Development of oral reading fluency in children with speech or language impairments: A growth curve analysis

Cynthia S. Puranik[1], **Yaacov Petscher**[1], **Stephanie Al Otaiba**[1], **Hugh W. Catts**[2], and **Christopher J. Lonigan**[1]

[1]Florida Center for Reading Research, Florida State University

[2]University of Kansas

Abstract

This longitudinal study used piece-wise growth curve analyses to examine growth patterns in oral reading fluency for students diagnosed with speech (SI) or language impairments (LI) from first through third grade (*N* = 1,991). The main finding of this study was that a diagnosis of SI or LI can have a detrimental effect on early reading skills and these problems can be persistent. The results indicate differences between subgroups in growth trajectories that were evident in first grade. These differences were associated with a students' speech or language status. A large proportion of students with SI or LI did not meet grade-level reading fluency benchmarks. Overall students with SI showed better performance than students with LI. Reading fluency performance was negatively related to the persistence of the SI or LI; the lowest performing students were those originally identified with SI or LI whose diagnosis changed to a learning disability. The results underscore the need to identify, monitor, and address reading fluency difficulties early among students with SI or LI.

Keywords

language impairment; learning disabilities; reading disabilities; reading fluency; speech impairment

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Learning to read and write is imperative in today's society. Literacy is the foundation for acquiring knowledge in school and for success in the workplace. Although the National Assessment of Educational Progress data suggest that reading achievement in the US has increased slightly since 1992, about 36% of fourth grade students cannot read at a basic level (U.S. Department of Education, 2005). Legislation such as the Reading First initiative of the No Child Left Behind Act (2001) and the Individuals with Disabilities Education Act (2001) was passed with the goal of teaching *all* children to read by third grade. Yet, far too many children with disabilities do not read well enough to meet grade level benchmarks on high stakes state and national assessments or to read grade level materials. One such group is children with speech impairments, language impairments, or both.

Researchers have demonstrated that speech or language impairments negatively impact individuals' reading and writing skills. There is a substantial body of evidence showing that children with a preschool diagnosis of language impairment (LI) are at a high risk for developing reading disorders (Aram, Ekelman, & Nation, 1984; Aram & Nation, 1975; Bishop & Adams, 1990; Bishop & Edmundson, 1987; Catts, 1993; Catts, Fey, Tomblin, &

Cynthia S. Puranik, Ph.D/CCC-SLP Florida Center for Reading Research 227 N. Bronough Street, Suite 7250 Tallahassee, FL 32301 Tel: 850-645-7105 Fax: 850-645-1907 cpuranik@fcrr.org.

Zhang, 2002; Catts & Kamhi, 1999; Magnusson & Naucler, 1990; Scarborough & Dobrich, 1990). As they progress through elementary school, these children lag behind age-matched controls on tests of decoding, word recognition, reading comprehension, and spelling. Longitudinal research has shown that children with language impairments continue to express deficits in written language throughout adolescence (Goulandris, Snowling & Walker, 2000; Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

Some researchers have argued that not all children with LI are at risk; instead, they argue that it is the persistence of the LI that is predictive of later literacy success or failure. According to Bishop and Adams (1990), who proposed the "critical age hypothesis," children whose early language impairments had resolved between 5 and 6 years of age, or by the time they begin to receive formal reading instruction, were not at risk for developing reading difficulties. In contrast, children whose language problems persisted beyond the beginning of formal reading instruction were at increased risk for reading difficulties (Bishop & Edmundson, 1987; Bishop & Adams, 1990; Catts et al., 2002).

The results of some longitudinal studies, however, indicate that a substantial proportion of the children with LI whose problems had resolved continue to be at risk as they move through later elementary grades and beyond (Snowling et al., 2000; Stothard et al., 1998). For example, Snowling et al. (2000) followed-up on the children from the Bishop and Adam's (1990) study, and they found that the prevalence of reading difficulties among children whose LI had resolved in preschool, increased from 6 percent to 24 percent between the ages of 8 and 15 years. This evidence appears contrary to the "critical age hypothesis." Instead, this evidence suggests that early recovery from oral language deficits might be illusory (Scarborough & Dobrich, 1990). Oral and written language deficits might resurface at least for some children past the preschool years.

Conclusions drawn from studies in which the relationship between reading and speech impairments is examined have also been contradictory. Some investigations have led to the conclusion that children with speech impairments (SI) are at risk for later reading failure (Bird, Bishop, & Freeman, 1995; Carroll & Snowling, 2004; Core, Lombardino, & Dyson, 2004; Gillon, 2005; Larrivee & Catts, 1999; Leitão & Fletcher, 2004). In contrast, other investigations have reported that the literacy performance of children with SI is not significantly different from that of children without SI (Bernhardt & Major, 2005; Hesketh, 2004; Leitão, Hogben, & Fletcher, 1997; Nathan, Stackhouse, Goulandris, & Snowling, 2004). Despite these inconsistencies, the persistence of the speech impairment has been identified as a risk factor for developing reading difficulties (Bird, et al. 1995; Larrivee & Catts, 1997; Nathan et al., 2004; Raitano, Pennington, Tunick, & Boada, 2004), similar to the risk associated with persistent language impairments.

Reading is a complex skill with several components contributing to a person being a good reader, namely, decoding, word recognition, vocabulary, reading fluency, and comprehension. To be a skillful reader, a person needs to be proficient in all of the component skills contributing to reading. Difficulty with decoding, poor sight word recognition, or a deficient vocabulary can interfere with reading fluency, which in turn affects reading comprehension--the ultimate goal of all reading. Past research has shown that children with LI have difficulty with decoding and word recognition. Difficulty with decoding, word recognition, or both can have a detrimental effect on reading fluency, perhaps making reading effortful and laborious and having negative consequences on comprehension. Deficiencies in phonological processes and speech difficulties in children with SI could contribute to them being less fluent readers. Yet, the majority of studies have examined only decoding or word recognition abilities in relation to SI or LI, and a few have

examined reading comprehension in children with LI. To date, no study has investigated the effect of SI or LI on oral reading fluency, despite its important role in reading comprehension. This is surprising because oral reading fluency appears to be especially important for reading comprehension in the early elementary grades (Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008; Riedel, 2007; Stahl, 2004).

