A Longitudinal Investigation of Reading Outcomes in Children With Language Impairments

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This investigation examined the reading outcomes of children with language impairments (LI). A large subsample of children who participated in an epidemiologic study of language impairments in kindergarten (J. B. Tomblin, N. Records, P. Buckwalter, X. Zhang, E. Smith, & M. O'Brien, 1997) was followed into second and fourth grades. Participants' language, reading, and nonverbal cognitive abilities were assessed. Results indicated that children with LI in kindergarten were at a high risk for reading disabilities in second and fourth grades. This risk was higher for children with a nonspecific language impairment (nonverbal and language deficits) than for those with a specific language impairment (deficits in language alone). Children with LI in kindergarten who had improved in spoken language abilities by second and fourth grades had better reading outcomes than those with persistent language impairments. Also, children's literacy knowledge/experience in kindergarten and their initial reading achievement in second grade were good predictors of subsequent reading outcomes.

KEY WORDS: language impairment, reading disabilities, longitudinal

The ability to read accurately and fluently is a highly valued skill in any educated society. Upon entering school, most children learn to read without great difficulty. However, each year a portion of children experience significant problems learning to read (Snow, Burns, & Griffin, 1998). One group of children that is at high risk for failure in reading achievement is children with a history of developmental language impairments. Reading is a language-based skill, and thus, deficits in language development can negatively affect reading achievement. Numerous studies have supported a relationship between language impairments and reading disabilities. In the earliest studies, children with a history of language impairments (LI) were located later in childhood or adulthood and their academic achievement at that time was compared to their earlier speech-language (dis)abilities, as indicated in clinical records (Aram & Nation, 1980; Hall & Tomblin, 1978; King, Jones, & Lasky, 1982). More recently, longitudinal prospective studies have identified children with LI in preschool or kindergarten and have investigated their reading development in the early school grades (Beitchman, Wilson, Brownlie, Walters, & Lancee, 1996; Bishop & Adams, 1990; Catts, 1993; Menyuk et al., 1991; Naucler & Magnusson, 1998; Silva, McGee, & Williams, 1987; Stark et al., 1984; Tallal, Curtiss, & Kaplan, 1989).

Although this research has documented the relationship between language impairments and reading disabilities, it has not clearly specified

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the nature of this association. Factors responsible for this lack of specificity include (a) relatively small size of participant samples, (b) predominant use of clinically referred participants, (c) limited consideration of subgroups of children with LI, and (d) limited attention to variables that might differentiate children with LI who have good reading outcomes from those with poor reading outcomes.

Participant Samples

Investigations of the reading outcomes of children with LI have generally involved small samples of the target population (fewer than 100 children with LI). Small sample sizes are, in part, a function of the low incidence of language impairments in the population. Nevertheless, these small samples have limitations. They often preclude the observation of the full variation and heterogeneity of the disorder (Tager-Flusberg & Cooper, 1999). Small samples also limit statistical power and thus may prohibit the types of multivariate statistical analyses that are necessary to understand the complex relationships between oral and written language impairments.

Sampling problems have been exacerbated by the fact that children participating in this line of research typically have been ascertained by clinical referral or convenience sampling. Such sampling procedures are known to be associated with numerous forms of ascertainment bias. For example, clinically referred groups generally have over-representation of the most extreme cases in the population (Berkson, 1946). Also, participants in these groups typically have numerous problems other than the clinical condition under investigation. These biases limit the generalizability of previous findings to the clinical population at large and undermine efforts to examine the nature of the relationship between oral and written language impairments.

Subgroups of Children With LI

It is generally accepted that children with LI represent a heterogeneous group (Aram & Nation, 1980; Fey, 1986). A variety of clinical classification systems have been used to capture this heterogeneity. However, the most common approach is one that makes a distinction between children with LI who have or do not have more general cognitive deficits (Stark & Tallal, 1981). The term specific language impairment (SLI) is typically used to refer to children with language problems who do not have nonverbal cognitive deficits (or histories of neurological disorder, hearing impairment, or emotional disturbance). Generally, to be identified as SLI, a child must display language abilities that are below normal (e.g., < 85 standard score) and nonverbal abilities that are within normal limits (e.g., ≥ 85). Children with LI may be classified as having a nonspecific language impairment (NLI) if both verbal and nonverbal abilities are below normal limits. The latter children can be distinguished further from those with mental retardation in that their overall IQ is generally above 70 and they do not show the adaptive and behavioral deficits associated with mental retardation according to the DSM-IV (American Psychiatric Association, 1994).

Traditionally, the distinction between children with SLI and with NLI has been an important one, especially with regard to clinical service. In many clinical settings, children with SLI have qualified for language intervention, and children with NLI have not. This practice, often called cognitive referencing, has been based on the assumption that children's overall cognitive functioning places a limit on their response to intervention (Casby, 1992; Cole & Fey, 1996). Thus, it has been assumed that children with NLI would not make the gains in language intervention that children with SLI would. Recently, however, investigators have challenged the distinction between SLI and NLI on theoretical and clinical grounds (Cole, Mills, & Kelley, 1994; Lahey, 1990; Plante, 1998). Most importantly, several recent studies have failed to find that nonverbal IQ is predictive of response to language intervention (Cole, Dale, & Mills, 1990; Fey, Long, & Cleave, 1994). These and other findings have led researchers to question the utility of the distinction between SLI and NLI (Plante, 1998; Tager-Flusberg & Cooper, 1999).

Studies of the reading outcomes of children with LI could provide relevant data for evaluating the usefulness of nonverbal IQ-based classification systems of language impairment. For example, Bishop and Adams (1990) observed that in a group of 4-year-old children with LI, children with NLI (referred to as a general delay) were much more likely than were children with SLI to have subsequent reading problems at age 8.5 years. This pattern also held when these same children were followed up at 15 years of age (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998; also see Aram, Ekelman, & Nation, 1984). If these results are replicated, they would provide support for the distinction between children with SLI and NLI and could have important implications for the early identification and treatment of reading disabilities.

