The Home Literacy Environment and Reading Development of Children with and without Learning Disabilities

PREPRINT on PsyArXiv

Currently under review

Rachelle M. Johnson https://orcid.org/0000-0002-8416-9262

Sara A. Hart https://orcid.org/ 0000-0001-9793-0420

Richard K. Wagner https://orcid.org/0000-0002-3243-7894

Department of Psychology, Florida State University

Florida Center for Reading Research, Florida State University

Author Note

Rachelle Johnson was supported by the FIREFLIES training fellowship funded by the Institute of Education Sciences grant R305B200020. Sara Hart and Richard Wagner were supported by Grant Number P50HD52120 from the National Institute of Child Health and Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. There are no conflicts of interest to declare. The ECLS-K:2011 data is not our data to share. Researchers may apply for access to the ECLS-K:2011 dataset through the U.S. Institute of Educational Sciences.

Corresponding author: Rachelle M. Johnson *rjohnson@psy.fsu.edu*

Research Highlights

- This paper utilizes a large, longitudinal, nationally representative sample of U.S. children with and without learning disabilities.
- Children with learning disabilities had a lower intercept or starting point but showed faster growth compared to children without learning disabilities.
- Home literacy environments provided prior to formal elementary education were predictive of children's early reading achievement in elementary school for both groups of children.
- The positive relation between home literacy environments and early reading achievement did not exist for rate of growth in reading through fifth grade for either group.

Abstract

Home literacy environment (HLE) refers to children's exposure to and engagement in reading related activities in the home. Although HLE is known to be related to successful early reading achievement in general, less is known about this relation for students with learning disabilities (LDs). We investigated the relation between HLE and reading achievement using a sample of 2,090 children from the ECLS-K:2011 dataset, half of whom were identified as students with LDs and half serving as controls. Latent growth curve modeling was used to examine growth in reading from kindergarten (age 5) through fifth grade (age 10). For both groups, growth was characterized by mastery learning with a negative correlation between intercept (i.e., performance at the first time point) and slope (rate of growth). Compared to controls, LD children had a lower mean intercept but a higher mean slope. HLE was positively related to intercept for both groups. However, the positive relation between HLE and reading did not extend to later grades, with a small but significant negative relation between HLE and slope for both groups. The pattern of results remained the same after controlling for socioeconomic status. It appears HLE is equally important to the reading achievement of both groups.

Keywords: home literacy environment; reading achievement; learning disability; longitudinal; ECLS-K:2011

The Home Literacy Environment and Reading Development of Children with and without Learning Disabilities

Reading is a fundamental skill in our society (Snowling & Hulme, 2005), and hence reading outcomes are a focus of much research. Much can be learned from evaluating reading outcomes measured at a given age, or specific timepoint. However, it is helpful to measure reading outcomes in terms of growth, as a measure of a child's rate in reading growth can better inform our understanding of how they are developing as a reader (Fuchs & Fuchs, 1999). Thus, research on the slope of reading growth, as opposed to only research on reading achievement at static timepoints, is critical as our field works to better understand and improve the reading achievement of children.

Reading is a skill that builds cumulatively (Chall, 1983). Early reading abilities in early formal schooling predict both reading skills in later grades and the rate of reading growth over time (Butler et al., 1985; Wagner & Torgesen, 1987; Cunningham & Stanovich, 1997; Schatschneider et al., 2004). Generally, reading growth is steeper during the schooling period when children are learning to decode, then less steep when schooling transitions from learning-to-read to reading-to-learn and reading is more comprehension based (in the U.S., this transition occurs at about age 8 in third grade; Foorman et al., 1998). Hill and colleagues (2008), in mapping reading gains of U.S. children using a cross-sectional design, found that reading growth was large in kindergarten, moderate in second grade, and small by sixth grade. However, there are individual differences in children's initial reading abilities and reading growth (Foorman et al., 1998; Parrila et al., 2005; McCoach et al., 2006; Skibbe et al., 2008).

Students with Learning Disabilities

Students with learning disabilities (LDs) have greater difficulty in one or more academic areas than would be expected. Learning disabilities can be disabling to areas of major life functioning, specifically to education for school-age children but also to other areas of life and work in adulthood (Compton et al., 2012; Cortiella & Horowitz, 2014; Grigorenko et al., 2020). Students with learning disabilities make up the largest category of children in United States (U.S.) elementary schools receiving disability-related services (Data Accountability Center, 2012). LD is an umbrella category for many more specific LDs such as dyslexia, dyscalculia, dysgraphia, and others. Difficulty reading is the most common deficit in LD students (Chan, 1994; Pintrich et al., 1994). However, it is common for LD students to have more than one specific LD as they often cooccur (Willcutt et al., 2013; Joyner & Wagner, 2020).