It is also important to examine how SI or LI affect reading fluency because dysfluent reading has been identified as the dominant problem preventing students from passing high stakes state assessments such as the Florida Comprehensive Assessment Test (FCAT; Schatschneider et al., 2004). Students' performance on state-wide assessments is an issue at the top of every school district's educational agenda, as it is a direct reflection of the school and district's performance. Because oral reading fluency measures reliably predict performance on a variety of state assessments (Barger, 2003; Good, Simmons, & Kame'enui, 2001; Shaw & Shaw, 2002; Wilson, 2005; Vander Meer, Lentz, & Stollar, 2005), they may be considered "early warning signs" that students need additional intervention support to be successful (Buck & Torgesen, 2003). Researchers have shown that remediation of reading fluency is especially challenging after the third grade (Torgesen, et al., 2001; Torgesen, Rashotte, & Alexander, 2001), and hence, early identification of reading fluency deficits is imperative. Given that the persistence of the LI or SI has been implicated as a key factor in causing reading difficulties, it also is important to learn whether there are reliable differences in oral reading fluency trajectories between children whose SI or LI has resolved versus children whose SI or LI has persisted.

Finally, studies examining reading outcomes in children with LI and SI have generally involved a small number of students, perhaps reflecting the low prevalence of speech and language impairments in the population. Studies with small samples have limitations in that they often preclude the observation of the full variation and heterogeneity of the disorder (Tager-Flusberg & Cooper, 1999). Most importantly, small samples limit statistical power and prevent the types of analyses required to understand fully the complex nature of the relationship between speech and oral language and reading impairments (Catts et al., 2002). Students for these studies are generally recruited through clinical referral or through their participation in special schools, and frequently, these studies exclude students from a range of socioeconomic backgrounds. Such procedures can under identify the degree of risk, given that poverty is associated with both oral language and reading difficulties (Snow, Burns, & Griffin, 1998).

This study was undertaken to examine the oral reading fluency (ORF) outcomes of students with SI or LI to address some of the gaps in current research. The specific aims of this study were: (a) To examine growth patterns in ORF in children diagnosed with SI or LI from first through third grade, and (b) To determine if ORF outcomes differed between students whose SI or LI had resolved versus those with persistent deficits.

Because reading is a language-based skill, it was expected that deficits in oral language skills and speech deficits would negatively impact reading achievement. It was anticipated that both children with SI and children with LI would show deficits in ORF. However, based on the literature, it was anticipated that students with speech impairments would outperform students with language impairments. Additionally, because persistence has been identified as a key factor in risk for reading difficulties, it was expected that students with either persistent SI or persistent LI would perform lower than students whose LI or SI had resolved.

Method

*Participant*s

Students were drawn from the Progress Monitoring and Reporting Network (PMRN), Florida's data management and storage database of over 1.2 million students in Florida. This database includes demographic information about all students attending Reading First schools, including gender, date of birth, free and reduced lunch status, ethnicity, special education status, and whether students are currently receiving English as a second language services. All students for whom three years of data existed from 2003-04 to 2005-06, who began as first grade students in 2003-04, and who had a diagnosis of either speech or language impairment were selected from the PMRN for further data screening and analyses. This resulted in a total sample of 1, 991 participants of whom 1,388 were identified with speech impairments and 603 were identified with language impairments in first grade. To identify students needing speech or language services, the general practice in the State of Florida is to show a discrepancy between the child's chronological age and their speech and language performance. Detailed eligibility requirements in practice for the State are provided in Appendix A. When students are diagnosed with both LI and SI, their primary exceptionality is considered to be LI; this precluded the isolation of students with a comorbid diagnosis of SI and LI.

The LI and SI groups were divided into resolved and persistent subgroups to examine if reading fluency growth rates were different for students who had persistent problems in speech or language versus those whose problems were resolved. Students were categorized as persistent if they had a diagnosis of SI or LI from first through third grade. Students were categorized as resolved if they did not have a diagnosis of SI or LI either in second or third grade. Finally, we observed that for approximately 27% of students with persistent problems, their diagnosis changed from LI or SI to a learning disability (LD) during second or third grade, indicating that these students began to experience significant academic difficulties in addition their speech or language difficulties. At the time of the study, to qualify for LD services in the State of Florida, students needed to show a difference of at least one standard deviation between their IQ and their performance scores. These students were retained in the sample not only because they were expected to have the most severe reading difficulties but also because their diagnosis began with a speech or language delay (e.g., Eisenmajer, Ross, & Pratt, 2005; Kamhi & Catts, 1986).

Participants were divided into six subgroups: (1) Speech Impaired-Persistent ($n = 1,047$): students who received speech therapy services from first through third grades; (2) Language Impaired-Persistent ($n = 475$): students who received language therapy from first through third grades; (3) Speech Impaired-Resolved ($n = 278$): students who exited out of speech services during second or third grade; (4) Language Impaired-Resolved ($n = 65$): students who exited out of language therapy during second or third grade; (5) Speech Impaired-Learning Disability ($n = 63$): students whose primary exceptionality changed from speech impaired to specific learning disability in either second or third grade; (6) Language Impaired-Learning Disability ($n = 63$): students whose primary exceptionality changed from language impaired to specific learning disability in either second or third grade.

Performance of the various LI and SI subgroups were compared to a local normative reference group ($n = 8, 833$) that was comprised of typically developing students from the PMRN database who did not have a diagnoses of a primary exceptionality (e.g., visually impaired, gifted, educable mentally handicapped, severely emotionally disturbed, SI, LI, LD) in first, second, or third grade. This reference group was taken from Reading First schools which included a significantly large numbers of students living in poverty. Because this reference group may not be representative of state or national norms, in addition to

comparing the performance of the various subgroups to the typical reference group, student's outcomes were also compared to statewide benchmarks for ORF to provide a metric of students' overall performance. These benchmarks have been developed to describe students' risk levels (high risk or moderate risk) and are used by educators to assist them in making decisions regarding the kind and amount of support that student's require. Demographic information for each of the six SI and LI subgroups as well as the local normative group is shown in Table 1.

Materials

The Oral Reading Fluency measure from the Dynamic Indicators of Early Literacy Skills (DIBELS™; Kaminski & Good, 1996) is a test of reading accuracy and speed with connected text. ORF passages are calibrated for the goal level of reading for each grade level. Student performance is measured by having students read previously unseen grade level passages aloud for one minute. Words omitted or substituted and hesitations of more than three seconds are scored as errors. Words self-corrected within three seconds are scored as accurate. The number of words correct per minute (WCPM) from the passage is the ORF rate. At each assessment, students are given three passages to read and scores are calculated for all three passages. A students' ORF score was the median score from these three passages. In Florida, from 2003-04 to 2005-06 school years, DIBELS™ were administered four times per year (i.e., September, December, February, April). Speece and Case (2001) reported parallel forms reliability coefficient of .94 and predictive criterion-related validity coefficient of .78 (October to May) with the Basic Reading Skills Cluster score of the Woodcock Johnson Test of Achievement-III (WJ-III; Woodcock, McGrew, & Mather, 2001). These data correspond with other reports of strong technical adequacy of ORF measures (e.g., Deno, 1985; Fuchs & Fuchs, 1992; Marston, 1989).