Differentiating Good and Poor Reading Outcomes

Though research indicates that many children with a history of LI have difficulties learning to read, this work shows that at least some children with LI go on to demonstrate typical reading development (Bishop &

Adams, 1990; Catts, 1993). What factors differentiate those with good and poor reading outcomes? As noted above, Bishop and Adams (1990) found that children with SLI typically had better outcomes than did those with NLI. However, the major factor they found to be related to reading outcomes was the persistence of the spoken language impairment. Specifically, they reported that 4-year-old children with LI who continued to have language problems at 5-1/2 years had poor reading achievement at age 8-1/2 years, whereas those who had resolved their language problems did not. Such a finding, of course, would be expected if there were a causal relationship between oral language development and reading achievement, regardless of the direction of influence.

The results of a recent follow-up study, however, indicate that the relationship between oral and written language impairments is more complex than the results cited above might suggest. Stothard et al. (1998) found that many of the above children with early LI who were no longer classified as LI at 8-1/2 and did not have reading problems at that age had significant reading difficulties and some language problems when seen at age 15. Such results suggest that early recovery in language may be illusory (Scarborough & Dobrich, 1990) and that oral and written language problems may resurface in children deemed to have outgrown these problems in elementary school years.

Another set of language variables that should be related to reading outcomes in children with LI involves measures of phonological processing. Numerous studies have shown a link between phonological processing and reading achievement in children selected from the general population (Catts, Fey, Zhang, & Tomblin, 1999, 2001; Torgesen, Wagner, & Rashotte, 1994; Wolf, Bally, & Morris, 1986). In a recent study, we found that measures of phonological awareness and rapid naming contributed uniquely to the prediction of reading achievement in our entire sample of approximately 600 participants (Catts et al., 2001). A few studies involving children with LI also have examined phonological processing (Catts, 1993; Kamhi, Catts, Mauer, Apel, & Gentry, 1988). For example, Catts (1993) found that kindergarten measures of phonological awareness and rapid naming predicted reading achievement in first and second grades in children with LI and/or articulation impairments in kindergarten.

A final factor that is likely to be related to reading outcome in children with LI is children's early literacy and/or reading achievement. In our prediction study noted above (Catts et al., 2001), we found that the best kindergarten indicator of subsequent reading achievement was a measure of letter identification (also see Scarborough, 1998). We expect that such a measure would also differentiate children with LI who have good reading outcomes from those with poor reading outcomes. However, once children with LI begin formal reading instruction, the best predictor of reading outcome is likely to be initial reading success/failure itself. Studies have clearly shown that children who get off to a good start in reading generally maintain that success, whereas those who have initial difficulties often continue to have reading problems (Scarborough, 1998).

The present study was undertaken to further investigate the reading outcomes of children with LI while overcoming the weaknesses of other studies. We identified a large representative group of children with LI in kindergarten, using epidemiologic methods of ascertainment rather than clinic referral, and followed them over a 4-year period. We sought to answer the following questions: (a) Do kindergarten children with LI have poorer reading achievement in second and fourth grades than do children with typical language development? If so, what proportion of kindergarten children with LI have reading problems in second and fourth grades? (b) Do reading outcomes vary for children with SLI versus those with NLI? and (c) What variables in children with LI are related to reading outcomes in second and fourth grades?

Method

Participants

The participants in this study formed a subsample of children who originally took part in an epidemiologic study of language impairments in kindergarten children (Tomblin et al., 1997). The epidemiologic investigation used a stratified cluster sample of 7,218 children. This normative sample was stratified by residential setting (i.e., rural, urban, suburban) and cluster sampled by school building. All available kindergarten children in selected schools were screened for language impairments. Children who failed the screening, and a random sample who passed, were given a test battery of language and other measures. The results of this assessment were used to estimate the prevalence of language impairments in kindergarten children (Tomblin et al., 1997).

On completion of the epidemiologic study, children who had received the test battery in kindergarten were solicited to participate in a follow-up longitudinal investigation conducted by the Child Language Research Center, a federally funded center for the study of language impairments in children (Tomblin, 1995). Because the primary purpose of the Center was the study of language and nonverbal cognitive impairments, all children who displayed these impairments on the kindergarten test battery were asked to participate. Of the 642 children with language and/or nonverbal impairments who received the kindergarten test battery in the epidemiologic study, permission to participate was received for 328. In addition to these children, a random sample of the children without impairments was recruited. Permission to participate was obtained for 276 non-impaired children, yielding a total sample of 604 children.[1] Complete or near-complete data are available on 570 of these children through fourth grade, and these children constitute the primary sample for the present investigation. Finally, all children were monolingual English speakers and had no history of sensory deficits or neurological disorders. In addition, no child had been diagnosed with autism or mental retardation at the beginning of the study.

The results of the diagnostic test battery administered in kindergarten were used to identify participants with and without LI. Our definition of a language impairment was consistent with that used in the epidemiologic study. This definition is based on a model of language that includes three domains of language (vocabulary, grammar, and narration) and two modalities (receptive and expressive). To use this definition, a composite score was calculated for each domain and modality of language (see "Language" section below). Participants were defined as having a language impairment if their performance on at least two of five language composite scores was 1.25 *SD* or more below their chronological age-expected score. These procedures identified 208 children with LI and 362 without LI.

For some analyses, children with LI were divided into those with specific language impairments (SLI) and those with nonspecific language impairments (NLI). Children with SLI (*N* = 117, 69 boys and 48 girls) met the definition for language impairment but scored no more than 1 *SD* below the mean on a measure of nonverbal IQ (Block Design and Picture Completion subtests of the WPPSI-R given in kindergarten). Children with NLI (*N* = 91, 44 boys and 47 girls) met the criterion for language impairment and scored at least 1 *SD* below the mean on the measure of nonverbal IQ. Although 24 of the latter children had estimated nonverbal IQ scores below 70, none had been diagnosed with mental retardation at the time of the epidemiologic investigation.

Children with typical language development could also be divided into those with and without nonverbal cognitive deficits. Participants who did not demonstrate a language impairment, but who met the criterion for a nonverbal deficit, composed the low nonverbal IQ (LNIQ) group (*N* = 94, 57 boys and 37 girls). This group, often missing in studies of language impairment, served as a useful comparison group when considering the relationship between nonverbal IQ and reading achievement. Those children who did not meet the criteria for either a language impairment or a nonverbal cognitive deficit composed the non-impaired control (NC) group (*N* = 268, 152 boys and 116 girls). Table 1 presents the means and standard deviations for chronological age, language composite score (described below), and nonverbal IQ for each of the groups and subgroups at the beginning of the investigation (kindergarten).