LD students demonstrate differences from their non-LD peers in their elementary school reading growth trajectories. Sullivan and colleagues (2017) compared the reading trajectories of children with and without LDs using a nationally representative sample in the U.S. followed longitudinally from kindergarten through eighth grade (using ECLS-K:1998). Similar to past studies on non-LD students (e.g., Foorman et al., 1998), they found that reading growth slowed in middle childhood. However, the point at which this shift happened was in third grade for children without LDs and in fourth grade for those with LDs. Sullivan and colleagues (2017) also found, in the years before this shift in middle childhood, not only did LD children start elementary school behind their peers in reading achievement but they had slower growth rates as well. This resulted in an increasing gap in achievement between the students with and without learning disabilities. After reading growth had slowed in middle childhood, reading growth was faster for children with than without LDs, however due to the reading achievement gaps already formed in early childhood, they stayed significantly below their peers in reading achievement in every grade kindergarten through eighth grade (Sullivan et al, 2017).

Among LD students there are individual differences in reading achievement. Although, many LD students do have low reading scores, some LD students have average to high reading achievement (Francis et al., 1996; Wagner et al., 2019). In fact, LD status only accounts for about 24% of the variance in early reading ability and elementary reading growth (Sullivan 2017). Thus, although a child's LD status does account for much of their reading achievement and growth, there are other factors at play determining reading outcomes among LD students. The question becomes, what factors make up the remaining variance in reading achievement and what factors predict individual differences in the reading achievement of LD students? One such factor that has received considerable attention in the general population of children is the home literacy environment (HLE). Limited attention has been paid to students with LDs in the literature on HLE, despite this being a group of students at high risk for low reading outcomes. The goal of this current paper research was to examine the role of home literacy environment (HLE) in the reading development of students with and without LDs.

Home Literacy Environment

The environment parents create in their home that promotes their children's learning is referred to as the home learning environment, and the home literacy environment (HLE) is a specific part of the home learning environment (Niklas & Schneider, 2017). HLE refers to children's access to and engagement in literacy related activities in the home (Puglisi et al., 2017). Sénéchal and LeFevre (2002) created the Home Literacy Model, which identifies two components of HLE: formal and informal literacy experiences. Informal literacy experiences are when print is present but not the primary focus (e.g., the parent reading to the child). Formal literacy experiences are when print is the primary focus (e.g., the parent teaching the child letter sounds). Each of these components of HLE are thought to have differential impacts on the reading outcomes of children (Sénéchal & LeFevre, 2002). In the current paper, we focused on the informal component of the HLE and thus will limit our review to such.

Informal HLE predicts early reading related skills (Sénéchal & LeFevre, 2014; Burris et al., 2019). In a meta-analysis, Dong and colleagues

(2020) found a moderate positive correlation between children’s HLE and reading comprehension (z = 0.32), across all four measures of HLE investigated: parental literacy beliefs, parent education level, parental involvement in children’s literacy activities, and home literacy resources. Shared book reading has been found to be positively correlated with children’s reading comprehension (Sénéchal, 2006; Yeo et al., 2014). Additionally, children with more access to books (e.g. number of books in the home and library card holders) tend to also have higher reading outcomes (Aikens & Barbarin, 2008; Bhattacharya, 2010; Zadeh et al., 2010).

The impact of HLE goes beyond initial reading skills in the first year or two of elementary school. Aikens and Barbarin (2008), using a large nationally U.S. representative longitudinal sample, found children with higher scores on informal HLE (i.e., number of books in the home) in kindergarten (age 5) had higher reading outcomes in every grade from kindergarten through three years later (third grade, age 8). They also found that HLE explained the association between children’s SES and early reading achievement. Sénéchal and LeFevre (2002) also found, in a U.S. sample, informal HLE (i.e., story book exposure) in kindergarten to be related to reading skills measured three years later in third grade. Inoue and colleagues (2018) found informal HLE in kindergarten (age 5) contributed to comprehension at ages 7 and 8 years old, even when controlling for socioeconomic status. Molfese and colleagues (2003) found that the reading scores of children ages eight to ten was predicted by their HLE in preschool. Some studies observe the effects of informal HLE on reading as late as fourth grade (age 9) in U.S. children. Sénéchal (2006) found kindergarten informal HLE directly predicted children's frequency of reading for pleasure in fourth grade and indirectly predicted fourth grade reading comprehension. Finally, Niklas and Schneider (2017) found kindergarten (age 5) HLE predicted not only early reading outcomes but reading skills through fourth grade (age 9). These studies suggest that early informal HLE not only predicts early reading skills but also accounts for variance in reading outcomes as late as fourth grade. However, it is important to investigate if informal HLE can also predict reading growth and not just its cross-sectional impacts on later reading achievement.

