Ensuring that American students improve their performance in reading achievement is at the forefront of educational research, due in part to mandates specified in the 2001 No Child Left Behind Act (U.S. Department of Education, 2001). According to this legislation, educators are challenged to promote better reading outcomes for their pupils, with a particular emphasis on using scientifically based reading research to equalize disparities between children who enter school with significant disadvantages (e.g., limited English proficiency, low socioeconomic status, identified disabilities) and their more advantaged peers. One group of children known to be at particular risk for difficulties with reading achievement is those who enter preschool with language difficulties (LD). The current work examined which theory of reading development, the cumulative reading trajectory or the compensatory trajectory of development, most accurately represents the reading trajectories of children with language difficulties (LD) relative to their peers with typical language (TL) skills. Specifically, initial levels of reading skills, overall rate of growth, and patterns of growth were examined.

**ABSTRACT:**

**Purpose:** The current work examined which theory of reading development, the *cumulative reading trajectory* or the *compensatory trajectory of development*, most accurately represents the reading trajectories of children with language difficulties (LD) relative to their peers with typical language (TL) skills. Specifically, initial levels of reading skills, overall rate of growth, and patterns of growth were examined.

**Method:** Children were classified according to whether or not they exhibited LD at 54 months of age (LD n = 145; TL n = 653), using data from the National Institute of Child Health and Human Development’s Early Child Care Research Network (see NICHD, 1993). A latent shape growth curve model was used to model reading skills at 4 time points from preschool through fifth grade.

**Results:** In comparison to children with TL, children with LD showed lower reading skills in preschool, but their overall reading growth was faster. All children developed the skills associated with reading more rapidly at earlier ages compared to later ages. Children with LD continued to exhibit reading skills that were substantially lower than those of children with TL during fifth grade.

**Conclusion:** Results supported the compensatory trajectory of development. Speech-language pathologists are encouraged to adopt evidence-based practices in order to boost reading outcomes for children with LD beginning in preschool.

**KEY WORDS:** literacy, language, quantitative research analysis
LD and Reading Achievement

Children with LD in preschool often exhibit long-term disadvantages in reading achievement, due in part to the fact that oral language ability facilitates both word recognition and reading comprehension (Catts, Fey, Tomblin, & Zhang, 2002; National Institute of Child Health and Human Development Early Child Care Research Network [NICHD ECCRN], 2005). Studies consistently show preschool language abilities to relate moderately and positively to later reading outcomes, and conversely, early LD to relate inversely to reading outcomes in the early elementary grades (Boudreau & Hedberg, 1999; Catts, 1993; Hayiou-Thomas, Harlaar, Dale, & Plomin, 2006). Accordingly, children who arrive at reading instruction with LD often face significant challenges in achieving skilled, fluent reading during the early elementary grades. Speech-language pathologists (SLPss) as well as other school-based professionals have been encouraged to adopt a preventive orientation both to identify as early as possible those children who exhibit LD and, as importantly, to implement systematic and explicit early language and literacy interventions that promote early achievement of skills that are causally associated with later reading success (e.g., see Justice & Kaderavek, 2004; Snow, Burns, & Griffin, 1998).

Several studies provide quantitative evidence concerning the reading achievement risks for children with different types of LD. As one of the more recent examples, Catts et al. (2002) followed children with SLI in kindergarten through fourth grade. This study found that 42% and 36% of kindergartners with SLI exhibited reading disability in second and fourth grade, respectively; by comparison, reading disability was observed in approximately 8% of nonimpaired controls, showing that the risk for reading disability is substantially elevated for children with SLI. The incidence of reading disability for children who exhibit language impairment with concomitant low scores in IQ, termed nonspecific language impairment, appears even more widespread, with 67% and 64% of second and fourth graders with nonspecific language impairment exhibiting depressed performance (bottom quartile) on measures of reading comprehension (Catts et al., 2002). Additional studies converge with such findings to show that children with a history of LD face substantial risks in becoming skilled readers. For instance, Snowling, Bishop, and Stothard (2000) conducted a follow-up study of 56 preschoolers with SLI at age 15 years. Forty-three percent of these adolescents met criteria for reading disability based on a measurement of word reading accuracy, and 23% exhibited dyslexia when considering reading comprehension. As others have also reported (e.g., Bird, Bishop, & Freeman, 1995; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998), we are aware of no study showing that, as a group, children with LD fare well in reading outcomes. Rather, compared to their typically developing peers, children with LD show depressed performance in reading development at preschool (Boudreau & Hedberg, 1999; Justice, Bowles, & Skibbe, 2006), during the elementary grades (Catts et al., 2002; Tomblin, Zhang, Buckwalter, & Catts, 2000), and into adolescence (Stothard et al., 1998). Likely, the risk for reading disability that is experienced by children with LD results from an interaction among a variety of biological and environmental factors. Importantly, children who enter reading instruction with underdeveloped skills in early literacy are relatively unlikely to “catch up” with their peers in reading achievement, as reported in a seminal paper by Juel (1988) and replicated in subsequent reports (e.g., Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996; Shaywitz et al., 1995) for a more general population of poor readers. An examination of how young children with LD develop reading skills over time could help educators to understand how likely (or unlikely) these children are to “catch up” with their peers who exhibit typical language (TL) skills.