Growth Modeling Analysis

To model student growth across first, second, and third grade in ORF, data were summarized using a hierarchical piecewise growth curve model (PGCM). The PGCM is an extension of the more traditional growth curve model, with the exception that it allows the researcher to simultaneously test separate growth profiles within the same regression model (Neter, Kutner, Wasserman, & Nachtsheim, 1996). A primary assumption of using the PGCM requires that the regression of the outcome measure (i.e., ORF) varies as a function of the model covariates. Within this study, it was expected that linear function would be more homogenous within grades and would have high heterogeneity in intercepts and slopes across grades. Thus, the PGCM was believed to be more appropriate for the current analysis. As the PGCM is simply an extension of traditional growth models, similar issues apply to the piecewise model including centering, estimation of random and fixed effects, and contrasts.

As seen in the PGCM in Appendix B, standard HLM notation is applicable to this model; that is, we are modeling the growth for student i at time t, where $t = 0$ for the month of September. A traditional growth model for one piece in time would include the parameters π_{0i}, π_{1i} for a linear model, and π_{2i} for a quadratic model, as well as the error term e_{ti}, and all associated level-2 parameters. Notation for the PGCM are indicated by π_{3i} ,- π_{8i} in the level-1 model, as the second and third grade intercepts and slopes. These covariates represent dummy coded parameters that are interpreted in a similar manner as any covariate in a traditional growth model. The level-2 model further explains the relationships among fixed effects, as the second and third grade grand mean intercepts and slopes are estimated for each of the six level-2 covariates. As one can observe in the level-2 portion of Appendix B, our structural model contained no intercepts. All of the level-2 predictors were dummy coded fixed variables; thus, it was not as important to compare fitted means to a referent

individual as it was to estimate fitted means for each group, and to test for differences in pair-wise comparisons.

The quadratic parameters added another dimension of complexity when estimating growth curves for different groups of students. The ability to test curvilinearity in a regression function as opposed to a linear relationship can improve the precision of any growth model, given the correct number of time points (i.e., > 3) and functional form. Thus, both linear and non-linear models were estimated, using a chi-square deviance test to establish the degree of improvement for adding the quadratic term. A quadratic term can be informative in describing growth of reading-related skills over time, as it accounts for the dynamic nature of this change (Raudenbush & Bryk, 2002). Furthermore, although a quadratic term accounts for non-linear changes, it also manipulates the interpretation of the slope. No longer is a standard linear interpretation relevant, and one must estimate growth rates for the specific intervals assessed. Raudenbush and Bryk (2002) provide the following to evaluate the growth at any point in time:

$$\text{Growth rate at time } x = \pi_{1i} + 2\pi_{2i}t$$

where

π_{1i} is the linear slope for person i at time x

π_{2i} is the change in slope for person i at time x

a_{ti} is the point in time one wishes to estimate the instantaneous growth rate for person i t is the number of months after September.

As an example, if growth in oral reading fluency were measured at the beginning of the school year (e.g., September), with time centered at the beginning of the study (i.e., 0) and an estimation for growth set during December (i.e., 3), our calculation would be *linear* + 2(*quadratic*) * (3) . Growth across the months within each year was calculated as a function of this formula, to provide a more reliable representation of group growth over each school year.

Results

Conditional and unconditional models for the combined sample

Variances in intercept, growth, and acceleration across the three grades for the combined sample are shown in Table 2. The results indicated that groups varied on their initial intercepts in all three grades. Relative rankings of groups based on their initial intercepts were predictive of the group's performance at the end of the year for all three grades. Significant variability among groups also was noted in growth (linear slope) and rate of acceleration (quadratic slope) for the third grade but not for the first or the second grade. This significant variance in third grade can be explained by the students' speech or language status as seen in the conditional model.

Growth in reading fluency

First Grade Growth—Parameter estimates for intercepts, growth, and acceleration for the PGCM are presented in Table 3. Most first grade students in this study began the school year above grade level in ORF (i.e., reading > 7 WCPM; Figure 1) with the exception of the SI- and LI-Learning disability groups, who were reading 4.6 and 6.3 words correct per minute (WCPM), respectively. Both these LD subgroups began first grade at a disadvantage, showing below grade performance in reading fluency and continuing to perform below grade level throughout the year.

The subgroups varied on their initial ORF scores starting in first grade, however, only certain comparisons were reliably differentiated in how groups began the school year. The SI-Persistent ($\chi^2 = 84.70$, $p < .001$) and the SI-Resolved ($\chi^2 = 63.52$, $p < .001$) subgroups performed significantly better than the SI-Learning Disability students. The initial ORF scores for the LI-Persistent subgroup was significantly lower than the ORF scores for the LI-Resolved subgroup ($\chi^2 = 5.34$, $p < .05$) and the LI-Resolved subgroup had better ORF scores at the beginning of first grade than the LI-Learning Disability ($\chi^2 = 8.70$, $p < .01$) subgroup. Differences between the SI-Resolved and SI-Persistent subgroups were not significant. The highest achieving subgroups, SI-Resolved, LI-Resolved, and SI-Persistent, were all relatively homogenous in their initial intercepts, and they appeared to maintain similar levels of growth throughout the year. Although the LI-Resolved students had a larger linear growth rate (1.02 WCPM/month) than did the SI-Resolved students, the divergence in the trajectories between them and the SI-Resolved subgroup was accounted for by the greater rate of acceleration observed in the SI-Resolved students (0.75). Furthermore, whereas the SI-Persistent subgroup started at a similar place as the SI- and LI-Resolved subgroups, their linear growth rate was only about half that of the SI-Resolved subgroup, which resulted in an end-of-year estimate that was 5 WCPM less than the SI-Resolved subgroup.

LI-Persistent students started the year above grade level (9.4 WCPM) but were performing below grade level by mid-year (i.e., by mid-October). Although children in this subgroup scored near the benchmark level between September and December, they began to significantly diverge from the benchmark in January, and they continued to deviate away from benchmark levels through the rest of the school year. This change was largely attributable to their poor linear growth and to the student's slower acceleration compared to the other persistent and resolved subgroups. One of the most striking features of the first grade data was that relative rank order of groups in September did not change across the year. Although a curvilinear shape existed, there was divergent growth occurring during this year. Differences between subgroups got wider from the beginning to the end of the year.