To our knowledge no studies have investigated if the impact of kindergarten HLE extends into late elementary school (i.e., past age 9). Additionally, while informal HLE has been found to predict reading outcomes at each age 5 through 9 years old, there is little known about its prediction of growth in reading achievement. To our knowledge, Sénéchal and LeFevre (2014) is the only paper to investigate reading growth in the context of informal HLE, finding that HLE (specifically U.S. parents' expectations for reading) predicted early literacy growth from the start of elementary school (kindergarten, age 6) to one year later (first grade, age 7). Studies investigating HLE's prediction of reading growth specifically, opposed to reading achievement at single timepoints, are critical to truly understand the relation between these constructs.

HLE in LD Children

Limited research has investigated the HLE of children with learning disabilities. However, what has been published led us to hypothesize that we would find a positive relation between HLE and reading outcomes in LD students. Struggling readers tend to have fewer books in the home and are read to less often than students with proficient reading abilities (Tichnor-Wagner et al., 2016). Additionally, intensity of parental involvement in reading intervention predicts reading growth for struggling readers (Leslie & Allen, 1999). Lower informal HLE and literacy skills have been observed in children with a reading disabled (RD) family member compared to children without, however this group difference did not hold up when SES was controlled for (Hamilton et al., 2016). Hamilton and colleagues (2016) went on to find that among children with a RD family member, storybook exposure at age 4 was predictive of age 6 word level literacy and reading comprehension. Rashid et. al., (2005) is the only existing paper, to our knowledge, that has looked at HLE as a predictor of reading achievement in an expressly LD sample. They investigated the association between the concurrent HLE and reading abilities of 65 children with RDs who were ages seven to nine. They found wide variability in HLE, but mixed results on if HLE predicted reading achievement. Home literacy activities of the children (e.g., the frequency that the child read alone) were not related to their current reading comprehension or spelling, but the home literacy activities of their parents (e.g., parent's ownership of a library card) were related to the RD children's reading comprehension and spelling.

The HLE of LD students is an important area of investigation so that best efforts can be made to promote the reading development of LD students. LD students have documented extreme difficulties in learning to read compared to their peers, especially at the start of elementary school (Grigorenko et al., 2020). These difficulties start early, even before they have been identified as LD or identified as in need of intervention (Sanfilippo et al., 2020). Profound LDs can be lifelong disabilities, with their disabilities being present prior to formal school and their LDs continuing to cause impairment into their adult life, particularly as a result of continued inadequate reading abilities (Sanfilippo et al., 2020). Our current study was designed to provide better understanding how the exposure to reading materials (in the form of informal HLE) LD students are provided prior to kindergarten is associated with their later reading development.

Research Questions

There were two main research questions in the current study. The first was to what extent do individual differences in the HLE among LD students predict their reading development from kindergarten through fifth grade? The second research question was does the relation between HLE and reading development differ between children with and without LDs? This study will provide better understanding of the extent to which the amount of exposure to reading materials (in the form of informal HLE) LD students are provided, prior to the start of kindergarten and formal reading instruction, is related to their reading development.

Method

Participants

This study was preregistered on Open Science Framework (Johnson & Hart, 2022; https://osf.io/vu65w). We used a subsample from the Early Childhood Longitudinal Study–Kindergarten Cohort of 2010-2011 (ECLS-K:2010; Tourangeau et al., 2017). The ECLS-K:2011 is a sample of about 18,170 U.S. children who are intentionally stratified to be nationally-representative of the children who started kindergarten during the 2010-2011 school year. The sample is representative on demographic such as socioeconomic status, racial and ethnic background, region of the country, type of school (private and public schools), and kindergarten type (full and half-day kindergarten). The ECLS-K:2011 students were then followed longitudinally and measured on numerus constructs from kindergarten (age 6) through fifth grade (age 11). A more detailed description of the ECLS-K:2011 dataset can be found in its publicly available manual and codebook (see Tourangeau et al., 2019). The ECLS-K:2011 data is not our data to share. Researchers may apply, as we did, for access to the ECLS-K:2011 dataset through the U.S. Institute of Educational Sciences.

