAS Version 9.1. A master data set devised in SAS was converted into SPSS version 15 for analysis.

The 71 participants were missing data for many of the tests. Of the 71 children who returned, the following number of children had scores on the language and reading measures: 71 for receptive vocabulary, 68 for expressive vocabulary, 68 for grammar, and 65 for speech articulation measures. It is not known why the data is missing. Data analysis was conducted on different subsamples of the participants. Techniques such as single imputation (Schafer & Graham, 2002) were considered to insert values into the data set for missing data but not implemented due to the small sample size.

Data Analysis

Standard scores were used in the primary analysis to control for age. Correlational analysis between language skills and reading at both ages was conducted to understand the relationship between the variables.

To evaluate a hypothesis about the contribution of vocabulary, grammar and speech articulation to reading outcome measures, a series of regression analyses tested

prediction models to identify speech and language variables predictive of reading achievement at age 7. The first run was a concurrent model at age 7 to determine if concurrent language and speech articulation predicted reading achievement. A second model tested variance accounted for by preschool vocabulary, grammar and speech articulation scores as a predictor of the reading achievement measures used, the WRMT-R word identification and word attack subtests, and the SDRT. A third model tested the effects of language at school age and preschool on reading comprehension, controlling for the effects of word identification using hierarchical regression.

To understand how language severity and the presence of an articulation disorder were related to reading achievement outcomes, an additional analysis was performed involving grouping children by severity (number of language areas involved) and the presence of a comorbid articulation disorder at both preschool and age 7. A one-way analysis of variance was conducted to compare score differences among the three groups (those with no area of involvement, those with a single area of involvement and those with two areas of involvement) on word identification, word attack and reading comprehension measures. A final analysis identified the percentage of children who would qualify as having reading difficulties by grouping children into four groups: children above and below 1 SD from the mean for word identification, and above and below the 4th stanine for reading comprehension.

CHAPTER 4: RESULTS

Results

Data Screening

Initial analyses involved a data screening process to determine whether participants in the study sample met eligibility requirements, and to identify missing variables, outliers, unusual data points or atypical distributions. Outliers identified for the PPVT and the ITPA grammatic closure subtest administered during preschool were not eliminated since these contributed to the range of variability in the population of young children with language disorders.

Forty-five participants had missing scores from the SDRT reading comprehension subtest. For participants scoring 10 or less on the word identification subtest, the lowest possible scores on the SDRT subtest replaced missing values. Thirteen scores (raw score of 2, stanine of 1) were added to the reading comprehension measure.

Preliminary analyses were performed to identify any violation of the assumptions of normality, linearity and homoscedasticity. Four variables showed significance on the Kolmogorov-Smirnov test: preschool grammar (ITPA; $p = .01$), school-age grammar (CELF; $p = .00$), school-age articulation (PAT; $p = .00$) and reading comprehension (SDRT; $p = .00$). Although violation of the normality assumption occurred, transformations were not performed due to the small sample size created by clinical referral.

Description of Study Sample

Participants' performance on speech, language and reading measures is displayed in Table 2. Surprisingly, preschool vocabulary, grammar, and speech scores were within the average range. By school age, group vocabulary and grammar scores were also within the average range. Skewness values reflected a clustering of scores at the low end of the scale.

Mean scores for reading outcome variables were within 1 standard deviation the mean except for reading comprehension scores, which were below the 4th stanine. As a group, only 11 children were able to complete the passage and question section of the reading comprehension measure, so only the sentence-cloze format was included in the analysis.

In order to explore language functioning further, children were classified according to whether or not they were 1 SD below the mean for areas of language (vocabulary, grammar, or both). In addition, children were classified by areas of language involvement (receptive vocabulary, expressive vocabulary, grammar or a combination of these areas). Only children who had test scores for both vocabulary and grammar were included. The results are presented in Table 3. The number of children in each group changed between preschool and school age: fewer children were in the typical range of language functioning (no areas below 1 SD of test norms) and more had at least one area of involvement. The number of children with a moderate to severe articulation disorder increased.