Second Grade Growth—Intercept differences for the subgroups that were observed at the end of first grade continued into second grade (Figure 2). The relative ranking of groups remaining unchanged; however, the gap between some subgroups widened. The SI- and LI-Resolved students began the year at the same level of fluency, reading 65 WCPM, but they began to diverge from each other at roughly the same month as in first grade (i.e., October). SI-Persistent subgroup started out second grade with a lower level of fluency than the SI-Resolved subgroup ($\chi^2 = 4.80$, $p < .05$), and a higher level of fluency than SI-Learning Disability subgroup ($\chi^2 = 73.37$, $p < .001$). The SI-Persistent subgroup outperformed the SI-LD ($\chi^2 = 80.10$, $p < .001$) students. The LI-Persistent subgroup also began the year lower than the LI-Resolved students ($\chi^2 = 26.97$, $p < .001$) but better than and the LI-Learning Disability students ($\chi^2 = 20.89$, $p < .001$).

The SI-Resolved students were above benchmark for more than half of the school year (September to mid-January), and they were then on grade level for the remaining time. LI-Resolved students, however, were only on grade level until mid-December, at which point they were below grade through April. Although the LI-Resolved students did show acceleration in their fluency growth during the second half of the year and almost caught up the SI-Resolved students, they were still classified as being below grade level. The SI-Persistent subgroup was above grade level at the start of second grade but was considered at moderate risk around mid-December (Figure 2). At the mid-point of the year, students in the SI-Persistent subgroup experienced an increase in their rate of fluency growth, at which point they were able to close the gap slightly with the SI-Resolved subgroup, but they continued to stay below grade level.

Replicating findings from first grade, the ORF scores for LI-Persistent students were not closely aligned to any of the other subgroups in terms of initial status. They began the year reading 46 WCPM, and although they appeared to be on grade level, their rate of deceleration during September to December was such that they were performing below grade level throughout this time period. By February, these students ORF scores had fallen significantly below grade level. Likewise, both the SI- and LI-Learning Disability subgroups, although at moderate risk in September, were significantly below grade level for most of the year beginning in December.

Third Grade Growth—The transition between second and third grade did not mark any noticeable increases in intercept differences, contrasting the change between first and second grade. Again, the relative rank ordering of subgroups stayed constant across the year, with the exception of the SI-Learning Disability students ending the year at a slightly higher level than the LI-Learning Disability subgroup. Both resolved subgroups (LI-Resolved and SI-Resolved) started the year at grade level, and they stayed at grade level for most of the school year. SI-Persistent subgroup began the year at a higher rate of fluency than the SI-LD subgroup ($\chi^2 = 49.09$, $p < .001$), replicating findings in earlier years. The LI-Resolved subgroup performed significantly better than the LI-Persistent subgroup ($\chi^2 = 41.09$, $p < .001$) and the LI-Learning Disability subgroup ($\chi^2 = 43.36$, $p < .001$). The SI-Resolved students outperformed the SI-LD ($\chi^2 = 52.08$, $p < .001$) students. Differences between the SI-Persistent and SI-Resolved groups were not significant.

The LI-Resolved students, showed a decline in ORF performance in March, and they ended the year slightly below grade level benchmarks. SI-Persistent students had a notable pattern of growth during the year. Namely, they began the year at moderate risk, but they accelerated enough to be on grade level from November through February. At this point, however, their rate of acceleration was not large enough to maintain grade level performance, which resulted in a moderate risk status by the end of the year. The LI-Persistent subgroup was below grade level throughout the school year, beginning third grade reading 20 WCPM less than the SI- or LI-Resolved subgroups (Table 2) and ending the year at the same level of discrepancy with both subgroups (Figure 3). Both LD subgroups were at high levels of risk, starting the school year reading approximately 40 WCPM, which is the end of year benchmark for first grade. Generally, the graphs for third grade (Figure 3) represented a linear trend, which was a departure from the curvilinear trajectories observed in both first and second grades. Estimates for quadratic change during third grade were fairly small (range = −0.14 to 0.04).

Intercorrelations among intercepts and growth parameters—Intercorrelations among the intercept and growth parameters for the two-level model are reported in Table 4. There were strong relationships between acceleration of growth in first grade and initial status in second (0.84) and third (0.78) grades. Such strong associations indicate the highly predictive nature of slope changes during first grade. Visually, the fan spread growth that began in September resulted in large end-of-year intercept differences in first grade (Figure 1). Furthermore, the strong correlation between first grade intercepts and slopes (0.98) reflect remarkably stable group rank order across the year. Specifically, students that started out higher in first grade grew faster, and this rate of growth was predictive of the relative rank order of groups in both second and third grades (Figures 2 and 3). Because the correlations between intercepts and slopes were small in second and third grades (-0.10 for both grades) and because the correlation between intercepts across second and third was collinear (0.91), it is apparent that the rate of acceleration in first grade was the most predictive component in determining the initial status of students ORF performance in 2nd and 3rd grade.

Performance of subgroups and typical reference group based on ORF benchmarks—Students were characterized as being at or above grade level or at moderate to high risk based on ORF benchmarks. The proportions of students in each of the SI and LI subgroups as well as for the typically developing group at these benchmark levels are shown in Table 5. A majority of the students in the LD subgroups were no longer on grade level by the end of first grade. This proportion of LD students not meeting grade level benchmarks remained relatively constant until the end of the third grade, with approximately 62% of the SI-Learning disability subgroup and 61% of the LI-Learning disability subgroup classified as being at high risk.

A slightly different trend was noted for the two persistent subgroups. The proportion of LI-Persistent students in the high-risk category at the end of first grade was almost three times greater than that in the typical reference group, and it was more than four times the proportion of LI-Resolved students. The total proportion of LI-Persistent student's not meeting grade level benchmarks more than doubled from first to third grade. Only a very small proportion of SI-Persistent students were classified as high risk at the end of first grade, but this proportion increased across second and third grade. However, this increase was comparable to the typical reference group. Similar results were obtained for the resolved subgroups.

Discussion

The main findings of this study were that speech or language impairments can have a negative impact on the growth of reading fluency skills. ORF growth trajectories differed based on the students' speech and language status. Overall, the language impaired subgroups showed poorer performance compared to the speech impaired subgroups. Furthermore, children with persistent-LI performed significantly more poorly than children with resolved-LI whereas children with persistent-SI showed marginally poorer performance than the children with resolved-SI. Not surprisingly, children whose diagnosis changed from SI or LI to LD showed the poorest performance. Most importantly, these differences in developmental trajectories for ORF appear early. That is, there were already substantial differences between groups of children by the middle of the first grade, and in most cases, these differences increased from grade one through grade three.