Cumulative Reading Trajectory

Children’s reading development shows the greatest amount of change within the early years of schooling, during kindergarten and first grade. During this period, children’s reading growth is equivalent to approximately 1.5 SDs (Hill, Bloom, Black, & Lipsey, 2007) over a 1-year period (based on nationally normed tests). From this period forward, average annual gains decrease in magnitude (e.g., average effect size = .97, .60, and .36 for Grades 1–2, 2–3, and 3–4, respectively; see Hill et al., 2007), and in the later years of schooling (e.g., Grades 10, 11, and 12), annual gains in reading skill are negligible. Such findings describe the normal trajectory of reading growth as aggregated over large groups of children, but it is unclear whether such findings are applicable to children with LD (e.g., Catts et al., 2002). That is, it is plausible that children with LD develop reading skills more slowly than other children and, as a result, fall further and further behind their peers in reading achievement, leading to a widening gap between typical children and those with LD. Although this phenomenon has not been examined for children with LD specifically, it has been documented for good and poor readers (Bast & Reitsma, 1998) and is referred to as both the Matthew effect (Bast & Reitsma, 1998; Stanovich, 1986) and the cumulative reading trajectory (Leppänen, Niemi, Aunola, & Nurmi, 2004). The cumulative reading trajectory predicts that the differences between achieving and nonachieving children in reading become larger over time, such that children with relatively better reading skills profit more from reading instruction (and hence have steeper achievement trajectories) compared to children with relatively poor reading skills. In other words, reading instruction actually accelerates the gap between the “rich” and the “poor,” using the Matthew effect analogy (i.e., the rich get richer while the poor get poorer).

Empirical evaluation of the applicability of the cumulative reading trajectory for children who enter reading instruction with underdeveloped reading skills has provided mixed results. Evidence suggests that most children learn reading skills in the same developmental sequence regardless of individual differences in the children’s rate of reading development (Spear-Swerling & Sternberg, 2007).
The present study investigated whether the cumulative reading trajectory or the compensatory trajectory of development most accurately represents the reading trajectory of children with LD relative to those of their peers with TL skills. Although normative data are available to describe the general trajectory of reading growth for the general population of pupils (see Hill et al., 2007), it is unclear whether such findings extend to children with LD. That is, it may be that children with LD develop their reading skills much more slowly compared to other children (i.e., cumulative theories) or, conversely, that they develop reading skills at faster rates (i.e., compensatory theories). Improved understanding of reading development among children who struggle with language development is important to the work of SLPs, who frequently serve as resident experts on such topics within school systems and who are vested in ensuring the academic success of children with LD. The primary aim we addressed was to determine whether individual differences in reading between two groups of children (those exhibiting LD and those with TL skills) widen or narrow over time. To address this aim, the present work used a growth curve model containing observations of reading performance at four points in time using dynamic latent variables. These variables included both measures of word reading and reading comprehension, but, in accordance with the emphasis of primary reading instruction, are more heavily weighted toward word reading.

The sample studied was drawn from the longitudinal database that was developed by the NICHD ECCRN and was designed to study children’s early and later educational experiences and their contribution to development longitudinally. There are several advantages to using a large dataset of this nature. First, the NICHD ECCRN dataset contains data on a nationally representative sample of children, promoting the generalization (i.e., external validity) of findings. Second, the large number of participants and repeated measurement of their performance allows for an examination of literacy development using growth curve modeling for children with LD, a group of children representing a small percentage of the overall population. Previous studies have used this database to model early influences on the transience versus persistence of SLI (La Paro, Justice, Skibbe, & Pianta, 2004); to examine the role of oral language on word recognition (NICHD ECCRN, 2005); and to examine children’s early academic functioning, including reading achievement, from preschool through first grade (Downer & Pianta, 2006). The present study identified children with LD within the larger NICHD ECCRN dataset based on a norm-referenced, standardized test of language that was administered to children in the longitudinal study, using a similar methodology to that of La Paro and colleagues (2004). This information was used to examine the reading trajectory of children with preschool LD by studying the initial level of reading ability, the rate of growth over time, and the overall pattern (i.e., shape) of growth relative to children with TL skills.

This study had three research aims.

- Replicate previous studies (e.g., Boudreau & Hedberg, 1999; Justice et al., 2006) that demonstrated that children with LD exhibit underdeveloped early literacy skills in comparison to their typically developing peers during the preschool period.
- Explore the overall rate of reading growth over four points in time for children with LD relative to children exhibiting TL skills, seeking resolution of conflicting evidence regarding how reading trajectories change over time for children with LD.
- Examine the pattern of reading growth over time, referred to as the shape of the growth curve, for children with LD compared to those with TL skills. That is, in addition to looking at the sum growth for the two groups of children, we sought to explore whether individual periods (e.g., between 54 months of age and first grade) of more and less rapid reading growth were the same for children with LD as for their peers.