Materials

Table 2 displays the tests or experimental tasks employed over the course of this investigation. The test batteries can be divided into those tasks that measure language, phonological processing, reading, and nonverbal cognitive abilities.

[1] These children, segregated by diagnostic category, did not differ significantly in terms of demographic characteristics or language and cognitive abilities from those children who were not asked or did not choose to participate.

Table 1. Means and standard deviations for chronological age, overall language composite score, and nonverbal IQ in kindergarten for children in the non-impaired control group (NC), the low nonverbal IQ group (LNIQ), the specific language impaired group (SLI), and the nonspecific language impaired group (NLI).

	NC (*N* = 268)		LNIQ (*N* = 94)		SLI (*N* = 117)		NSLI (*N* = 91)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	5;10	0;4	6;0	0;4	6;0	0;4	6;0	0;4
Language	102.5	13.3	94.8	9.9	76.8	5.4	72.3	7.5
Nonverbal IQ	105.7	11.3	79.0	6.3	99.5	9.0	75.0	8.7

Note. Values for language composite score and nonverbal IQ are reported in standard scores with a mean of 100 and *SD* of 15. These scores were converted from *z* scores based on local norms (Language) or national norms (Nonverbal IQ).

Table 2. Test batteries administered in kindergarten, second, and fourth grades.

	Kindergarten	Second	Fourth
Language			
Test of Language Development–2 Primary			
Picture Vocabulary	X		
Oral Vocabulary	X		
Grammatical Closure	X		
Grammatical Understanding	X		
Sentence Imitation	X		
Narrative story task	X		
Clinical Evaluation of Language Fundamentals–3			
Sentence Structure		X	
Concepts and Directions		X	X
Word Structure		X	
Recalling Sentences		X	X
Listening to Paragraphs		X	X
Formulated Sentences			X
Peabody Picture Vocabulary Test–Revised		X	X
Comprehensive Receptive and Expressive Vocabulary Test			
Expressive Vocabulary		X	X
Narrative production task		X	X
Phonological Processing			
Deletion task	X	X	X
Rapid naming of animals task	X	X	X
Reading			
Woodcock Reading Mastery Tests–Revised			
Letter Identification	X		
Word Identification		X	X
Word Attack		X	X
Passage Comprehension		X	X
Gray Oral Reading Test–3		X	X
Diagnostic Achievement Battery–2			
Reading Comprehension		X	X
Nonverbal Abilities			
Wechsler Preschool and Primary Scale of Intelligence–Revised			
Block Design	X		
Picture Completion	X		
Wechsler Intelligence Scale for Children–III			
Performance Scale		X	

Note. The kindergarten testing was done as part of the Epidemiologic Study of Language Impairments (Tomblin et al., 1997).

Language

Because of the age span covered in this investigation, it was necessary to use a different set of language measures in kindergarten than in second and fourth grades. As part of the epidemiologic study, five subtests of the Test of Language Development–2 Primary (TOLD-2:P; Newcomer & Hammill, 1988) and a narrative story task (Culatta, Page, & Ellis, 1983) were administered to evaluate kindergarten language abilities. Local norms were used to convert raw scores to standard scores.[2] The

[2] Local norms were used for all language tests (including phonological processing) administered in kindergarten, second, and fourth grades. This procedure had the advantage of placing data from the standardized (e.g., TOLD-2:P) and nonstandardized (Narrative, Deletion, RAN-A) language measures on the same scale. This assured that the subtests we employed to diagnose a language impairment contributed to the diagnosis in similar ways. It also allowed for direct comparisons to be made across (cont'd)

standard scores, which were in the form of *z* scores, from the TOLD-2:P Picture Identification and Oral Vocabulary subtests were combined to form a vocabulary composite score. *Z* scores from the TOLD-2:P Grammatical Understanding, Grammatical Completion, and Sentence Imitation subtests were used to form a grammar composite score, and scores from the Narrative Comprehension and Recall measures were employed as a narrative composite score. To derive a receptive language composite score, *z* scores from the Picture Identification, Grammatical Understanding, and Narrative Comprehension subtests were combined. Finally, to obtain an expressive language composite score, *z* scores from the Oral Vocabulary, Grammatical Completion, Sentence Imitation, and Narrative Recall subtests were used. An overall language composite score was also calculated using the expressive and receptive language composite scores.

In second and fourth grades, language abilities were assessed by several standardized instruments and an experimental task designed for this investigation. The Peabody Picture Vocabulary Test–Revised (Dunn & Dunn, 1981) and the Expressive Vocabulary subtest of the Comprehensive Receptive and Expressive Vocabulary Test (Wallace & Hammill, 1994) were used to assess vocabulary knowledge and abilities. The Sentence Structure (second grade only), Concepts and Directions, Word Structure (second grade only), Formulated Sentences (fourth grade only), and Recalling Sentences subtests of the Clinical Evaluation of Language Fundamentals–Third Edition (CELF-3; Semel, Wiig, & Secord, 1995) were employed to measure grammatical knowledge and abilities. The Listening to Paragraphs subtest of the CELF-3 and a narrative production task (Fey, Catts, & Proctor-Williams, 2001) were employed to measure narrative processing abilities. The narrative production task involved participants telling a story in response to a series of pictures. Stories were scored on the basis of length and grammatical complexity. Again *z* scores were combined to form composites for each of the language domains, as well as overall language composite scores for second and fourth grades.

Phonological Processing

Two other language measures were administered to participants. These measures are subsumed under the heading of phonological processing. A distinction between phonological processing and other aspects of language processing is often made in reading research (Catts & Kamhi, 1999). Phonological processing measures included phonological awareness and rapid naming tasks. Phonological awareness was assessed by a syllable/phoneme deletion task that was an adaptation of Rosner's Auditory Analysis Test (Rosner & Simon, 1971). In this task, participants were required to delete a syllable or phoneme of a word and say the remaining sound sequence (see Catts et al., 2001). The deletion task was selected because research has shown that such tasks rank highly among phonological awareness tasks in predicting reading achievement (Torgesen et al., 1994; Yopp, 1988).