Table 2. *Performance on Language, Speech and Reading Measures.*

	n	*Mean*	*SD*	*Variance*	*Range*	*Skewness*	*Kurtosis*
Preschool Speech and Language							
TELD	74	77.39	13.50	182.11	60-118	.546	-.353
Preschool Receptive Vocabulary	73	87.27	16.45	270.56	41-124	-.314	.252
Preschool Expressive Vocabulary	71	86.93	19.40	376.35	55-122	-.369	-.932
Preschool Grammar	56	88.73	20.71	428.82	55-145	.782	-.065
Preschool Articulation	59	80.59	20.84	434.18	55-128	.676	-.171
School-Age Speech and Language							
School-Age Receptive Vocabulary	71	91.58	16.49	271.79	53-118	-.398	-.567
School- Age Expressive Vocabulary	68	103.85	20.51	420.58	55-141	-.388	-.300
School-Age Grammar	54	8.02	3.44	11.83	3-14	.622	-.889
School-Age Articulation	61	35.79	30.92	956.037	1-102	.224	-1.508
School-Age Reading Variables							
Word Identification Standard Score	60	97.32	20.01	400.19	32-157	.174	1.815
Word Attack Standard Score	49	94.45	17.43	303.63	33-140	-.504	2.60
Reading Comprehension Stanine	46	3.57	2.41	5.807	1-8	.260	-1.472

Table 3. *Classification by Severity, Co-morbidity with Speech Articulation Disorder and Area of Language Involved*

	Preschool (n=55)	School Age (n=43)
Severity		
No areas below 1 SD of test norms	38%	16%
1 area below 1 SD of test norms	35%	61%
2 or more areas below 1SD of test norms	27%	24%
Co-morbidity with speech articulation disorder		
Mild disorder (greater than 80)	37%	2%
Moderate to Severe Disorder (less than 80)	63%	98%
Area of language involvement		
No areas below 1SD	17%	16%
Receptive Vocabulary Only	10%	2%
Expressive Vocabulary Only	12%	0%
Grammar only	25%	43%
Receptive and expressive vocabulary	6%	14%
Receptive vocabulary and grammar	10%	24%
Expressive vocabulary and grammar	6%	2%
All three areas	15%	14%
Met Criteria for Reading Difficulties		
Word Identification		22%
Word Attack		31%
Reading Comprehension		48%

The Relationship between Language, Speech and Reading

Relationships between language, speech and reading were examined by calculating bivariate correlations between speech and language variables at each age and reading outcome variables. Table 4 displays the findings. Within age, language variables showed a significant relationship. Across age, correlations between speech and language

Table 4. Correlations between Speech, Language and Reading Variables.

	TELD PRE	PPVTPRE	OWPRE	ITPAPRE	PATPRE	PPVT7	OW7	CELF7	PAT7	WORD ID	WORD AT
1. TELD PRE											
2. PPVT PRE	.49**(73)										
3. OWPVT PRE	.46**(71)	.45**(70)									
4. ITPA PRE	.57**(56)	.40**(56)	.37**(55)								
5. PAT PRE	.03(59)	.07(59)	-.19(59)	-.01(52)							
6. PPVT 7	.44**(71)	.81**(70)	.50**(68)	.39**(54)	.18(57)						
7. OWPVT 7	.48**(68)	.67**(67)	.57**(65)	.34*(65)	.36**(55)	.73**(67)					
8. CELF- SENT 7	.49**(54)	.64**(53)	.43**(52)	.44**(53)	.09(43)	.56**(54)	.58**(51)				
9. PAT 7	.17(61)	.12(60)	.19(58)	-.04(49)	.49**(50)	.16(61)	.38**(60)	.04(46)			
10. WORD ID 7	.11(60)	.22(60)	.16(58)	.26(47)	.26(49)	.17(60)	.38**(58)	.27(44)	.15(53)		
11.WORD AT 7	.13(49)	.11(48)	.11(47)	.22(40)	.20(41)	.19(49)	.31*(47)	-.07(34)	.02(42)	.85**(48)	
12. READ COMP 7	.49**(46)	.54**(45)	.46**(45)	.44**(34)	-.003(37)	.53**(46)	.66**(45)	.58**(38)	.34**(39)	.66**(45)	.60**(34)

TELD= The Test of Early Language Development; PPVT=Peabody Picture Vocabulary Test; OWPVT = Expressive One Word Picture Vocabulary Test; ITPA= Illinois Test of Psycholinguistic Abilities; PAT= Photo Artic Test; CELF-SENT= Clinical Evaluation of Language Function Sentence Subtest; WORD ID= Word Identification Subtest of the Woodcock Reading Mastery Test of Reading; WORD AT = Word Attack subtest of the Woodcock Reading Mastery Test of Reading; READ COMP= Stanford Reading Comprehension Stanine.