**METHOD**

**Participants**

Participants for this research were selected from the NICHD ECCRN database, which collected data beginning in 1991, when children were 1 month in age (NICHD ECCRN, 1993, 1996). As part of the larger study, mothers in 31 hospitals across the United States were asked to participate, representing 10 locations: (a) Little...
Rock, AR; (b) Orange County, CA; (c) Lawrence and Topeka, KS; (d) Boston, MA; (e) Philadelphia, PA; (f) Pittsburgh, PA; (g) Charlottesville, VA; (h) Morgantown and Hickory, NC; (i) Seattle, WA; and (j) Madison, WI. Mothers (N = 8,986) were contacted in the hospital shortly after they had given birth in order to determine whether their families would be eligible for this study. All mothers who had given birth within a preselected 24-hr period were contacted. From these initial recruiting efforts, 5,416 families were considered to be eligible based on the following criteria: The mother was over the age of 18, the mother was conversant in English, the family planned to stay in the same area for the foreseeable future, the child was not hospitalized for more than 7 days following birth and had no obvious disabilities, and the mother had no known or acknowledged substance abuse problem. Of these 5,416 families, 1,364 families were randomly selected to participate in the study, representing approximately 136 families per location (see NICHD ECCRN, 1993, 1996 for more recruitment information).

Selection Procedures for the Present Study

From these 1,364 families, only children who exhibited typical cognitive abilities as measured by scores >80 on the Mental Development Index of the Bayley Scales of Infant Development (Bayley, 1969) at a 24-month home visit were included in the present study. Our intent in excluding children with Bayley scores ≤80 was to develop a sample of children whose early cognitive development could be grossly characterized as normal. One hundred and sixty-two children were excluded from the present study because they did not meet the Bayley criterion. At 54 months of age, children’s receptive and expressive language skills were assessed directly by a researcher using the Preschool Language Scale—3 (PLS–3; Zimmerman, Steiner, & Pond, 1992) during a home visit. Test performance is based on information from a nationally representative sample of children. The PLS–3 has internal consistency reliability between .47 and .86 for the Auditory Comprehension subscale and .68 to .86 for the Expressive Communication subscale. Alpha values on the lower range were for children less than 1 year of age, suggesting that this scale may not be as reliable for children in that age group. Four hundred and four children were excluded from all analyses due to incomplete data on either the Bayley or the PLS–3.

Although there is no gold standard used by researchers and SLPs for diagnosing children with LD, previous research using the PLS–3 has considered a child who performs more than 1 SD below the mean, or below the 16th percentile, to show signs of language delay (e.g., King, Rosenberg, Fuddy, McFarlane, Sia, & Duggan, 2005). The creators of the PLS–3 used a more stringent cutoff of 1.5 SDs below the mean, or below the 7th percentile, as indicative of a language disorder. Using this cutoff, sensitivity ranged from .91 to 1.00 for 3- to 5-year-olds, and specificity ranged from .60 to .72. In addition, for 4-year-olds, the overall level of agreement for diagnosing a language disorder was 80%, with the majority of discrepancies due to misidentification of those children who had been previously classified with a language disorder. Thus, the present study chose a slightly less stringent cutoff that is consistent with previous research in this area (e.g., La Paro et al., 2004). Children who scored at or below the 10th percentile, or 1.33 SDs below the mean, on the Auditory Comprehension and/or Expressive Communication portions of the PLS–3 were considered to have significantly depressed language skills—that is, LD—at 54 months of age.

Children were classified as having LD based on their performance on one or both of the subscales of the PLS (Auditory Comprehension, Expressive Communication) rather than the composite score; this allowed us to identify children who experienced language problems in one domain. Forty-three children had scores below the 10th percentile on the Expressive Communication subscale only, 51 had scores below the 10th percentile on the Auditory Comprehension subscale only, and 51 had scores below the 10th percentile on both subscales. Note that a receptive-only language disorder is difficult to explain at a theoretical level and may indicate measurement error on one or both subscales. Nevertheless, other studies have also found a receptive-only group (e.g., Beitchman et al., 1994), and our intention was to include children who demonstrated any type of language difficulty rather than to diagnose children with a clinical disorder. Standard scores on the Auditory Comprehension subscale ranged from 50 to 131 (M = 80.03; SD = 12.14), and standard scores on the Expressive Communication subscale ranged from 54 to 123 (M = 82.14; SD = 15.22). For comparison purposes, children were considered to have TL development if they scored above the 10th percentile on both the Auditory and Expressive subscales of the PLS–3. For this group, standard scores on the Auditory Comprehension subscale ranged from 82 to 139 (M = 108.78; SD = 14.96), and scores on the Expressive Communication subscale ranged from 84 to 128 (M = 111.48; SD = 11.77). Scores on the PLS–3 for both groups of children are included in Table 1. It should be noted that there was no information available on any speech-language therapy or other special education services that the children with LD might have received. Children with LD differed significantly from those in the TL group regarding their overall household incomes as measured by the family’s income-to-needs assessment at 54 months, t(786) = 5.87, p < .001, d = .55. This assessment was calculated by dividing family income, not including federal aid, by the federal poverty threshold for the number of people in that family. For example, in 1995, when children were 4 years of age, the poverty threshold was $15,455 for a family of four with two children under the age of 18 (for a full index of poverty thresholds, see U.S. Census Bureau, 2006). Using this threshold, if the overall household income was $30,000, then the income-to-needs score for that family would be 1.94.