Rapid naming was assessed by the Rapid Automatized Naming of Animals task (RAN-A). In this task, participants rapidly named a series of colored animals presented on an 8 × 11-inch chart. Colored animals were chosen as stimuli rather than letters or numbers because previous work had shown that many kindergarten children, especially those with LI, could not consistently name letters or numbers (Catts, 1993). The 24 stimulus items used in our naming task consisted of three animals (cow, pig, horse) randomly displayed in one of three colors (black, blue, red). These items were randomly repeated in four rows of six items each. The total duration to name all stimulus items was measured with a stopwatch and recorded. The number of uncorrected errors was noted but was not included in the present analysis of results.

Reading

In kindergarten, early literacy knowledge was assessed by a measure of letter identification. In second and fourth grades, word recognition and reading comprehension were assessed.

Letter Identification. The Letter Identification subtest of the Woodcock Reading Mastery Tests–Revised (WRMT-R; Woodcock, 1987) was administered in kindergarten. This task measures children's ability to name letters of the alphabet presented in upper or lower case. Because letters are also shown in various typefaces, this test may also be sensitive to individual differences in literacy experience. Furthermore, because letter-name knowledge is largely dependent on instruction (Adams, 1990), grade-based norms were used rather than age-based norms.

Word Recognition. The Word Identification and Word Attack subtests of the WRMT-R were administered in

[2] (cont'd from prev. page) subtests. In kindergarten, the normative sample consisted of 1,456 children who received the entire test battery as part of the epidemiologic study. In second and fourth grades, scores were standardized based on the present sample of 570 children. Each of these samples differed from the original representative sample used in the epidemiologic study. However, because major participant characteristics were known in both cases, weighted scores could be employed to assure that our local norms were representative. In the process of converting scores, participants were grouped according to 6-month age intervals in kindergarten and 1-year intervals in second and fourth grades (see Tomblin, Records, & Zhang, 1996, for more details concerning justification of the norming procedures). Finally, because the measures of nonverbal intelligence and reading achievement (letter identification included) were not used in the diagnosis of language impairments and had well-accepted norms themselves, we used the published national norms to standardize these data. The latter standard scores were further converted to *z* scores using the weighted means and standard deviations of our local sample.

the second and fourth grades. The Word Identification subtest measured participants' ability to accurately pronounce printed English words ranging from high to low frequency of occurrence. The Word Attack subtest assessed participants' ability to read pronounceable nonwords varying in complexity. Again, grade-based norms were used to adjust raw scores. In order to form a composite score for word recognition, standard scores for these subtests were subsequently converted to z scores using the weighted means and standards deviations of our sample.

Reading Comprehension. Three tests of reading comprehension were administered. These included the Passage Comprehension subtest of the WRMT-R, the comprehension component of the Gray Oral Reading Test–3 (GORT-3; Wiederholt & Bryant, 1992), and the Reading Comprehension subtest of the Diagnostic Achievement Battery–2 (DAB-2; Newcomer, 1990). These tests/subtests measured comprehension in different ways; the WRMT-R subtest uses a cloze procedure, whereas the other two measures assess comprehension by having the participants read a passage and answer multiple-choice questions (GORT-3), or open ended questions (DAB-2). Again, grade-based norms (except for the GORT-3, which only included age-based norms) were employed to convert raw scores to standard scores. These scores were subsequently converted to z scores in order to derive a composite score for reading comprehension.

Nonverbal Cognitive Abilities

In kindergarten, the Block Design and Picture Completion subtests of the Wechsler Preschool and Primary Scale of Intelligence–Revised (WPPSI-R; Wechsler, 1989) was administered as a shortened version of the Performance Scale (Bishop & Adams, 1990; LoBello, 1991). These subtests measure a range of nonverbal cognitive abilities including visual attention, visual recognition, visual-motor coordination, and spatial reasoning (Kaufman, 1979). In second grade, participants were given the entire Performance Scale of the Wechsler Intelligence Scale for Children–III (WISC-III; Wechsler, 1991).

Procedures

Participants were tested during two 2-hour sessions in each grade. A total of 14 examiners participated in the administration of the kindergarten test battery and 3 in the second- and fourth-grade test batteries. Seven of the examiners were certified speech-language pathologists, and the remaining had undergraduate degrees in speech and hearing (n = 3) or education (n = 7). All language measures were administered by examiners certified in speech-language pathology. In addition, all examiners received approximately one week of training by the investigators on the administration of the testing protocols. Testing was conducted in specially designed vans parked at the participants' schools or homes.

Results

Reading Outcomes for Children With LI

Our first question concerns the nature of the reading outcomes of children with LI. Table 3 displays the reading achievement standard scores of the non-impaired control group, the LI group (also broken into the SLI and NLI subgroups), and the low nonverbal IQ control group in second and fourth grades. In our initial analyses, we compared the reading outcomes of the entire group of children with LI to that of the non-impaired control group. Multivariate analysis of variance

Table 3. Reading achievement in second and fourth grades for the non-impaired control group (NC), the language-impaired (LI) group (also divided into the SLI and NLI subgroups), and the low-nonverbal-IQ control group.

		Word Recognition				Reading Comprehension			
		2nd		4th		2nd		4th	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
NC	268	101.8	13.6	101.5	13.2	102.2	12.8	101.9	12.4
LI	208	87.0	14.4	87.1	17.3	83.9	12.4	83.5	14.1
SLI	117	90.3	13.3	91.3	15.2	87.3	11.1	87.2	12.6
NLI	91	82.9	14.6	81.8	18.4	79.6	12.5	78.8	14.7
LNIQ	94	93.1	15.5	92.6	16.1	89.9	12.8	89.9	14.4

Note. Values for reading achievement are reported in standard scores with a mean of 100 and *SD* of 15. These scores were converted from *z* scores based on national norms and weighted according to characteristics of the epidemiologic sample.

(MANOVA) indicated that the LI group performed significantly less well than did the non-impaired control group, Wilks Lambda (4, 471) = .62, $p < .001$. Follow-up univariate analyses of variance showed that children with LI scored significantly lower than did non-impaired control children in word recognition and reading comprehension in second and fourth grades, *F*s (1, 474) = 106.2–243.1, $p < .001$, *d*s = .86–1.17.[3]

Another way of characterizing the reading outcomes of children with LI is in terms of the percentage of these children who could be classified as having a reading disability in second and fourth grades. For the purpose of this investigation, a reading disability was defined as performance of at least 1 *SD* below the weighted mean of the present sample on the reading comprehension composite score. This cut-off value is consistent with that used by other researchers in the study of reading problems in young children (McArthur, Hogben, Edwards, Heath, & Mengler, 2000; Meyer, Wood, Hart, & Felton, 1998). It also represents a compromise criterion level when compared to that found in more liberal definitions (25th percentile, Fletcher et al., 1994; Stanovich & Siegel, 1994) or in more conservative definitions of reading disabilities (1.5 *SD*, Badian, McAnulty, Duffy, & Als, 1990).