A subsample of 1,090 children with and 1,000 without LDs in the ECLS-K:2011 dataset was used for this specific paper. We excluded children who were deaf, blind, or had intellectual disabilities from the analytic sample. The LD group was 65% male, and in the non-LD group it was 51% male. Both groups had a range in annual household income of less than $5,000 to over $200,000; the LD group had a $40,000 average and the non-LD group had a $45,000 average. Level of parent education ranged from a 7th grade education through a profession/doctoral degree for both groups. A vocational program after high school was the median for the LD group and "some college but no degree" was the median of the non-LD group. There was a similar percentage of children of each race across the LD and non-LD groups (47% White, 14% Black, 30% Hispanic, 3% Pacific Islander, 1% Native American, and 5% multi-race for the LD group; 48% White, 12% Black, 26% Hispanic, 1% Pacific Islander, 1% Native American, and 5% multi-race for the non-LD group).

Measures and Procedure

The current study followed children's reading development from kindergarten through fifth grade. In the spring of each year, students were administered direct cognitive assessments of their reading skills. A parent interview was conducted during fall of kindergarten, which was used to obtain an assessment of HLE and demographics. LD status was captured by both teacher and parent report.

Learning disability status. During every year of data collection, parents reported to the ECLS-K:2011 whether their child had a diagnosed LD. However, many parents were not asked this question about their child's

LD status due to the skip logic of the parent interview, and thus some children with diagnosed LDs may have been missed by this parent report. Thus, we decided this parent report was not sufficient to use alone to identify the LD sample, and a teacher report of LD status was used in combination with this parent report. Children receiving special education services for LDs were additionally placed in our LD sample group. During every year of the ECLS-K:2011 data collection, this information was reported by children's special education teachers indicating which disability category each child was classified under. We considered children to be LD if they had been identified as LD by either their teacher or parent during any round of the six years of ECLS-K:2011 data collection. LD status was binary coded (LD = 1). There was not a way to further different the specific LDs of the LD children with the ECLS-K:2011 data, and thus LD was operationalized as one larger umbrella category of disability. With reading LDs being by far the most common and the knowledge that there is high co-occurrence across LD subtypes, with LD students often struggling in multiple academic disciplines (Compton et al., 2012; Cortiella & Horowitz, 2014), it was determined acceptable to leave LD as a single category. Using this method, a sample of about[1] 1,090 LD students was idented for inclusion in this study. For the comparison non-LD group, a random sample of 1,000 children from the remaining non-LD children was selected. We decided to

---

[1] Per the data security guidelines required by the ECLS-K:2011, all *N* sizes throughout this paper have been rounded to the nearest ten's place.

limit the size of the non-LD sample to have comparable sensitivity for analyses on both groups.

Reading achievement was the main outcome variable of the study. Reading achievement was directly assessed in the spring of each year from kindergarten to fifth grade, using a computer-assisted adaptive assessment. The reading assessment measured a range of reading skills including basic reading skills (e.g., word recognition) and reading comprehension (e.g., interpretation of a text). The reading outcome measurement provided in the ECLS-K:2011 dataset was a composite measure created by combining these reading components to capture reading ability at each year of data collection. An Item Response Theory (IRT) based theta score for reading was the variable used (Tourangeau et al., 2017). IRT theta scores are appropriate to use for longitudinal analysis, analyzing subgroups of children, and correlating reading scores with child and family characteristics. The IRT theta scores for each year of data collection were on the same metric, which allowed comparison of reading gains over the years. IRT theta scores incorporate item-level difficulty, which allowed the comparison of children's reading scores even though the children had different sets of items in their reading assessments. T-tests showed the LD group had significantly lower reading achievement than the non-LD in every grade (t's ranged from 26.85 to 35.20, all p's < .001).

Home literacy environment. As part of an interview at the start of kindergarten, parents were asked five questions about aspects of their children’s informal HLE the summer before kindergarten. This included, (1) how often the child was read to by their parent, (2) the length of time the child was read to, (3) the number of books in the home, (4) how often the child looked at picture books on their own, and (5) how often the child pretended to read to themselves. These 5 questions were then represented by a single latent factor of HLE (Johnson et al., 2024).