The results of this study add to the current body of research regarding reading underachievement of children with SI or LI by demonstrating that a significant proportion of these students did not meet grade level ORF benchmarks and had lower performance compared to the typical reference group. It is evident that a substantial proportion of students with LI or SI not only struggle with decoding and word recognition as demonstrated by previous research but also with fluent reading in the early elementary grades. It is only logical that difficulty decoding and poor word recognition abilities would negatively impact reading fluency which in turn is bound to have deleterious effects on the students' ability to read and comprehend grade level material. A striking degree of continuity and stability was noted in ORF difficulties from first through third grade. Significantly, the findings indicate that first grade growth and performance by the middle of the school year predicted relative rank status in ORF development and performance across all three years. The results of this study extend the findings of previous investigations with typically developing students that have shown strong evidence of continuity and stability between early and later reading difficulties to the population of students with speech or language disorders (Juel, 1988; Scarborough, 1998; Torgesen & Burgess, 1998). Additionally, these findings also extend the findings of studies examining ORF development across the early elementary years, showing that difficulty with reading fluency can be

reliably detected as early as first grade in students with SI or LI (Deno, Fuchs, Marston, & Shin, 2001; Riedel, 2007; Speece & Ritchey, 2005).

The persistence of the language impairment was strongly associated with ORF outcomes. The results of this study provide support for the "critical age hypothesis" (Bishop & Adams, 1990) which states that children whose language impairments resolve by the time they begin formal reading instruction are not at risk for developing reading difficulties. The LI-Resolved subgroup performed significantly better than the LI-Persistent subgroup across all three years, thus adding to the extant research base reporting that children with persistent-LI are at a much higher risk than those with resolved-LI (Bishop & Edmundson, 1987; Catts et al., 2002; Snowling et al., 2000; Stothard et al., 1998). The gap between the LI-Resolved and LI-Persistent subgroups and the LI-Resolved and LI-LD subgroups was apparent starting in the middle of first grade, and this gap continued through the end of third grade. The LI-Persistent and LI-LD subgroups consistently showed below grade level performance for all three years.

Whereas on the one hand our results support the 'critical age hypothesis,' on the other hand the results do not clearly indicate that children whose language problems had resolved were not at risk. Although the results of the growth curve analysis show that the LI-Resolved subgroup started first grade meeting grade-level ORF benchmarks, the proportion of LI-Resolved students considered to be at moderate or high risk increased substantially from first through third grade. This finding validates the results of Snowling et al. (2000) and Stothard et al. (1998) by showing that the prevalence of reading difficulties among the resolved LI children increased after first grade. The evidence instead seems to suggest that early recovery from oral language deficits might be illusory, at least for a substantial proportion of students (Scarborough & Dobrich, 1990). LI-Resolved students appear to maintain grade levels ORF skills in first grade but start presenting with ORF deficits in second and third grades, perhaps when the difficulty and complexity of the reading materials increase. Following these students beyond third grade will help to further clarify this issue. Differences in vocabulary skill, decoding, and word recognition abilities could also be factors why some student's are more successful than others and should be included in future research.

Unlike in the case of the students with language impairments, differences between the resolved versus persistent SI subgroups were not significant. Additionally, on average, children with SI showed performance comparable to the typical reference group. However, when examining the proportion of students in terms of grade level benchmarks, the ORF achievement in children with SI appears to be related to the persistence of their impairment. The proportion of children with SI in the high to moderate risk category (see Table 5) was substantially high, with the SI-LD subgroup with the highest proportion, followed by the SI-Persistent group. Hence, these results can be interpreted as being consistent with studies showing that children whose speech disorders had resolved were not at risk for reading difficulties (Bishop & Adams, 1990; Nathan et al., 2004) but those whose problems were persistent are at risk (Bird et al., 1995; Leitão & Fletcher, 2004; Nathan et al., 2004; Raitano et al., 2004). These data were taken from a statewide database and information regarding students' specific speech difficulties was not included. It is highly likely that some students with mild but persisting articulation, voice, and speech fluency disorders were included in the SI-Persistent subgroup. Including them might have inflated the means for the SI-Persistent subgroup thereby obscuring the overall results. A unique contribution of the present study is that the large sample size allowed findings to be disaggregated by persistent versus resolved subgroup. The make-up of the aggregated SI groups in some of the previous studies may therefore explain contradictory findings regarding the relationship between speech impairments and reading difficulty.

Limitations and Directions for Future Research

As with all research, there are certain limitations to this study that warrant mention. Although the hierarchical piecewise growth curve model provided a good fit for the data, large standard deviations were noted in the fitted means for ORF, which generally implies large variability in students' performance. Because of these relatively large individual differences, these data should not be interpreted to mean that *all* students with resolved speech or language problems will *never* develop reading difficulties. As a corollary, these data must not be taken to mean that *all* students with persistent language impairments or with an LD diagnoses will *never* read fluently. This is particularly important because we were not able to rule out comorbid diagnoses of SI and LI , which is considered by some to be a high risk factor for reading failure (e.g., Bishop & Adams, 1990; Catts, 1993; Nathan et al., 2004; Raitano et al., 2004). As already mentioned, these data were taken from a statewide database and information regarding students' specific speech or language difficulties was not included. Future research with researcher-collected assessment of individual students' speech or language impairments is warranted. School-based personnel gathered the data used in this study and also did the assessment and determination of the SI or LI. Yet, this study shows that even school designations of speech or language impairments represent risk factors for reading achievement.

Our conclusions regarding the performance of some of our subgroups to the typical reference group must be interpreted with caution. The sample for this study was drawn from Reading First schools and therefore included relatively large numbers of students living in poverty. It is more than likely that these students may be less fluent than a state or national normative group. Findings from this study need to be replicated using students drawn from epidemiological samples. Generalizability of these findings to a higher SES group must be made cautiously.

Another issue that constrains interpretation of findings concerns the equivalence of the ORF passages during the various administration time-points. This is a controversial issue that continues to be debated; however, it is beyond the scope of this paper (see Francis et al., 2007). The developers of DIBELS have made significant efforts and have used the Spache readability index to choose equivalent passages at each grade. Even so, this issue continues to be problematic especially in light of the fact that readability indices in and of themselves are highly variable and unreliable. To overcome some of the effects of the non-equivalence of passages, students are required to read three passages aloud and the median score is selected as the ORF score. It was not possible to determine which specific DIBELS passages were administered. Ensuring homogeneity in the readability index of passages chosen for assessment at each administration will be an important consideration for future research.