* $p < .05$, ** $p < .01$. Sample sizes used in calculation contained in parenthesis.

measures (TELD, vocabulary, grammar, and speech articulation) demonstrated stability over time with strong, significant relationships. Language variables and reading comprehension at both ages showed significant, positive relationships. A significant link between expressive vocabulary and both single word-reading measures (word identification and word attack) was also observed.

A moderate relationship between speech articulation and expressive vocabulary was found at age 7. Reading comprehension showed a modest relationship to speech articulation at age 7. No other reading or language variables were related to speech articulation.

Speech and Language Performance as Predictors of Reading Achievement at School Age

Three multiple regression models were analyzed using the reading achievement measures (reading comprehension, word attack and word identification) as dependent variables. Receptive and expressive vocabulary, grammar and speech articulation at age 7 were the predictors in each of the models.

The model for school age vocabulary, grammar and speech was significant ($F_{4, 33} = 8.90$, $p = .000$), accounting for 46% of the variance in reading comprehension (adjusted R square = .462). Grammar scores made a unique significant contribution ($p = .04$) to this model. Expressive vocabulary approached significance ($p = .08$). Neither receptive vocabulary nor speech articulation was related to reading comprehension when other variables were controlled for.

Table 5. *School-age Speech and Language Variables as Predictors of Comprehension.*

	Reading Comprehension	
	$F_{(4,33)}$ =8.930, p =.000	
Predictor Variable	**Beta**	***p***
School age Receptive Vocabulary	.044	.81
School age Expressive Vocabulary	.370	.08
School age Grammar	.329	.04
School age Speech Articulation	.180	.19

In contrast, speech and language scores did not predict word identification ($F_{4,39} = 2.13$, $p = .10$) or word attack ($F_{4, 29} = 2.06$, $p = .11$).

Because word identification in theory contributes to reading comprehension, hierarchical regression, controlling for the influence of word identification on reading comprehension, was performed. Results are illustrated in Table 5. Word identification was entered in step one. Vocabulary and grammar were entered into the equation at step two. Combined, the variables accounted for 68% of the variance in reading comprehension ($F_{4, 33} = 15.27$, $p = .00$). School age language scores explained an additional 25% of the variance in reading comprehension when the effects of word identification were controlled for. Grammar scores approached significance as a unique predictor score at school age. Neither receptive nor expressive vocabulary achieved significance as unique predictors.

Table 6. *Hierarchical Regression using School-age Language Scores as Predictors.*

$F_{(4,33)} = 15.27$, $p = 0.00$

		Total			
Variable	Beta	R^2	R^2 change	t	*p*
Step 1		0.429			
Word identification	0.474			5.197	0
Step 2		0.678	.28**		
School age receptive vocabulary	0.134			.88	.39
School age expressive vocabulary	0.253			1.57	.13
School age grammar	0.225			1.793	.08

** *p*>.01

Preschool Speech and Language Standard Scores as Predictors of Reading Achievement

Three regression analyses determined whether preschool speech and language skills predicted reading achievement. The model for reading comprehension was significant ($F_{4, 29} = 4.593$, $p = .005$), accounting for 30% of the variance (adjusted R square = .303). Only receptive vocabulary made a unique contribution. No predictive relationship was observed between preschool expressive vocabulary and grammar on one hand and reading outcome variables on the other. When word identification was controlled for, the model did not achieve significance. Preschool speech and language variables did not predict a relationship for word identification and word attack scores.