Socioeconomic status. A composite measure of socioeconomic status (SES) provided by the ECLS-K:2011 dataset was included as a covariate. It was a combination of father’s education level, mother’s education level, father’s occupational prestige, mother’s occupational prestige, and household income.

Data Transformations and Missingness

All variables were checked for outliers and the shape of their distributions were examined. For each variable, datapoints outside of the median plus or minus twice the interquartile range for that variable were considered outliers and adjusted to be set at the edge of that range. This resulted in 1-5% of the data points on each of the variables being adjusted. After doing so, all variables had acceptably low skew (within -2 to 2) and kurtosis (within -3 to 3) values. The distribution of the data for each measure was also examined at in a histogram as a final check. About 26% of those with and without LDs were missing HLE data. Attrition occurred for reading achievement data, with about 5% missingness in kindergarten for both groups but in fifth grade 30% missingness in the LD group and 18%

missingness in the non-LD group. Little's MCAR was run, and the data were missing completely at random for the LD group (chi-square = 498, $p = .216$) but were not missing completely at random in the non-LD group (chi-square = 396, $p < .001$). Missing data were handled with full information maximum likelihood (FIML).

Analyses

All analytic models were conducted in Mplus. We used curve fit analysis and preliminary latent growth curve modeling to first determine the best model of reading growth that would then be used for the final model. Once the most appropriate reading growth curve function was determined, the full model of HLE predicting reading intercept and slope was run. In looking at intercept, of interest was if HLE predicted children's initial reading abilities at the end of kindergarten. Next, it was investigated if HLE predicted slope in reading growth, specifically how HLE predicted the rate of change in the slope. Finally, to test whether HLE predicted slope and intercept independent of SES, the full model was rerun with SES added as a second predictor of slope and intercept.

When running each of these multigroup models, they were run first as unconditional models and then run again as a conditional model, to determine if there were differences between the LD and non-LD group. A chi-squared difference test was performed comparing the fit of the original model (which was unconstrained) and a model that constrained the parameters to be identical between the LD and non-LD groups. If the constrained model was found to significantly reduce fit compared to the original unconstrained model, the unconstrained full model would be preferred, indicating differences between children with and without LDs.

Evaluating Model Fit

Several fit statistics were used to evaluate the fit of each model. First the probability that the model fits the population covariance matrix perfectly is provided by the chi-squared test. The *p*-value associated with the chi-square test indicates the probability that the model perfectly fits the data in the population, thus a higher p-value indicates a well-fitting model. Theoretically, the chi-square values of models with perfect fit should be about equal to the model's degrees of freedom. However, the chi-square tests penalize models with large sample sizes, thus additional model fit indicators were examined. Indications of adequate fit were values greater than .90 on the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI). Values greater than .95 for these two measures of model fit indicated an excellent fitting model. Values below .1 for the Root Mean Square Error of Approximation (RMSEA) indicate adequate fit, and values below .05 indicate excellent fit. Finally, the average distance between the values of the observed and implied correlation matrix was interpreted with the standardized root mean square residual (SRMR) test. Models with SRMR values less than .10 were considered to have good fit to the data.

Results

Multigroup Reading Growth Curve Model

First, a preliminary inspection of the growth function was carried out on the means using the curve fit analysis from SPSS, the results of which revealed that neither a linear, quadratic, nor cubic fit was likely to best fit the data. This was confirmed with multigroup reading growth curve models that specified linear, quadratic, and cubic growth functions in Mplus. Both the linear and quadratic models had poor fit and the cubic model would not converge because of high multicollinearity between the quadratic, and cubic coefficients. Consequently, we used a freeloading model (Muthen & Muthen, 2008), in which we fixed the slope loadings of reading in kindergarten (fixed at 0) and first grade (fixed at 1) and allowed the loadings at the remaining four grades to be freely estimated. By using a freeloading model, nonlinearity of reading growth in the form of predicted slowing over time was able to be fit. A multigroup growth curve model was run for the LD and non-LD groups. This model had a moderately good fit to the data, supporting use of the freeloading model compared to the poorly fitting linear and quadratic models. The slope loadings for the freeloading model were constrained to be equal across the two groups to make group differences in slopes meaningful.