Learning to read is a complex phenomenon and several sociocultural factors could account for students' successes or failures. Isolating factors that differentiate resilient students with speech and language impairments who become successful readers would also be a useful endeavor for future research. Additionally, research in the future also will need to examine factors related to persistence (e.g., severity, family history, type of disorder) to improve early identification. Finally, this longitudinal examination was confined to ORF development. Further research examining a broader range of reading skills such as vocabulary, reading comprehension, and the interaction between the two would provide a more comprehensive picture of the reading difficulties experienced by this group of students.

Educational Implications

Research has indicated that remediation of reading difficulties is more difficult after third grade (Donavan & Cross, 2002; Kennedy, Birman, & Demaline, 1986). The results of this study emphasize the need for early identification and intervention in children with SI or LI. They demonstrate the need to utilize curriculum-based measures like ORF to identify the poorest readers (both LD and the LI-Persistent subgroups) as early as December of first grade, instead of waiting until third grade when remediation efforts might be less effective. These results reinforce suggestions made by other researchers that oral reading fluency needs to be addressed concomitantly with decoding and word recognition in first grade for students with SI or LI (Deno et al., 2001; Speece & Ritchey, 2005). Researchers have cautioned that improving reading fluency is challenging, even when improvements for decoding and word recognition are noted (Torgesen et al., 2001a, b). Addressing this issue before these students start to fall below benchmarks might help ameliorate some of the poor response to intervention obtained when these students are older.

Although there is no "blueprint" for the optimal frequency, intensity, and duration of remedial support needed by these "at risk" students, clearly, the data from this study suggests great urgency for change in current instructional practices. Specifically, educators and school personnel need to consider the nature of the disorder (LI vs. SI) and the persistence (resolved vs. persistent) of the disorder when assessing the degree of risk for reading disabilities and when planning and making intervention decisions regarding the frequency, intensity, and duration of support needed by these students.

Appendix

Appendix A:

Eligibility for qualifying for speech (articulation) therapy services in Florida

A. Based on normative data, the frequency of incorrect sound production and the delay of correct sound production are significant. (Determination of "significant:" 3 or more consonantal error sounds delayed by at least one year, 2 or more delayed by at least two years, 1 delayed by at least three years, or a pattern of five or more consonantal error sounds affecting overall intelligibility.)

OR

B. The error pattern is characteristic of disordered rather than delayed acquisition.

OR

C. Articulation is rated as moderately or severely impaired on an articulation severity rating scale.

Eligibility for qualifying for language therapy services in Florida

A. The composite language score on a standardized Global Language test is 1 1/2 standard deviations below the mean (SS 77 or below), for the student's chronological age. AND at least one of the following is met:

B. A significant difference of one standard deviation or more between the global language score and the nonverbal intelligence score on a standardized nonverbal test of cognitive ability.

OR

C. A significant difference of one standard deviation (15 points) or more between receptive and expressive language scores within the same global instrument or correlated tests.

OR

D. Two or more, but not all components, of the language system are rated moderately or severely impaired on a Language Severity Rating Scale.

Appendix B:

*Level*1 *Model*

$$ORF_{ti} = \pi_{0i} + \pi_{1i}(Month^2{}_{ti}) + \pi_{2i}(Month^2{}_{ti}) + \pi_{3i}(2^{nd}\ Grade\ Int_{ti}) + \pi_{4i}(3^{rd}\ Grade\ Int_{ti}) + \pi_{5i}(2^{nd}\ Grade\ Lin_{ti}) + \pi_{6i}(3^{rd}\ Grade\ Lin_{ti}) + \pi_{7i}(2^{nd}\ Grade\ Quad_{ti}) + \pi_{8i}(3^{rd}\ Grade\ Quad_{ti}) + e_{ti}$$

Level 2 *Model*

$$\pi_{0i} = \beta_{01}(SI - PE_i) + \beta_{02}(LI - PE_i) + \beta_{03}(LI - RE_i) + \beta_{04}(SI - RE_i) + \beta_{05}(SI - LD_i) + \beta_{06}(LI - LD) + \beta_{07}(Norm) + r_{0i}$$

$$\pi_{1i} = \beta_{11}(SI - PE_i) + \beta_{12}(LI - PE_i) + \beta_{13}(LI - RE_i) + \beta_{14}(SI - RE_i) + \beta_{15}(SI - LD_i) + \beta_{16}(LI - LD) + \beta_{17}(Norm)$$

$$\pi_{2i} = \beta_{21}(SI - PE_i) + \beta_{22}(LI - PE_i) + \beta_{23}(LI - RE_i) + \beta_{24}(SI - RE_i) + \beta_{25}(SI - LD_i) + \beta_{26}(LI - LD) + \beta_{27}(Norm)$$

$$\pi_{3i} = \beta_{31}(SI - PE_i) + \beta_{32}(LI - PE_i) + \beta_{33}(LI - RE_i) + \beta_{34}(SI - RE_i) + \beta_{35}(SI - LD_i) + \beta_{36}(LI - LD) + \beta_{37}(Norm) + r_{3i}$$

$$\pi_{4i} = \beta_{41}(SI - PE_i) + \beta_{42}(LI - PE_i) + \beta_{43}(LI - RE_i) + \beta_{44}(SI - RE_i) + \beta_{45}(SI - LD_i) + \beta_{46}(LI - LD) + \beta_{47}(Norm) + r_{4i}$$

$$\pi_{5i} = \beta_{51}(SI - PE_i) + \beta_{52}(LI - PE_i) + \beta_{53}(LI - RE_i) + \beta_{54}(SI - RE_i) + \beta_{55}(SI - LD_i) + \beta_{56}(LI - LD) + \beta_{57}(Norm)$$

$$\pi_{6i} = \beta_{61}(SI - PE_i) + \beta_{62}(LI - PE_i) + \beta_{63}(LI - RE_i) + \beta_{64}(SI - RE_i) + \beta_{65}(SI - LD_i) + \beta_{66}(LI - LD) + \beta_{67}(Norm) + r_{6i}$$

$$\pi_{7i} = \beta_{71}(SI - PE_i) + \beta_{72}(LI - PE_i) + \beta_{73}(LI - RE_i) + \beta_{74}(SI - RE_i) + \beta_{75}(SI - LD_i) + \beta_{76}(LI - LD) + \beta_{77}(Norm)$$

$$\pi_{8i} = \beta_{81}(SI - PE_i) + \beta_{82}(LI - PE_i) + \beta_{83}(LI - RE_i) + \beta_{84}(SI - RE_i) + \beta_{85}(SI - LD_i) + \beta_{86}(LI - LD) + \beta_{87}(Norm) + r_{8i}$$