Our results indicated that 52.9% and 48.1% of children with LI met this criterion in second and fourth grades, respectively. This compared to rates of 8.6% and 8.2% in the non-impaired control group. Although nearly half of the children with LI did not meet our definition of reading disabilities in second and fourth grades, many of these children were, nevertheless, poor readers. Further analyses indicated that when a more liberal criterion of below the 25th percentile was used as the criterion for a reading disability, 69.7% and 64.4% of children with LI were classified as poor readers in second and fourth grades, respectively. Finally, most children with LI who were poor readers based on reading comprehension scores also would have been identified as poor readers based on word recognition scores (67% in second grade, 61% in fourth grade). A small percentage of children with LI had word recognition deficits but did not meet the criterion for poor reader based on reading comprehension scores (10% in second grade, 12% in fourth grade).

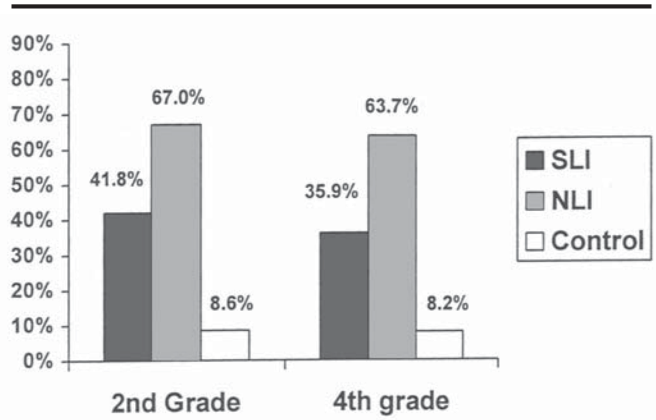
Subgroups of Children With LI

For our second question, we queried whether children with SLI and NLI have different reading outcomes. Table 3 displays the reading achievement scores of children with SLI and those with NLI. MANOVA indicated that children with NLI performed significantly less well in reading achievement than did children with SLI, Wilks' Lambda (4, 203) = .893, $p < .001$. Follow-up analyses of variance further showed that the NLI subgroup scored significantly lower than did the SLI subgroup on each of the measures of reading achievement, *F*s (1, 206) =14.8–22.3, $p < .001$, *d*s = .52–.63.

Reading outcomes of the above subgroups also were examined in terms of the percentage of children experiencing a reading disability in second and fourth grades (see Figure 1). These data showed that 67% of the children with NLI met the criterion for reading disability (i.e., 1 *SD* below the mean) in second grade and that 63.7% met this criterion in fourth grade. Children with SLI demonstrated corresponding rates of 41.8% and 35.9%. Again, though some children with LI (especially those with SLI) did not meet our definition for reading disabilities in second or fourth grades, most had below-average reading achievement scores. This pattern of performance is illustrated by the reading achievement distributional data displayed in Figure 2. These data show that only 17 children with SLI and 3 children with NLI scored above the mean (i.e., *z* score > 0) in fourth-grade reading achievement. (Although they are not displayed, similar distributions characterized reading comprehension in second grade.)

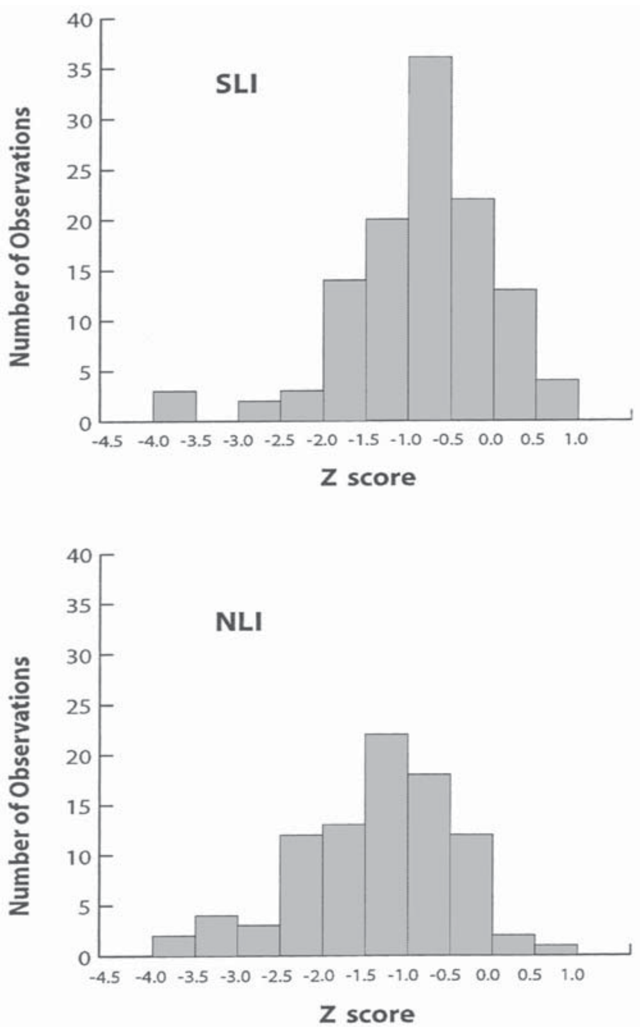
Further analyses indicated that about 30% of the participants in both the SLI and NLI subgroups had reading problems in one grade, but not the other. However, much of this variability was due to participants falling just outside the cut-off criterion level. When we used a cut-off criterion of –1 *SD* in one grade and a criterion of –.68 (25th percentile) in the other, only about 15% of the children in both subgroups showed an inconsistent pattern. In general, then, reading performance

Figure 1. Percentage of children in each group meeting the criterion for reading disability in second and fourth grades.



[3] Initially, we were also interested in the reading outcomes of children with LI who had primary deficits in one domain or another (e.g., grammar vs. vocabulary) or one modality or another (i.e., expressive vs. receptive). However, our initial analysis of the language data revealed little evidence of dimensionality in terms of domain or modality of language impairment (Tomblin & Zhang, 1999). This may have resulted, in part, from the assessment instruments we used and/or the way we defined a language impairment. We plan to pursue this issue further in the future.