Demographic information about the children included in the present study is provided in Table 1.

General Procedure

Data used in this study were collected through standardized assessment protocols of the NICHD ECCRN (1993). Measures were selected by the national network of principal investigators on the basis of established psychometric qualities. All data were gathered in university laboratory settings and in children’s homes

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1For exploratory purposes, we also considered alternative cutoffs for identifying LD, including the 16th percentile and a mixed 10th (below considered as having LD)/25th (above considered typically developing) percentile cutoff (with children in between dropped from the analysis). The results (parameter estimates, fit statistics, etc.) for all analyses were nearly identical to those obtained with the 10th percentile cutoff, resulting in the same substantive conclusions. Therefore, in this article, we report only results with the 10th percentile cutoff, although alternative findings are available from the first author.
to characterize maternal, child, and demographic factors when children were 54 months of age and to assess children’s academic experiences during first grade, third grade, and fifth grade. The time interval between data collection occasions was uneven: on average, there was 2½ years between the 54 month and first-grade occasions and 2 years between each of the other occasions. A full description of the laboratory protocols, tasks, and scoring is publicly available on the Web site of the NICHD Study of Early Child Care and Youth Development (http://secc.rti.org/).


The WJ–R is a battery of tests that are designed to measure aspects of intellectual ability, cognitive ability, oral language, and academic achievement. For the present study, three subtests of the WJ–R were used to characterize children’s reading development from preschool through fifth grade: Letter-Word Identification (LW), Word Attack (WA), and Passage Comprehension (PC). For all four time points, W scores, the Rasch-scaled scores in which performance on the WJ–R is reported, were used as dependent measures in this study. An issue for the analyses of these data is that not all three of the measures of reading were given at each time point, for reasons outside our control: LW was administered at all four occasions, WA only once, and PC twice. Table 2 describes the pattern of incompleteness. As a result of this missing data, our reading construct is most strongly influenced by LW. However, we aimed to examine the comprehensive construct of reading to the greatest extent possible, and therefore included all relevant measures of reading. For example, even though WA was administered only once, it does offer more precise measurement of reading directly at that occasion and indirectly at other time points through its association with the other measures.

The LW subtest contains a total of 57 items. Five items measure children’s ability to match a pictorial representation of a word with a picture of a corresponding object. The remaining 52 items measure children’s ability to identify isolated letters and words. This measure assesses children’s letter knowledge and decoding ability. The WA subtest evaluates children’s ability to decode pseudowords and low-frequency English words. The PC subtest assesses children’s ability to supply a missing word that would make the most sense in a given written text. This subtest measures text comprehension, although research suggests that the PC subtest also relies heavily on children’s decoding skills (Francis, Snow, & August, 2006). Table 3 includes performance by group for each of the WJ–R subtests. Reliability coefficients for the measures used in the present work ranged from .84 to .98 across age groups.

## Analytic Approach

Our analytic approach focused on examining the growth of reading skills over time for children with LD compared to those with TL skills. In order to examine the growth of reading skills, as opposed to growth in specific reading components measured by the WJ–R subtests, and to handle the incomplete collection of the various subtests of the WJ–R (see Table 2), we fit a factor model at each measurement occasion (e.g., McArdle & Hamagami, 2005).

### Table 1. Descriptive information of study participants.

<table>
<thead>
<tr>
<th>Children with language difficulties (N = 145)</th>
<th>Children with typical language (N = 653)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>79 (54%)</td>
</tr>
<tr>
<td>Female</td>
<td>66 (46%)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Asian</td>
<td>2 (1%)</td>
</tr>
<tr>
<td>African American</td>
<td>26 (18%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>108 (74%)</td>
</tr>
<tr>
<td>Other</td>
<td>8 (6%)</td>
</tr>
<tr>
<td>Language</td>
<td></td>
</tr>
<tr>
<td>Comprehension mean (SD)</td>
<td>80.03 (12.14)</td>
</tr>
<tr>
<td>Expression mean (SD)</td>
<td>82.14 (15.22)</td>
</tr>
<tr>
<td>Income-to-needs score during Pre-K Mean (SD)</td>
<td>2.46 (1.82)</td>
</tr>
</tbody>
</table>

*Note.* Language comprehension and expression were measured using standard scores from the PLS–3 Auditory Comprehension and Expressive Communication subscales (Zimmerman et al., 1992). The income-to-needs score was computed by dividing family income, not including federal aid, by the federal poverty threshold for the number of people in that family.

### Table 2. Availability of Woodcock-Johnson Psycho-Educational Battery—Revised Tests of Achievement (WJ–R; Woodcock & Johnson, 1989) subtests for each age group.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pre-K</th>
<th>1</th>
<th>3</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>WA</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. Mean and SD W scores by group on the WJ–R subtests.