Table 7. *Preschool Speech and Language Variables as Predictors of Reading Comprehension.*

	Reading Comprehension	
	F(4,29)=4.593, p =.005	
Predictor Variable	**Beta**	***p***
Preschool Receptive Vocabulary	.343	.06
Preschool Expressive Vocabulary	.227	.20
Preschool Grammar	.225	.18
Preschool Speech Articulation	.020	.89

Because of the significance of the school age model and the theoretical assumption concerning the contribution of word identification to reading comprehension, the school age model was tested by hierarchical regression, using preschool language and speech articulation variables with reading comprehension as an outcome variable, in order to determine if earlier language skills were predictive of reading skills. Word identification was entered first, followed by preschool language skills. The model was significant ($F_{4, 29} = 13.14$, $p = .00$). Combined scores accounted for more than 60% of the variability in reading comprehension. Preschool age language scores explained 22% of the variance in reading comprehension when the effects of word identification were controlled for. Preschool receptive vocabulary, measured by the PPVT, was a significant unique predictor. There was no significant relationship between preschool expressive vocabulary and grammar and reading outcomes.

Table 8. *Hierarchical Regression for Preschool Language*

$F_{(4,29)} = 13.15$, $p = .000$

	Beta	Total R^2	R^2 change	t	*p*
Variable					
Step 1		.655			
Word identification	.530			4.58	0
Step 2		.803	.216**		
Preschool receptive vocabulary	.277*			2.13	0.04
Preschool expressive vocabulary	.209			1.64	0.11
Preschool grammar	.119			.947	.35

** *p*>.01

Severity Group and Comorbid Speech Disorder Group Membership as Predictors

At school age, there is a significant group effect between the group with the most areas of language involved and the group with no areas of involvement for reading comprehension scores ($F_{2, 34} = 4.27$, $p = .02$). Post hoc analysis using Tukey's honestly significant difference test (HSD) indicated that the most severe group (both areas involved) was significantly different from the group with no areas involved on reading comprehension scores ($p = .02$). Groups were not significantly different in word identification or word attack performance. Significance was not achieved for speech articulation groups, defined as those with and without multiple articulation errors.

Table 9. *Mean and Standard Deviations for Reading Measures by School-age Severity Group (n=43).*

Severity Group at School Age	Word Identification		Word Attack		Reading Comprehension	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
No areas below 1 SD	106.12	8.90	92.25	16.11	5.14	1.95
One area (Vocabulary or grammar) below 1 SD	95.68	18.21	98.29	12.16	4.00	2.63
Both areas (Vocabulary and grammar) below 1 SD	92.62	16.31	92.00	10.45	2.09	1.76

At preschool, a significant group effect was observed between number of areas involved and word identification ($F_{2, 43} = 3.24$, $p = .05$). Post hoc analysis using HSD indicated that the children who had no areas below average were different from those who had a single area below average ($p = .04$). A significant group difference was also observed in reading comprehension ($F_{2,34} = 5.37$, $p = .009$). Post hoc analysis using HSD indicated that children who had no areas of language below average were different from those with one ($p = .008$) or both areas ($p = .008$) below average.

Table 10. *Means and Standard Deviations for Reading Measures by Preschool Severity Group*

Severity Group at Preschool	Word Identification		Word Attack		Reading Comprehension	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
No areas below 1 SD	106.2	13.71	101.60	9.22	5.22	2.22
One area (Vocabulary or grammar) below 1 SD	90.8	21.46	88.40	22.76	3.28	2.37
Both areas (Vocabulary and grammar) below 1 SD	94.09	16.53	88.00	10.87	2.86	2.12

Speech and Language Skills Based on Reading Comprehension Group

Based on reports of latent language impairment in children with reading comprehension difficulties (Catts, Adolf, 7 Weismer, 2006; Nation, Stackhouse et al., 2004) and current study results indicating a strong relationship between language skills and reading comprehension at both ages, scores were classified into two groups: high comprehenders (4 or greater stanine) and low comprehenders (less than 4th stanine). Ten (45%) of the participants in the low comprehenders group were those whose low scores were added based on word identification raw scores less than 10. Results are presented in table 11. Significant differences were observed for vocabulary and grammar at both ages between the two groups. Differences in language performance occurred from the very beginning of the study when the TELD was administered to determine enrollment eligibility. Children with average or above reading comprehension had higher language scores at both preschool and concurrent ages than those who scored below average. These two groups also had significant differences in word attack scores. School age speech

articulation scores revealed a significant difference between the two groups that was not observed at preschool.