Figure 2. Reading achievement distribution for fourth-grade reading comprehension in children with SLI and NLI.



was highly consistent across grades for this group of children with LI.

Variables Related to Reading Outcomes

Given that by definition, SLI and NLI subgroups differed on the basis of nonverbal IQ, the above results concerning subgroup differences in reading achievement suggest that nonverbal IQ is related to reading outcomes in children with LI. However, as shown in Table 1, SLI and NLI subgroups also differed in the severity of their language impairment. To control for the latter difference, analysis of covariance was employed. This analysis indicated that even when the degree of language impairment in kindergarten was statistically controlled, children with NLI had significantly poorer reading outcomes than did children with SLI, Wilks' Lambda (4, 202) = .94, $p < .05$.

The relationship between nonverbal IQ and reading achievement could be examined further by comparing the reading outcomes of the children with LNIQ to those of the non-impaired control group. Recall, that children with LNIQ had poor kindergarten performance in nonverbal IQ, but did not meet our definition for LI. For this issue, a comparison between the NC and LNIQ groups would be most informative if these subgroups were similar in language abilities, while differing primarily in nonverbal IQ. To assure this was the case, we again used analysis of covariance. This analysis showed that when kindergarten language abilities were used as a covariate, the LNIQ subgroup had significantly poorer reading outcomes than did the non-impaired control group, Wilks' Lambda (4, 356) = .89, $p < .001$.

Another factor that has been linked to reading outcomes in children with LI is the persistence of the language impairment (Bishop & Adams, 1990). To examine this issue in the present study, we compared the reading achievement scores of those children with LI in kindergarten who no longer met the definition for LI in second and fourth grades to those who continued to meet the definition. Results presented here are based on second-grade language status only (see Table 4). Results were quite similar when groups were based on fourth-grade language status. In addition, differences in reading outcomes based on language status were similar for children classified as SLI and NLI in kindergarten; thus, these groups were collapsed in the data presented here. Analysis of variance showed that children with LI in kindergarten but not second grade had significantly higher reading achievement in second and fourth grades than did those who continued to meet the definition of LI, Fs (1, 206) = 13.6–58.5, $p < .001$, ds = .51–.96. It should be noted, however, that although children who no longer met the criteria for LI were better readers than were those with persistent LI, these children's reading achievement scores were still significantly lower than were those of non-impaired control children, Fs (1, 350) = 28.8–64.5, $p < .001$, ds = .65–.92.

In interpreting the above results, it is not clear whether reading outcomes in children with LI are related to the degree of change in language from kindergarten to second/fourth grades or the actual language attainment at these grades. In other words, children who changed the most in language abilities from kindergarten to second or fourth grades may have had the best reading outcomes. Alternatively, those who achieved the higher language abilities in second or fourth grades may have had the best outcomes in those grades, regardless of the amount of change from their prior language status. To examine this issue, we carried out a series of hierarchical multiple regression analyses (see Table 5). These analyses showed that it was language attainment

Table 4. Reading achievement in second and fourth grades for children with LI in kindergarten who did or did not have language impairments in second grade.

		Word Recognition				Reading Comprehension			
		2nd		4th		2nd		4th	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
LI in kindergarten but not in second grade	84	93.0	11.7	92.3	13.6	91.0	9.5	90.0	10.1
LI in kindergarten and LI in second grade	124	83.8	8.7	82.5	10.7	79.2	11.8	79.1	14.8

(measured by language composite score in second/fourth grade) and not language change (measured by the difference score of kindergarten and second- and fourth-grade language composite) that was most closely related to reading outcomes. When the second- and fourth-grade language attainment was entered as the first variable, it accounted for a large amount of variance in the corresponding measures of reading comprehension. Once language attainment was entered, the amount of language change from kindergarten to second/fourth grades did not account for significant variance. As the first variable, language change did account for significant variance, but language attainment continued to account for a significant amount of variance in both second- and fourth-grade reading comprehension. The pattern of results was comparable when second- and fourth-grade word recognition was used as the measure of reading outcome.

Given that reading outcome was closely related to language attainment in second and fourth grades, we also examined whether one domain or modality of language at these grades was more highly related to reading outcome than others. This analysis showed that in both second and fourth grades the grammar composite (rs = .67 and .67) was more highly correlated with reading comprehension than was the vocabulary composite (rs = .50 and .55) or narrative composite (.31 and .41). Correlations between reading comprehension and receptive language (rs = .56 and .59, for second and fourth grades, respectively) were comparable to similar correlations involving expressive language (.52, .55). Again, the pattern of results was similar when word recognition served as the measure of reading outcome.

Although the above results concerning the concurrent relationships between language abilities and reading outcomes are important, they are limited when it comes to forecasting reading outcomes in children with LI. From a clinical perspective, we would like to know which children with LI in kindergarten (or second grade) are most likely to have poor versus good reading outcomes in second or fourth grades. To examine this issue, we carried out a set of stepwise multiple regression analyses. In the first of these analyses, we sought to determine which kindergarten variables were predictive of second- and fourth-grade reading outcomes in the children with LI. Given the above results indicating differential concurrent relationships between language domains and reading achievement, domain composite scores (i.e., vocabulary, grammar, narrative) were used in these analyses. Table 6 shows that the best kindergarten predictor of reading outcomes was letter identification. This variable explained 24.7% and 13.4% of the

Table 5. Hierarchical multiple regression analyses of language change and attainment as related to second- and fourth-grade reading comprehension.

		R^2	R^2 change	Partial correlations
Second grade				
1	Language attainment (second)	.375		.587
2	Language change (second-K)	.375	—	.031
1	Language change (second-K)	.261		
2	Language attainment (second)	.375	.114*	
Fourth grade				
1	Language attainment (fourth)	.429		.634
2	Language change (fourth-K)	.429	—	.024
1	Language change (fourth-K)	.329		
2	Language attainment (fourth)	.429	.100*	

*$p < .01$

Table 6. Stepwise multiple regression analyses of kindergarten predictors of second- and fourth-grade reading comprehension and word recognition.