<table>
<thead>
<tr>
<th>Children with language difficulties</th>
<th>Children with typical language</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Letter-Word Identification</td>
<td></td>
</tr>
<tr>
<td>Pre-K</td>
<td>358.90</td>
</tr>
<tr>
<td>First grade</td>
<td>446.75</td>
</tr>
<tr>
<td>Third grade</td>
<td>487.89</td>
</tr>
<tr>
<td>Fifth grade</td>
<td>504.14</td>
</tr>
<tr>
<td>Word Attack</td>
<td></td>
</tr>
<tr>
<td>First grade</td>
<td>469.70</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td></td>
</tr>
<tr>
<td>Third grade</td>
<td>490.03</td>
</tr>
<tr>
<td>Fifth grade</td>
<td>500.44</td>
</tr>
</tbody>
</table>

*Note.* Performance on the WJ–R was calculated in W scores, which is a unit with desirable psychometric characteristics based on the Rasch model. For more information, see the WJ–R manual (Woodcock & Johnson, 1989).
At each occasion, the observed WJ–R subtests (e.g., LW, WA, PC) were related to a latent reading skills factor, Read \( t \), such that

\[
\text{LW}(t)_n = \mu_{\text{LW}} + \lambda_{\text{LW}} \cdot \text{Read}(t)_n + u_{\text{LW}}(t)_n,
\]

\[
\text{WA}(t)_n = \mu_{\text{WA}} + \lambda_{\text{WA}} \cdot \text{Read}(t)_n + u_{\text{WA}}(t)_n,
\]

\[
\text{PC}(t)_n = \mu_{\text{PC}} + \lambda_{\text{PC}} \cdot \text{Read}(t)_n + u_{\text{PC}}(t)_n.
\]

In this model, the intercept parameters \( \mu \), the factor loadings \( \lambda \), and the unique factors \( u \) are subscripted by the abbreviated test name and were constrained to be equal at each measurement occasion. This type of metric factorial invariance (Horn & McArdle, 1992; Horn, McArdle, & Mason, 1983; Meredith, 1964a, 1964b, 1993) was required to ensure that the factor was measured in the same scale at each occasion so that change in reading skills over time can be assessed meaningfully. A limitation due to the pattern of missing data is that we must assume factorial invariance but cannot test the assumption.

The changes in the reading factor were then modeled with a latent growth curve (McArdle, 1988; Meredith & Tisak, 1990). The latent growth curve accounts for individual differences in growth trajectories in longitudinal data (McArdle & Nesselroade, 2003) and can be written as

\[
\text{Read}(t)_n = \text{InitLevel}_n + A(t) \cdot \text{TotChange}_n + u(t)_n,
\]

where \( \text{Read}(t)_n \) is the latent reading skill level for person \( n \) at time \( t \), \( \text{InitLevel}_n \) is the latent reading level for person \( n \) at the initial measurement occasion (54 months), \( A(t) \) is a set of shape coefficients for the population that define an individual’s pattern of growth throughout the study, \( \text{TotChange}_n \) is the total change in reading skills for person \( n \) over the course of the study (54 months to fifth grade), and \( u(t)_n \) is the time-specific residual for person \( n \).

Three latent growth curves were fit with different sets of shape coefficients in order to determine the most appropriate pattern of development for reading skills. The first was a no growth model. In this model, the participants are predicted not to grow in their reading skills through elementary school. This model may be unrealistic for the current investigation but provides a baseline from which to compare models that allow for change. The second model was a linear growth model in which the participants’ scores are predicted to change in a linear fashion reflecting equivalent growth per year. The third growth model was a latent shape model in which the shape of development was determined from the data. In this model, the total change is identified by setting the first shape coefficient \( 0 \) (i.e., \( A(t) \) for \( t = 54 \) months is set to \( 0 \)) and the last to \( 1 \) (i.e., \( A(t) \) for \( t = \) fifth grade is set to \( 1 \)); the two middle shape coefficients are estimated. In this latent shape model, the two estimated shape coefficients can be interpreted as the proportion of growth between 54 months of age and fifth grade that occurred up to time \( t \). For example, if the shape coefficient for first grade is estimated to be 0.5, then half of the total growth during the study occurred between 54 months and first grade. The latent shape model is depicted in Figure 1 as a simplified path diagram in which changes in the reading factor are accounted for by the initial level and total change factors. In this diagram, squares represent observed or manifest variables, circles represent unobserved or latent variables, the triangle represents the constant, one-headed or directed arrows represent regression-like relationships, and-headed arrows represent variance or covariance parameters. The constant (triangle) allows for the mean expectations to be included in the same diagram as the covariance expectations (McArdle & Boker, 1990).

After establishing the shape of development for reading skills, we examined whether this shape was invariant across both groups of children, LD and TL. For this analysis, we employed a multiple group growth model (McArdle, 1989). Two multiple group models were fit to examine whether the shape of the development for reading skills was the same for children with LD as for children with TL. In the first multiple group model, the shape coefficients were constrained to be equal for both groups, so the pattern of development was the same for both LD and TL children. In the second model, the shape coefficients were separately estimated for the LD and TL children, allowing the two groups to have different shapes or patterns of development.