Reading comprehension scores showed that 52% of the study sample performed in the average or above average range and qualified as high comprehenders. The majority of children in this group (85%) had word reading scores (word identification and word attack) in the average or above average range (above 85 standard score). Using this definition, only 15% of the children in this group experienced difficulty with word reading. Children in the low comprehension group comprised 48% of the study sample, with a majority (75%) demonstrating difficulty with word reading.

Table 11. *Comparison of Low versus High Comprehenders on Speech and Language Measures.*

		Low Comprehenders		High Comprehenders				
Preschool	*n*	Mean	SD	Mean	SD	t	*p*	eta squared
Receptive Vocabulary	45	79.64	15.23	97.35	15.05	-3.92	.00	.26
Expressive Vocabulary	45	80.68	17.53	94.43	20.36	-2.43	.02	.12
Grammar	34	84.19	14.20	98.83	23.64	-2.22	.04	.12
Articulation	39	78.06	14.52	81.05	22.10	-.493	.64	.06
TELD	46	70.86	10.75	83.33	14.01	-3.40	.001	.21
School Age								
Receptive Vocabulary	44	86.50	16.45	99.96	13.60	-3.01	.04	.17
Expressive Vocabulary	44	95.95	18.43	119.43	12.95	-4.47	.00	.36
Grammar	38	6.53	2.401	10.43	3.472	-4.08	.00	.32
Articulation	39	24.37	25.43	45.25	30.30	-2.34	.03	.13
Word Attack	34	82.70	2.21	99.42	13.12	2.23	.05	.29

CHAPTER 5: DISCUSSION

Discussion

The purpose of this study was to examine the relationship between speech, language and reading for children classified as DLD in preschool. Children in this study were a clinically referred convenience sample who scored more than 1 SD below the mean on a general language test. Children demonstrated language impairments based on TELD scores at the time of study entry, and their language impairments persisted through elementary school. 84% had one or more areas of involvement. Almost all of the children had comorbid speech impairment in elementary school. Language scores were stable from preschool to school age. The aspect of language involved changed from a broad range of functions impaired at preschool to primarily grammar at school age.

The Relationship between Language and Reading

School-age speech and language skills were strong predictors of reading comprehension abilities, accounting for 46% of the variance. Even after controlling for word identification skills, school age language skills continued to predict an additional 25% of the variance in reading comprehension performance. At school age, grammar was a unique significant predictor of reading comprehension, and expressive vocabulary approached significance as a unique predictor. In contrast, language was not strongly related to word reading. Only expressive vocabulary demonstrated a significant relationship to word identification at age 7. Speech articulation showed a modest relationship with reading comprehension, but there was no relationship to word reading.

At the beginning of the study, the group mean TELD score was below average, but individual vocabulary and grammar measures were within the average range (above 85 standard score). Some children who qualified for the study as DLD performed within the average range on individual measures (27%). Preschool language skills accounted for an additional 22% when word identification was controlled for. Receptive language approached significance as a predictor for reading comprehension at preschool.

What Accounts for the Relationship between Language and Reading Comprehension?

Language, particularly oral vocabulary and grammar, is the foundation for reading connected text (Catts , Hogan 7 Fey, 2003; McGregor, 2004). This assumption provides a theoretical framework for understanding the strong relationship between language and reading comprehension in children with language disorders in this study. Based on this perspective, it is not surprising in this study that language at school age predicted half of the variance of reading comprehension and preschool language predicted a quarter of the variance. Word reading is the other portion of the formula for reading comprehension based on the simple view of reading. The combination of word identification and oral language accounts for the largest proportion of the variance, a finding which supports the simple view of reading. Even when controlling for word identification statistically, language skills at both ages continue to predict reading comprehension skills.

Results from this study provide confirmation of the ability of preschool language skills to predict reading comprehension at age seven. Correlation findings and significant prediction models support Scarborough's notion that language skills measured at 3-4 years of age can predict reading performance (Scarborough, 2005).