Order of kindergarten predictors		R^2	R^2 change	Partial correlations
Second grade Reading Comprehension				
1	Letter Identification	.247		.376
2	Grammar Composite	.312	.065**	.195
3	Nonverbal IQ	.347	.036**	.201
4	Rapid Naming	.367	.020*	−.179
Second grade Word Recognition				
1	Letter Identification	.273		.395
2	Phonological Awareness	.315	.042**	.185
3	Rapid Naming	.343	.027**	−.190
4	Nonverbal IQ	.361	.019*	.160
Fourth grade Reading Comprehension				
1	Letter Identification	.134		.225
2	Nonverbal IQ	.196	.062**	.173
3	Rapid Naming	.218	.022*	−.131
4	Phonological Awareness	.238	.020*	.134
Fourth grade Word Recognition				
1	Letter Identification	.195		.305
2	Nonverbal IQ	.244	.049**	.155
3	Rapid Naming	.270	.027**	−.156
4	Grammar Composite	.287	.016*	.119

$^*p < .05$; $^{**}p < .01$.

variance in second- and fourth-grade reading comprehension scores, respectively. Letter identification also accounted for 27.3% and 19.5% of the variability in second- and fourth-grade word recognition scores, respectively. Among the remaining variables, grammar composite, nonverbal IQ, rapid naming, and phonological awareness accounted for unique variance in the various measures of reading achievement.

We also examined which second-grade measures were the best predictors of fourth-grade reading outcomes in children with LI (Table 7). In these analyses, we entered second-grade measures of reading, language, nonverbal IQ, phonological awareness, and rapid naming. As expected, the best predictor of fourth-grade reading achievement was second-grade reading achievement. These analyses showed that second-grade reading comprehension explained about 57% of fourth-grade reading comprehension, whereas second-grade word recognition accounted for nearly 75% of fourth-grade word recognition. Once reading achievement was entered in the regression equation, second-grade grammar composite score accounted for a significant portion of the variance in reading comprehension (3.7%) and phonological awareness accounted for a significant portion of the variance in word recognition (1.2%).

Discussion

Our results provide strong evidence of a relationship between developmental language impairments and reading disabilities. We found that children with LI in kindergarten performed significantly less well than did the non-impaired control children on measures of word recognition and reading comprehension in second and fourth grades. In addition, approximately 50% of the children with LI could be considered to have a reading disability in second and fourth grades. This rate is about six times that found for the non-impaired control group. The prevalence rate of reading difficulties observed in our participants with LI is generally consistent with that reported in previous studies (Aram et al., 1984; Catts, 1993; Menyuk et al., 1991). However, our study had the

Table 7. Stepwise multiple regression analyses of second-grade predictors of fourth-grade reading comprehension and word recognition.

Order of second-grade predictors		R^2	R^2 change	Partial correlations
Reading Comprehension				
1	Reading Comprehension	.567		.568
2	Grammar Composite	.603	.037**	.291
Word Recognition				
1	Word Recognition	.746		.735
2	Phonological Awareness	.758	.012*	.148

*$p < .05$; **$p < .01$.

advantage of having a large sample of children with LI who were identified using accepted epidemiologic methods and were not referred by a clinic. In addition, children with LI were identified in our sample on the basis of a current and replicable research-based definition of a language impairment. Our results are also presented in a manner that allows for the use of multiple criteria for reading disabilities in estimating prevalence rate (e.g., 1 *SD* versus 1.5 or 2 *SD* below the mean; see Figure 2). Thus, our findings should be useful for clinical practice as well as for policy formation in many different contexts.

Children With SLI Versus Those With NLI

Our findings concerning the differences in reading outcomes between children with SLI and those with NLI are consistent with, and serve to validate, other follow-up investigations that have examined similar subgroups (Aram et al., 1984; Bishop & Adams, 1990; Stothard et al., 1998). In our study, approximately 65% of children with NLI in kindergarten had a reading disability in second or fourth grades compared to about 40% of children with SLI. Thus, the empirical evidence available to date suggests that children with NLI are about 1.5 to 2 times as likely as children with SLI to have a subsequent reading disability.

Despite the fact that the differences in reading problems between children with SLI and NLI are likely to be more quantitative than qualitative, the above results suggest that a distinction between these groups can be clinically relevant. As indicated below, this distinction can serve to alert professionals to differences in the degree of risk for reading disabilities and assist them in planning intervention.

Variables Related to Reading Outcomes

Another important aim of this investigation was to identify factors that are related to reading outcomes in children with LI. Knowledge of such factors is relevant for both theoretical and clinical reasons. The above results showing differences in reading achievement between children with SLI and those with NLI indicate that nonverbal IQ may be one factor that is related to reading outcome. Such a conclusion is also supported by the comparison of the reading outcomes of non-language-impaired children with typical nonverbal abilities (i.e., NC) and those with low nonverbal IQ (i.e., LNIQ). Furthermore, our regression analyses demonstrated that kindergarten nonverbal IQ accounted for unique variance beyond letter identification and other variables in both second- and fourth-grade reading comprehension and word recognition.

Nonverbal cognitive abilities have not generally been considered to affect reading achievement as much as verbal abilities (Stanovich, 1991). However, it seems quite possible that the visual-spatial and analytic reasoning skills tapped by our measures of nonverbal IQ actually could contribute to learning to read. Also, nonverbal abilities could co-vary with higher-level language abilities that influence reading achievement but were not measured by our current battery of language tests (e.g., verbal reasoning). These results thus underscore the need for closer investigation of the complex relationships between reading achievement and particular verbal and nonverbal cognitive abilities.

Reading achievement in children with LI was also found to be related to degree of language impairment. Although, by definition, all children with LI had low language skills in kindergarten, there was variability in these skills. Those children with more severe language problems tended to have poorer reading outcomes. Our results further indicated that an important factor in the reading outcomes of children with LI was the persistence of the language impairment. Children who continued to meet the definition of LI in second grade (and fourth grade) had much poorer reading outcomes than did those whose language scores had improved. Additional analyses clarified that it was the language attainment and not the amount of language change that was most closely related to reading outcomes. Children who reached higher levels of language ability in second and fourth grades had better outcomes than those who had not improved to such levels, regardless of the amount of improvement children had exhibited.