An invariant pattern of reading skills development allows for the meaningful prediction of differences in the initial level and total change from the language status variable (coded \( 0 = \) TL, \( 1 = \) LD). In this framework, the initial level and total change are predicted by the language status variable in a regression-like manner, such that

\[
\text{InitLevel}_n = \beta_{00} + \beta_{10} \cdot D_{LD}^n + \nu_{0n},
\]

\[
\text{TotChange}_n = \beta_{01} + \beta_{11} \cdot D_{LD}^n + \nu_{1n},
\]

where \( D_{LD}^n \) is a dummy variable representing child \( n \)’s language status and \( \beta_{10} \) and \( \beta_{11} \) are the group differences (TL vs. LD) in the initial level and total change respectively. All analyses were performed in Mplus 4.0 (Muthén & Muthén, 2006) using full information maximum likelihood (FIML).

**RESULTS**

The results are presented to describe (a) longitudinal factor analysis of the reading skills factor; (b) latent curve analysis of the reading skills factor; (c) multiple group model to test shape invariance; and (d) analysis of the effect of LD on the initial level of reading skill in preschool (first research aim), total change of reading skill from 54 months through fifth grade (second research aim), and pattern of change in reading skill (third research aim). The means, standard deviations, and correlations (adjusted for missing data using FIML estimation) for the observed measures are provided in Table 4.

**Longitudinal Factor Analysis**

The longitudinal factor model, in which there was a single reading factor at each of the four measurement occasions with invariant factor loadings, intercepts, and unique variances, fit the data well, \( \chi^2 = 56, df = 10 \), root mean square error of approximation (RMSEA) = 0.07 (95% confidence interval [CI] 0.06–0.09), comparative fit index (CFI) = 0.99, Tucker-Lewis Index (TLI) = 0.97. The standardized factor loadings were all high, ranging from 0.73 to 0.96, indicating that the three measures of reading skills were strongly related to each other and to the latent reading factor. The estimated means of the reading factor increased over time (0, 83, 123, 140 in \( W \) score units compared to the level at 54 months), indicating growth in reading skills from 54 months of age through fifth grade. The variances of the reading factor fluctuated over time (389, 463, 226, 182), first increasing and then subsequently decreasing. The
reading factor correlated highly across time: The lowest correlation ($r = .55$) was between the reading factor at 54 months and first grade; the highest correlation ($r = .96$) was between the reading factor at third and fifth grades.

**Latent Curve Analysis**

The latent growth curves were fit to capture the changes in the reading skills factor across the four measurement occasions (Figure 1). The first growth model fit to the data was the no growth model, which showed substantial misfit, $\chi^2 = 7544$, $df = 21$, RMSEA = 0.65 (95% CI 0.64–0.66), CFI = 0.00, TLI = −0.99, as this growth model was not able to capture the changes that were occurring in the reading skills factor. The linear growth model, $\chi^2 = 3301$, $df = 18$, RMSEA = 0.46 (95% CI 0.45–0.48), CFI = 0.13, TLI = −0.02, was an improvement over the no growth model ($\Delta\chi^2 = 4243$, $\Delta df = 3$, $p < .01$); however, the variances for the level and slope were negative, providing evidence that the linear model was not a good representation of the changes in the reading skills factor. The latent shape model, $\chi^2 = 681$, $df = 16$, RMSEA = 0.22 (95% CI 0.21–0.24), CFI = 0.82, TLI = 0.77, was a significant improvement over the linear model ($\Delta\chi^2 = 2620$, $\Delta df = 2$, $p < .01$) and the no growth model ($\Delta\chi^2 = 6863$, $\Delta df = 5$, $p < .01$). This model still did not provide a close fit in absolute terms (i.e., RMSEA > .05; CFI and TLI < .90), but the primary source of misfit was a mismatch between observed and predicted variances for the measures of reading skills. Our research aims addressed neither amounts nor changes in variance; therefore, we accepted the latent shape model as the best representation of the data given our research aims. The two estimated basis coefficients equaled .59 and .88, indicating that most of the total growth in reading skills occurred between 54 months of age and first grade. There was significant variation in the initial level and total change, and the correlation between initial level and total change was −0.57, indicating that children who had lower scores at 54 months tended to change more from 54 months to fifth grade. The parameter estimates and fit statistics for these models appear in Table 5.

**Multiple Group Model to Test Shape Invariance**

Two multiple group models were fit to examine whether the shape of development was the same for children with LD and children with TL. In the first model, the shape coefficients were constrained to be equal for both groups of children. This model fit
the data moderately well, $\chi^2 = 730, df = 44, \text{RMSEA} = .20, \text{CFI} = .80, \text{TLI} = .81$. The shape coefficients were then separately estimated for the children with LD and TL in a second multiple group model. This model, $\chi^2 = 725, df = 42, \text{RMSEA} = .20, \text{CFI} = .80, \text{TLI} = .80$, fit similarly to the first multiple group model ($\Delta \chi^2 = 5, \Delta df = 2, p > .05$) in which the shape coefficients were constrained to be equal. This proved that the two groups have the same shape of development.