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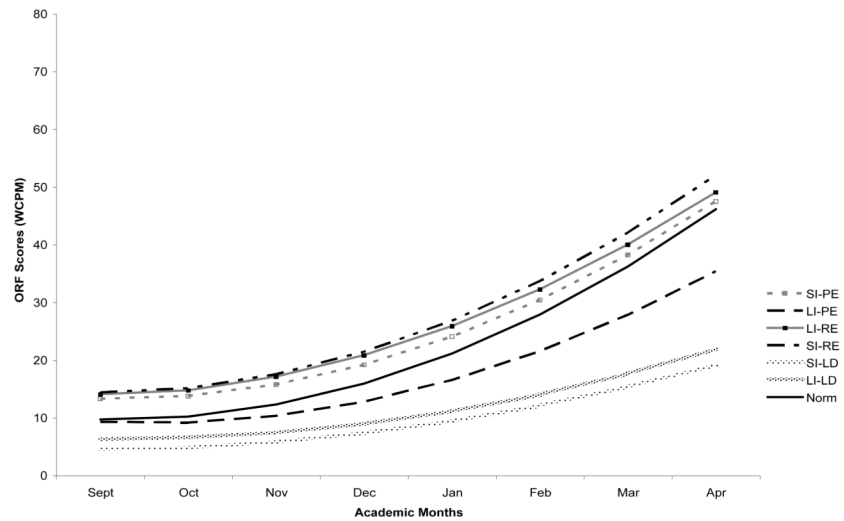
Figure 1.
First grade growth curves. SI-PE = Speech-Persistent, LI-PE = Language-Persistent, SI-RE = Speech Resolved, LI-RE = Language Resolved, SI-LD = Speech Learning disability group, LI-LD = Language Learning disability group, Norm = Local normative reference group.
Note: 1st grade-Beginning of year benchmark = 7 wcpm; End of year benchmark = 40 wcpm.
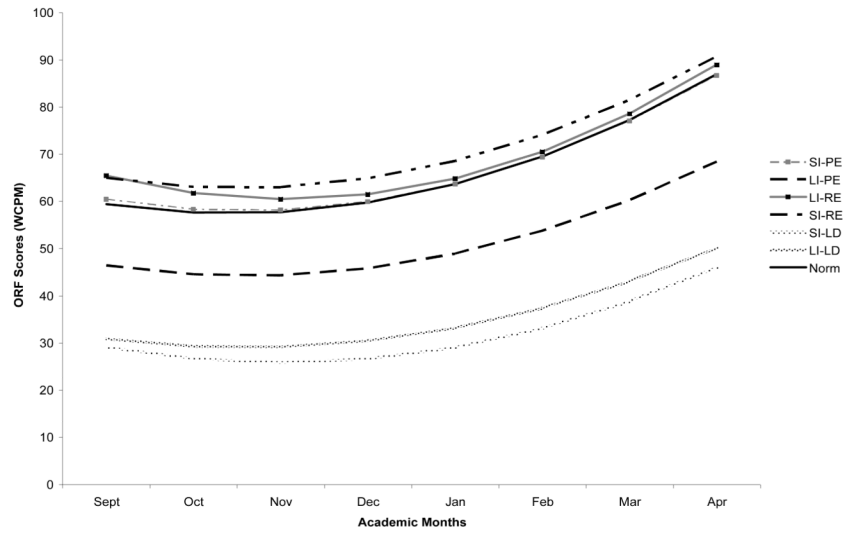
Figure 2.
Second grade growth curves. SI-PE = Speech-Persistent, LI-PE = Language-Persistent, SI-RE = Speech Resolved, LI-RE = Language Resolved, SI-LD = Speech Learning disability group, LI-LD = Language Learning disability group, Norm = Local normative reference group.
Note: 2nd grade-Beginning of year benchmark = 44 wcpm; End of year benchmark = 74 wcpm.
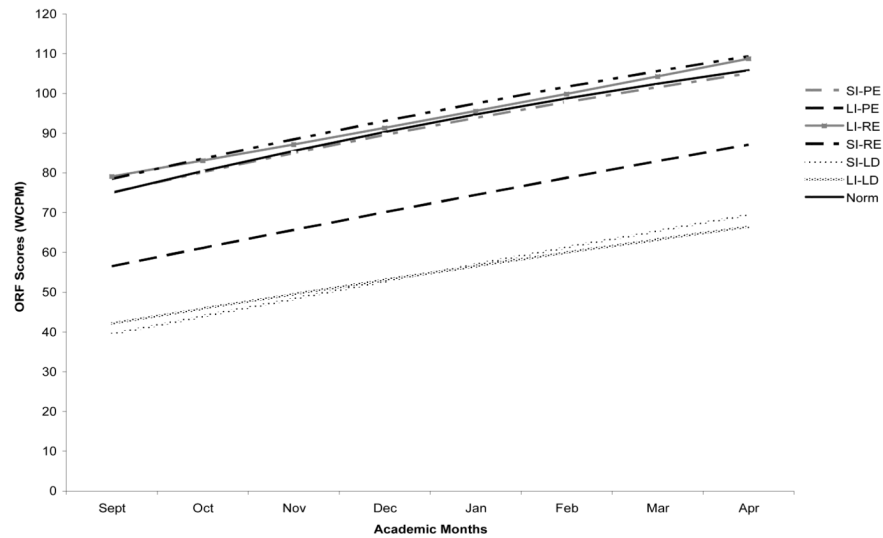
Figure 3.
Third grade growth curves. SI-PE = Speech-Persistent, LI-PE = Language-Persistent, SI-RE = Speech Resolved, LI-RE = Language Resolved, SI-LD = Speech Learning disability group, LI-LD = Language Learning disability group, Norm = Local normative reference group.
Note: 3rd grade-Beginning of year benchmark = 77 wcpm; End of year benchmark = 110 wcpm.

Table 1

Student demographics by subgroups.

Group	Status	n	% Male	% FARL[a]
Speech				
	Persistent	1, 047	63.7	76.6
	Resolved	278	56.6	68.3
	LD	63	82.5	82.5
	Total	1, 388		
Language				
	Persistent	475	62.3	82.9
	Resolved	65	47.7	82.2
	LD	63	71.4	80.6
	Total	603		
Typical Reference	----	8,833	52.1	72.4

[a]*Note*: Free and reduced lunch status

Table 2

Variances for the unconditional and conditional models.