Findings in this study support a developmental effect of language measurement for prediction of reading skills proposed by Scarborough (1998, 2005). Scarborough suggested that the aspect of preschool language able to predict reading depends upon the age at which language is measured. When language is measured between the ages of 3.5 and 4, as was done in the current study, the semantic aspects of language are better predictors (Scarborough, 2005). Results concur with findings from the Bishop and Adams 1990 study that examined models using specific language skills measured at age 4½. In that study, vocabulary and grammar abilities measured during preschool contributed significantly to reading comprehension outcomes at age 8.

Receptive vocabulary measured at preschool emerged as a unique predictor for reading comprehension in the current study. One potential reason for this finding is that receptive vocabulary reflects the amount of vocabulary knowledge a child knows but is not required to produce. At a younger age, assessing this type of vocabulary may more accurately reflect a child's knowledge of words.

Grammar at school age emerged as the strongest unique predictor for reading comprehension. This finding supports a previous study by Catts and colleagues (2002) in which a grammar composite score predicted reading comprehension performance in second and fourth grades better than a vocabulary composite score for children indentified as DLD in kindergarten.

Investigations comparing the performance of children who have strong and weak skills in reading comprehension concur with the current findings about the strong relationship between language and reading comprehension. Low language performance on vocabulary and grammar measures characterizes poor comprehenders, with a

substantial number of those children identified as having difficulties with reading comprehension meeting the criteria for language impairment (Nation & Snowling, 1998; Stothard & Hulme, 1992). In the current study, language skills predict reading comprehension performance such that children with comprehension difficulties had lower language scores.

Of the children in the current study, 48% were described as "poor comprehenders", meaning their reading comprehension score was one standard deviation or more below the mean. Other longitudinal studies report a tendency for more comprehension difficulties to emerge as children progress through elementary school (Snowling et al., 2000; Stothard et al., 1998). Children in the current study were tested at a younger age when demands for reading connected text are less stringent and there is more dependence on word reading.

Some researchers predict that poor reading accuracy will limit reading comprehension (Ehri & Snowling, 2004; LaBerge & Samuels, 1974; Perfetti & Hogaboam, 1975). However, evidence from multiple studies shows that some children with comprehension difficulties perform comparably to typical children on word reading tasks (Catts et al., 2006; Cain, Oakhill, & Bryant, 2004 Nation et al., 1999; Nation & Snowling, 1998; Stothard & Hulme, 1992). Unlike these investigations, children in the current study who demonstrated reading comprehension problems had word attack skills significantly below those at or above average reading comprehension. Significant speech articulation skill differences also characterized those with low comprehension skills. The combination of weak language and articulation skills may account for below average performance on the word attack subtest.

The Relationship between Language and Word Reading

Several theoretical positions predict a relationship between language and word reading. Word production models describe vocabulary as consisting of both semantic and phonological representations which develop simultaneously in preschool (Levelt, 1999; Metsala & Walley, 1998; Morrisette, 1999; Storkel & Morrisette, 2002). Another position is that children's vocabulary size relates to their word reading ability because a larger vocabulary gives rise to more well rehearsed phonological representations (McGregor, 2004. In addition, both semantics and phonology create dual pathways to word reading (Snowling & Hayiou-Thomas, 2006).

For typically developing children, there is evidence supporting a relationship between first grade grammar and vocabulary and word identification (Swank, 1997), and showing that preschool grammar (MLU) can predict word-reading skills (Bishop & Adams, 1990). Researchers report that only a small amount of variance in word reading is account for by language skills when phonological awareness is controlled for (Storch & Whitehurst, 2002) and predict a stronger pathway between receptive vocabulary and phonological awareness than between receptive vocabulary and word reading (Wise et al., 2007).

Findings in the current study did not support any of the predictions based on previous research. Neither preschool speech and language skills nor school age receptive vocabulary and grammar were related to word reading measures. Unlike the children in the Bishop and Adams study (1990), children in the current investigation had speech articulation disorders. Even though speech articulation did not show a relationship with

reading measures, perhaps the ability to produce accurate articulation patterns restricted word-reading performance for this sample.