Effect of LD on Reading Skills

The child’s language status was used as a predictor of the initial level and total change in the latent shape growth model. Concerning the first research aim, the results indicated that, on average, the children with LD had a lower level of reading skill at 54 months by .98 SD ($SE = .102, t = 9.6, p < 0.01; SD$ units based on pooled SD of initial level factor), equivalent to a difference of –17.14 W-units. This replicates previous findings and fits the a priori hypothesis.

For the second research aim, and consistent with the compensatory view of reading development, the results indicated that children with LD had a relatively greater total change by .58 SD ($SE = .149, t = 3.9, p < 0.01; SD$ units based on pooled SD of total change factor), equivalent to a difference in total change of +7.08 W-units. Children with LD were therefore able to make up 41% (7.08/17.14) of the 54-month difference in reading skill through fifth grade. This finding shows that children with LD exhibited some compensation for the reading disadvantages that were seen at 54 months.

Regarding the third research aim, the invariance of the shape parameters described above ($\Delta \chi^2 = 5, \Delta df = 2, p > .05$) showed there to be no evidence of differences in the patterns of growth for children with LD and TL. For both groups of children, the shape coefficients indicated that 59% of the total growth from 54 months to fifth grade occurred between 54 months and first grade. An additional 29% of the total growth occurred between first and third grade. The remainder, 12% of the total growth, occurred between third and fifth grades. The predicted trajectories for the children with and without LD are plotted in Figure 2. Note that the children with LD grew faster than the children with TL and partially caught up over the course of the study. This is difficult to see in Figure 2.

The parameter estimates and fit statistics for the latent growth curves are shown in Table 5. The values indicate that the parameters were fixed to the specified values, $\chi^2$ = maximum likelihood chi square fit statistic, RMSEA = root mean square error of approximation, CFI = comparative fit index.
because the magnitude of total change overshadows the reduced group differences. Therefore, in Figure 3, we plotted the predicted group differences between children with LD and children with TL in SD units over the four points in time. From this figure, it is clear that the size of the group differences decreased as children progressed through school.

**DISCUSSION**

The goal of the present study was to model growth in reading for children with LD at 54 months of age through fifth grade and to compare this trajectory of reading achievement to the trajectory of reading achievement of children with TL skills. Our analytic goals were to examine initial differences in reading skills for the two groups at 54 months, to assess differences in the overall growth in reading skills over time, and to determine if there were differences in the pattern of growth in reading skills for the two groups. Theoretically, we were particularly interested in determining whether the growth trajectories of children with LD would converge to or diverge from the growth trajectories of typically developing children, consistent with either a compensatory trajectory of development or a cumulative reading trajectory. Major findings are discussed in turn.

Our first major finding, which is consistent with previous research (Boudreau & Hedberg, 1999; Justice et al., 2006), was that children who were identified with LD at 54 months of age exhibited poor prereading skills compared to same-age children with TL. The magnitude of these differences was substantial, with children with LD falling nearly 1 SD behind their typically developing peers at 54 months. Thus, children with LD were poised to enter kindergarten with significantly underdeveloped skills related to reading relative to their same-age, typically developing peers, which is consistent with our a priori hypothesis. These findings may be partially explained by environmental factors unrelated to children’s language development given that, similar to other research (e.g., Whitehurst & Fischel, 2000), the mean household income of children with LD in the present study was more likely to be lower than that of their peers. Nonetheless, research on preschool literacy development for children with SLI has shown that environmental disadvantage alone does not explain the differences that are seen in early reading skill when comparing skills of children with SLI to those of children with TL (Justice et al., 2006). That is, when children from similar socioeconomic backgrounds who significantly differ in language ability are compared for prereading achievements, there are substantial differences that are consistent with very large effect sizes.

Our second major finding concerned reading achievement gains over the early years of schooling. Specifically, growth curve analyses showed that reading achievement increased quickly from 54 months of age to first grade, followed by a decelerating growth rate through Grades 3 and 5 for all children. Children from both groups demonstrated growth in reading over all years, but the actual rate of growth in reading varied between specific time points, with growth relatively faster in the early years of schooling and slowing in the later elementary grades. More specifically, both groups of children gained approximately 59% of their reading skills between preschool and first grade, approximately 29% between first and third grade, and the remaining 12% between third and fifth grade. These findings strongly converge with research findings derived from Hill and colleagues (2007), who demonstrated that children show the largest growth in reading skill between kindergarten and first grade, with the second largest period of growth occurring from first to second grade. Gains continue to decrease through the middle and high school periods, with annual reading growth by the 11th and 12th grades occurring at negligible rates. Importantly, our third major finding was that the same pattern of reading growth was observed for both groups of children. Although children with LD demonstrated lower levels of reading skills at every time point, the growth models suggest that they experience normal patterns of reading development, similar to findings demonstrating that children with language impairment develop rules.
and principles in the same ways as their peers when learning to construct grammar (Curtiss, Katz, & Tallal, 1992). Put another way, the children with LD did not appear to show deviant patterns of reading growth, as would be indicated by growth curves differing in shape from those of their typical peers. All children demonstrated more reading growth earlier in their schooling careers. The present study found, however, that the total change in growth in reading ability was notably faster for children with LD, thereby contributing to a reduction in the average difference between the typical children and the children with LD over time. Findings from the present work suggest that children with LD gain back approximately 41% of their initial deficit in reading skill from preschool to fifth grade. Thus, differences between good and poor readers were attenuated with time, with children with LD showing greater rates of growth than their peers with TL skills.