Unconditional Model				Conditional Model			
Random Effect	**Variance**	χ^2	**p-value**	**Random Effect**	**Variance**	χ^2	**p-value**
First Grade				First Grade			
Intercept, r_{0i}	141.94	8,997.30	0.000	Intercept, r_{0i}	312.16	40,573.89	0.000
Linear Slope, r_{1i}	3.19	1,856.19	0.500	*Linear Slope, r_{1i}	-	-	-
Quadratic Slope, r_{2i}	0.14	2,498.12	0.500	*Quadratic Slope, r_{2i}	-	-	-
Second Grade				Second Grade			
Intercept, r_{3i}	409.42	12,233.21	0.000	Intercept, r_{3i}	212.67	15,640.06	0.000
Linear Slope, r_{4i}	7.17	2,467.65	0.500	*Linear Slope, r_{4i}	-	-	-
Quadratic Slope, r_{5i}	0.19	2,736.85	0.500	*Quadratic Slope, r_{5i}	-	-	-
Third Grade				Third Grade			
Intercept, r_{6i}	644.17	17,833.46	0.000	Intercept, r_{6i}	327.92	10,792.82	0.000
Linear Slope, r_{7i}	14.69	2,993.49	0.016	Linear Slope, r_{7i}	1.68	2,649.21	0.500
Quadratic Slope, r_{8i}	0.32	3,199.12	0.000	Quadratic Slope, r_{8i}	0.01	2,645.77	0.500
Error Variance	59.46			Error Variance	96.73		

*
Effect was fixed at level-2

Table 3

Parameter estimates for piecewise growth curve model.

Fixed Effect	SI-PE Estimate	S.E.	LI-PE Estimate	S.E.	SI-RE Estimate	S.E.	LI-RE Estimate	S.E.	SI-LD Estimate	S.E.	LI-LD Estimate	S.E.	Norm Estimate	S.E.
1st Grade														
Intercept, π_{0i}	13.37	0.53	9.35	0.61	14.45	0.95	14.15	1.99	4.6	0.79	6.35	1.82	9.78	0.09
Linear Growth, π_{1i}	0.49	0.13	−0.11*	0.18	0.89	0.27	1.02*	0.57	0.42*	0.31	0.11*	0.51	0.49	0.06
Quadratic Growth, π_{2i}	0.73	0.02	0.64	0.03	0.75	0.04	0.67	0.09	0.28	0.07	0.35	0.09	0.78	0.01
2nd Grade														
Intercept, π_{3i}	60.51	0.68	46.47	0.94	64.99	1.39	65.48	2.57	29.12	2.55	30.88	2.59	59.45	0.24
Linear Growth, π_{4i}	−2.13	0.21	−1.9	0.29	−1.89	0.45	−3.66	0.95	−2.44	0.65	−1.58	0.78	−1.81	0.08
Quadratic Growth, π_{5i}	0.98	0.03	0.84	0.04	0.93	0.07	1.17	0.13	0.81	0.09	0.72	0.13	0.96	0.01
3rd Grade														
Intercept, π_{6i}	75.08	0.84	56.53	0.84	78.5	1.53	79.12	2.5	39.45	3.74	42.16	3.66	74.99	0.28
Linear Growth, π_{7i}	5.11	0.24	4.6	0.35	5.09	0.42	3.99	0.98	4.49	0.68	3.72	0.82	5.45	0.09
Quadratic Growth, π_{8i}	−0.14	0.03*	−0.04	0.03*	−0.11	0.06	0.04	0.05*	−0.03	0.02*	−0.04	0.01	−0.17	0.01

Note. SI-PE = Speech-Persistent, LI-PE = Language-Persistent, SI-RE = Speech Resolved, LI-RE = Language Resolved, SI-LD = Speech Learning disability group, LI-LD = Language Learning disability group, Norm = Local normative reference group.

*Not significant

Table 4

Growth parameter correlation matrix.

	1st – Int	1st – Slope	1st – Quad	2nd – Int	2nd – Slope	2nd – Quad	3rd – Int	3rd - Slope	3rd - Quad
1st – Int	--								
1st – Slope	0.98	--							
1st – Quad	−0.19	−0.29	--						
2nd – Int	0.31	0.22	0.84	--					
2nd – Slope	−0.71	−0.68	0.18	−0.10	--				
2nd – Quad	0.12	0.10	−0.62	−0.57	−0.49	--			
3rd – Int	0.17	0.05	0.78	0.91	0.04	−0.38	--		
3rd - Slope	−0.52	−0.49	−0.49	−0.22	0.57	−0.13	−0.10	--	
3rd - Quad	0.12	0.16	−0.57	−0.46	−0.33	0.53	−0.44	−0.67	--

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Table 5

Proportion of students at various risk levels in ORF.

Risk Level	1st grade		2nd grade		3rd grade	
	Initial	End	Initial	End	Initial	End
SI-RE						
High	5.1	7.9	6.7	18.4	20.8	17.3
Moderate	34.5	24.1	20.4	22.6	26.3	34
At or above grade level	60.4	68	72.9	59	52.9	48.7
LI-RE						
High	11.3	4.6	5.1	8.5	15	16.1
Moderate	32.2	24.6	10.2	32.2	28.3	33.9
At or above grade level	56.5	70.8	84.7	59.3	56.7	50
SI-PE						
High	6.5	8.9	7.8	21.6	24.3	21.9
Moderate	39.7	30.6	20.6	27.3	26.7	36.2
At or above grade level	53.8	60.5	71.6	51.1	49	41.9
LI-PE						
High	13.5	21.3	18.9	44.9	46.9	42.3
Moderate	39.2	35.3	31	21.8	25.8	33.1
At or above grade level	47.3	43.4	50.1	33.3	27.3	24.6
SI-LD						
High	22.6	63.5	55.7	74.2	74.2	61.7
Moderate	59.7	27	26.3	16.1	11.3	26.6
At or above grade level	17.7	9.5	18	9.7	14.5	11.7
LI-LD						
High	37.9	58.7	54.8	65.6	66.1	61.3
Moderate	46.6	25.4	17.8	14.7	1.3	25.8
At or above grade level	15.5	15.9	27.4	19.7	32.6	12.9
Local normative reference group						
High	4.7	7.4	6.1	17.4	20.4	18.1
Moderate	35.1	26.2	18.9	25.2	16.4	35.8

Risk Level	1st grade		2nd grade		3rd grade	
	Initial	End	Initial	End	Initial	End
At or above grade level	60.2	66.4	75	57.4	63.2	46.1

Note: ORF = DIBELS™ Oral Reading Fluency; Initial- beginning of school year (September); End = end of the school year (April). SI-PE = Speech-Persistent, LI-PE = Language-Persistent, SI-RE = Speech Resolved, LI-RE = Language Resolved, SI-LD = Speech Learning disability group, LI-LD = Language Learning disability group.