A small proportion of the current sample met criteria (below 1 SD) for word reading difficulties (22% for word identification, 31% for word attack). This finding concurs with previous reports that many children with language disorders demonstrate proficient word reading performance (Bishop & Adams, 1990; Catts et al., 2002).

Expressive vocabulary at age 7 was the sole language aspect to predict word reading outcomes in this study, approaching a moderate degree of significantce undert the concurrent language model. Perhaps by school age, children have a more robust vocabulary knowledge which increases their capacity to produce a greater variety of words, subsequently increasing phonological representations (McGregor, 2004; Metsala & Walley, 1998). Measurement of expressive vocabulary and word identification offers an additional explanation for this finding. Word identification requires labeling of isolated words in context just as expressive vocabulary measures required picture name in context. At age 7, measures assessing both tend to contain more high frequency words.

What Do Comorbid Speech Problems Contribute to Reading Outcomes?

Comorbid speech problems were not significantly related to language or reading outcomes for this sample. Speech articulation performance was stable across time, and many of the children had a moderate to severe disorder. Although earlier studies support this lack of relationship, more recent theories and evidence support a relationship between speech production and word reading that was not seen in the current study (Carroll et al., 2003 Larivee & Catts, 1999; Nathan et al., 2004). Larrivee and Catts (1999), examining articulation and production of the sound form of the word, reported

that children's speech production composite score accounted for 43 % of the variance in word identification. The lack of significance in the current study may be due to the method used to measure speech articulation. Errors of articulation based on age percentile scores are not the same as consonant inventories or phonological production measures used in other studies. More comprehensive measures of speech production that include inventories of consonants produced and measures of phonologic form production offer a wider range of measures for speech production, and may show a stronger relationship to reading outcomes.

Study Limitations

The small sample size and the amount of missing data restrict generalization of results to the larger population of children with DLD. Attrition was high, with only 33% of the participants from the original preschool sample returning for testing at age 7. Families who returned for further assessment may have been more likely than those who did not to have the child still enrolled in therapy at one of the centers or to notice that the child may have a more severe disorder prompting a desire for additional testing. Another limitation of this study is that measures of phonological awareness were not analyzed. Inclusion of these would offer an opportunity to explore the mechanism of the language-reading relationship. A further limitation in this study is that word identification scores adjusted the reading comprehension variable. Although this is commonplace in reading studies, the effects of this adjustment increased the number of children in the below average reading comprehension group. If the test had been administered, there is a chance that some children would have achieved a higher score. In a study with a small sample size, this can influence findings. Despite the limitations, results from this study concur

with other investigations about the language-reading relationship in children with DLD: Such children are more likely to have difficulties with reading comprehension than word reading.

Future studies of larger numbers of children using phonological awareness and production measures, and analyses using more powerful statistical techniques such as structural equation modeling (SEM) or growth curve analysis may be able to estimate if the relationship is a direct one, between reading achievement measures, or an indirect one, through phonological awareness. This type of analysis provides an opportunity to examine whether the relationship between preschool language and reading outcomes is completely mediated by school-age language performance. Monitoring the effects of language intervention will also be helpful.

Conclusions

Research indicates that the most prominent predictor of future reading difficulties in elementary school is the presence of developmental language impairment during preschool (Catts, Hogan & Fey, 2003). This study adds to the body of literature on reading outcomes for children with language impairments by showing that preschool language skills can predict reading comprehension in early elementary school. Receptive language, which is commonly measured as part of a preschool language assessment, is an indicator of future reading comprehension performance.

Once identified, language remediation efforts may facilitate improved reading outcomes. Children whose language differences were resolved by age 5 are still at risk for reading difficulties, but at a much lower rate than those who have more severe impairments (Snowling et al., 2000; Stothard et al., 1998). Vocabulary and grammar,

which differentiate children with language disorders from typically developing children, provide the focus for intervention efforts. Improvement in these two skills may change the course of reading outcomes for children with DLD.

Early in the reading process, it is important to assess skills in both word reading and reading comprehension. In the current study, children tested at age 7 showed deficits in reading comprehension but not necessarily in word reading. Comprehension measures are more likely to capture the type of skill deficits related to language impairment.

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