Using a latent growth curve model, Parilla et al. (2005) also found that children’s initial abilities were negatively correlated with their later reading growth. These researchers argued that although individual differences in reading ability remained fairly stable over time, the extent to which children differed decreased across time points. Thus, the results of the current work favor a compensatory trajectory of development rather than a cumulative reading trajectory. Nonetheless, the results of the present study should not be interpreted as showing that children who begin school as poor readers fully catch up with better readers over time; indeed, this is not the case, for the children with LD exhibited lower levels of reading ability at Grade 5 compared to the children with TL. Given that children who have LD develop reading abilities at a faster rate than their typically developing peers, it is important to consider whether these children will ever catch up to their peers. Evidence from the present study suggests that they will not. As a group, children with LD showed no signs of performing at the same level as their peers on tasks measuring reading skills during the 6-1/2 years of growth represented in the present work. If children with LD maintained the same level of growth across 6-1/2 years as seen in the present work throughout their lifetimes, they would not catch up with peers demonstrating TL skills until approximately 21 years of age. However, it is unlikely that this would happen for two reasons.

First, for the time period studied in the present work, children’s growth in the area of reading decelerated over time, with the largest amount of growth occurring between 54 months of age and Grade 1; this finding suggests that the reading achievement gap narrows at a slower rate as children age. Second, the children with LD had access to formal schooling over the course of this study and were presumably receiving reading instruction in their classrooms. As children progress from the elementary grades to middle school and beyond, considerably less emphasis is placed on reading instruction. Thus, the present findings suggest that the initial amount of delay that was associated with reading for children with LD is so large as to make complete mitigation of these differences unlikely.

These findings have important implications for the design of high-quality reading programs within preschool and elementary school, as they suggest the importance of ensuring that children with LD have early opportunities to develop critical reading competencies. Although the present research demonstrated that children with LD exhibit accelerated reading growth compared to children with TL, our findings suggest that this acceleration may not be adequate to achieve skilled reading. School-based professionals must be vigilant in identifying pupils who exhibit critical weaknesses in language ability and supporting these pupils to promote their reading development across the reading trajectory. Our findings suggest that diagnostic work should be done in the preschool years in order to boost children’s early skill levels.

Limitations

There are a few limitations in the present work that warrant attention. First, children were identified with LD post hoc using norm-referenced assessment data from the available battery, yet we did not have access to information concerning whether the children had been clinically identified with a language impairment. Similarly, the identification of LD in this study was based on a global measure of language development, making it impossible to ascertain specific areas of deficits among children. Children with LD represent a heterogeneous group of children who vary in the language “symptoms” that they exhibit (Conti-Ramsden & Botting, 1999). Given the large amount of variability in the reading abilities for the children included in the present study, it may be that children with different typologies of LD may be more or less likely to have concomitant reading difficulties, and that reading growth may vary as a function of specific symptomatology.

Second, the methodology used in this study also made it impossible to know what kinds of services the children were receiving within their schools. For instance, it is unknown whether any of the children we identified as having LD did, in fact, receive clinical speech/language services. In addition, we do not know the extent to which explicit attention to literacy was integrated into any clinical services received, given that literacy has also recently emerged as within the scope of practice for the school-based SLP. As a result, we were unable to investigate whether the faster rates of growth for children with LD that were observed in the present study resulted from effective intervention programs. The extent to which these reading trajectories may look different for children with LD who are receiving intensive literacy supports (through clinical services or high-quality classroom instruction) is an important question for future empirical research.

Third, an additional limitation is that the present study used four points in time to document growth in reading over a period of more than 6 years. Although this number of time points was sufficient to model growth, additional data points would have allowed us to consider more complex forms of growth over time. Likewise, our estimates of children’s reading skills were constrained by the availability of measures in the NICHD ECCRN database, which focused primarily on word reading. Availability of a more complete battery of reading measures at each of the four time points may have provided a better model of reading growth than did the measures available.

Conclusion

The methods of the current study allowed us to describe patterns of growth in the area of reading for children with LD as compared to children with TL skills. Findings from the present study support the compensatory model of reading development given that differences in reading skills between children with LD and those with TL narrowed over time, although the reading skills of children with LD did not fully catch up to those of their peers by fifth grade. However, it is important to note that the majority of students
demonstrated the most reading skill growth during the first few years of school. Thus, in order to provide the high-quality language and literacy instruction that is currently mandated by the No Child Left Behind Act (U.S. Department of Education, 2001), and to mitigate the risks for poor reading outcomes typical of many children with LD, it is important that school-based SLPs adopt evidence-based practices that are empirically shown to elevate the reading outcomes of struggling readers from the earliest ages possible (e.g., Denton, Fletcher, Anthony, & Francis, 2006).

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