Further results showed that the second- and fourth-grade grammar composite score was more closely associated with reading outcomes than were other domain scores. The grammar composite is composed of scores from subtests that tap several aspects of grammatical knowledge (morphology, syntax), as well as other abilities such as working memory. The importance of grammatical weakness in the identification of SLI is well established (e.g., Leonard, 1998; Rice, Wexler, & Hershberger, 1998), so this finding is not surprising. It is unclear from our investigation, however, whether cognitive skills related specifically to grammatical processing contribute directly to children's problems in reading or whether a deficit in grammar is simply the best index of persistent language impairment, with deficits in specific grammatical subskills contributing only indirectly to reading failure. The nature of grammatical impairments and their relationships to reading problems must be explored more closely in future investigations.

As noted above, Bishop and Adams (1990) also reported that children with LI who improved in their language abilities from the initial evaluation had higher reading achievement scores than did those with persistent language impairments. In their study, the age range in which language change was observed was from 4 to 5 years of age. Our study measured language abilities at 6 years of age and again at 8 and 10 years. Thus, our results extend those of Bishop and Adams and indicate that a primary factor associated with reading outcomes in children with LI is change in language impairment status over the period from 4 to 10 years of age. Children with LI who improve in their language abilities and reach more typical levels of functioning during this period should be expected to have better reading outcomes than those with persistent language impairments.

It is important to note, however, that these children may still experience reading problems. Participants who no longer met the definition of LI in second grade were still found to have significantly lower reading achievement in second and fourth grades than did the nonimpaired control children. Also, Stothard et al. (1998) reported that children with LI who improved from 4 to 5 years of age (those from the Bishop & Adams study), and no longer met the criteria for language impairment, nevertheless often had reading disabilities at 15 years of age. We also plan to reevaluate our participants in the later school grades and therefore should be able to offer further data concerning the relationship between persistence of LI and reading achievement.

In interpreting the results concerning the relationship between language attainment and reading achievement, it is important to bear in mind that the measurements involved were concurrent in nature. As such, the causal direction of the relationship is not known. Though it is well accepted that children's language abilities lay the groundwork for reading achievement (Catts et al., 1999; Catts & Kamhi, 1999; Scarborough, 1990; Snow et al., 1998), learning to read likely influences spoken language development. In other words, once children gain sufficient (emergent) reading skills, reading and oral language probably have mutual influences on one another. Such a reciprocal relationship may thus account for the associations between language attainment and reading achievement in children with LI.

Predicting Reading Outcomes in Children With LI

Another problem associated with using concurrent observations is the inability to predict future outcomes from such data. In the present case, we would like to know which children with LI in kindergarten are at most risk for reading problems in later grades. To address this issue, we carried out a series of stepwise multiple regression analyses. Results showed that a combination of kindergarten variables explained 36–37% of the variance in second-grade reading achievement and 24–29% of the variance in fourth-grade reading achievement. The best kindergarten predictor of subsequent reading achievement was a measure of letter identification. Such a measure may be especially predictive of subsequent reading achievement for several reasons. First, the cognitive/perceptual processes involved in learning to distinguish and name letters are similar to those involved in word recognition. Also, letter identification is in part a reflection of literacy experience, which in turn affects reading achievement. Either way, knowledge of letter names in kindergarten is a good indicator of subsequent reading achievement in many children, including those with LI (also see Scarborough, 1998).

Other kindergarten variables also accounted for unique variance in reading achievement. The grammar composite, nonverbal IQ, rapid naming, and phonological awareness each explained unique variance in reading achievement. Although the combination of these measures and letter identification accounted for less than half of the variance in second or fourth-grade reading achievement, knowledge of children's performance on these tasks might still be helpful in identifying children with LI who are at high risk for reading disabilities. Alternatively, procedures described in another study involving our entire sample may prove more useful in this regard. These procedures, which use a similar set of variables, were shown to accurately predict subsequent reading outcomes in kindergarten children without first requiring a diagnosis of language impairment (see Catts et al., 2001).

Beyond kindergarten, the prediction of reading outcomes in children with LI is much more accurate. Our results showed that measures of reading comprehension and word recognition in second grade accounted for much of the variance in similar measures in fourth grade (57%, 75%). Thus, these results indicate that children with LI who get off to a good start in reading are likely to have much better subsequent reading achievement than those who demonstrate initial difficulties in reading. Finally, in addition to second-grade reading achievement, we found that second-grade measures of grammar and phonological awareness added significantly to the prediction of fourth-grade reading comprehension and word recognition, respectively. Thus, each of these measures in second grade might also be considered in predicting future reading achievement.

Clinical Implications

Practitioners and researchers are becoming increasingly interested in the early identification of reading disabilities (Scarborough, 1998; Snow et al., 1998). Research demonstrating the long-term stability of reading problems (Juel, 1988; Scarborough, 1998) has led to an emphasis on early intervention (Fey, Catts, & Larrivee, 1995; Snow et al., 1998; van Kleeck, Gillam, & McFadden, 1998). To provide such intervention, at-risk children need to be identified prior to beginning formal reading instruction. Our results indicate that the presence of a developmental language impairment should be taken as an important sign of risk for reading disabilities. Thus, these children should be candidates for special attention on early literacy, whether that attention is provided through special education resources or through the regular education system. Clinicians working with children with LI should ensure that these children are identified as at risk and that they receive appropriate early intervention services.

Our results further show that children with NLI are at a higher risk for reading disabilities than are children with SLI. Thus, the former children may be especially good candidates for early intervention. However, as noted in the introduction, children with NLI have often not qualified for language intervention. It has typically been assumed that these children did not have high potential for improvement in language. As reported above, recent research has not supported this assumption (Cole et al., 1990; Fey et al., 1994). This work suggests that children with NLI can benefit from language intervention, and in a comparable manner to children with SLI. Furthermore, reading intervention research indicates that poor readers with lower IQs (many of whom also likely have NLI) may respond to reading intervention (at least at the word recognition level) as well as those with higher IQs (Hatcher & Hulme, 1999; Raining-Bird, Cleave, & McConnell, 2001; Torgesen et al., 1999; Vellutino, Scanlon, & Lyon, 2000). This work combined with that in language intervention, indicates that children with NLI and SLI should be identified early and provided with literacy-based intervention.

Beyond the designation of SLI versus NLI, other factors can distinguish children with LI who are most at risk from those who are less at risk. Our results indicate that individual differences in letter identification in kindergarten can inform early identification. Also, once reading instruction has begun, initial levels of attainment should be particularly predictive of subsequent success/failure. Finally, those children who continue to show deficits in language should be considered most at risk.

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