There was a significant negative correlation between slope and intercept (-0.849 for the LD group; -0.850 for the non-LD group), meaning that children with lower reading achievement in kindergarten grew faster in reading throughout elementary school. Model fit statistics are presented in Table 1 and parameter estimates are presented in Table 2. The models that constrained mean intercepts or slopes to be equal across groups had a significantly poorer fit than the unconstrained model. This indicated that the LD group had a significantly lower mean intercept (mean = -0.885) and higher mean slope (mean = 0.900) than the non-LD group (mean intercept = -0.173, mean slope = 0.743; both *p's* $< .001$).

Finally, Figure 1 displays two spaghetti plots (one of LD students and one of non-LD students) each containing 50 randomly selected students and their reading achievement in each grade. This figure provides a visualization of the reading growth of children with and without LDs. Reading growth for both groups appear steeper in the earlier grades and flattening after third grade.

HLE Predicting Reading

The constraints did not significantly reduce model fit, indicating no difference across the LD and non-LD group in HLE as a predictor of reading intercept and slope. See Table 3 for the results of this model. This model had moderate fit to the data as both CFI and TLI were above .90 and RMSEA was under .1 indicating moderate fit and SRMR was under .1 indicating moderate fit; see Table 1. HLE significantly predicted intercept (estimate = 0.302, $p < .001$) for both the LD and non-LD groups. HLE negatively predicted slope (estimate = -0.069, $p < .001$) for both the LD and non-LD groups. Both reading intercept and slope had significant residual variance that was not explained by HLE.

Adding SES to the Model

HLE significantly predicted intercept (estimate = 0.182, $p < .001$) and slope (estimate = -0.036, $p < .001$) for both the LD and non-LD groups with SES added to the model. SES also significantly predicted intercept (estimate = 0.201) and slope (estimate = -0.036). Chi-square difference testing showed that there were no group differences in the degree to which HLE predicted slope and intercept with SES added to the model. See Table 4 for the results of this model.

Discussion

Reading Development

As a preliminary part of this paper, we first investigated the reading growth rates in children with and without LDs before including HLE in the investigations. Although this was not a major research question of the planned study, through this preliminarily investigation, insights were gained on reading growth across elementary school. See Figure 1 for a visualization of the reading growth curves in spaghetti plots. Children's growth in reading was steeper in the earlier years and slowed over time, appearing to start flattening out after third grade. This shape of reading growth rates slowing in later elementary school, and specifically after third grade in U.S. contexts, are reflective of past research on the topic (Foorman et al., 1998; Hill et al., 2008).

There was a strong negative correlation between reading intercept and slope of -0.85, which indicates mastery learning. Children who had lower reading achievement in kindergarten grew in their reading achievement at faster rates than children with higher kindergarten reading achievement. Compared to their non-LD peers, LD children had a lower reading intercept but a higher slope. Lower reading achievement and slower reading development is often considered a hallmark trait of learning disabilities, specifically in children with reading disabilities (Chan, 1994; Pintrich et al., 1994), thus this finding was unexpected. However, this did not translate to the LD children closing the achievement gap with their non-LD peers; despite this faster growth LD children had lower mean reading achievement than non-LD children at every timepoint.

This is similar to the findings of Sullivan et al (2017) who compared the reading growth rates of elementary age children with and without LDs in a previous wave of the ECLS-K project (ECLS-K:1998). They found that non-LD children were higher in reading achievement at every time point and had a steeper slope through third grade than the LD children, and after third grade the non-LD students' slope slowed. However, the LD children did not display this slowing in their slope until after fourth grade and after it did slow their slower slope was steeper than that of the non-LD children. This could explain the steeper slope observed in the LD students of the present study. It is possible that children who had high reading achievement in kindergarten reached this slowing point (that often is assumed to happen in third grade for U.S. children) earlier than the LD children and low achieving children, thus meaning these children maintained a steep slope for more years before slowing. Finally, it should be noted that most of the LD children in the sample were on an IEP for LDs, thus we assume these children were receiving some form of reading remediation in intervention. It is possible that the interventions were effective enough to raise the slope of these children's reading achievement, but not enough to get these children at the same mean reading achievement as their peers by fifth grade.

HLE Prediction of Early Reading

We found that HLE positively predicts children's reading achievement intercept, such that children who experience higher HLE prior to the start of kindergarten tend to have higher reading achievement at the end of kindergarten. This is supported by a large literature base indicating that HLE predicts reading achievement in early elementary school (Aikens & Barbrin, 2008; Inoue et. al., 2018). A meta-analysis found a moderate association of 0.32 between HLE and reading comprehension (Dong et al., 2020). This is comparable to the resulting standardized effect size of 0.260 found in the current study. The novelty of this study was in the inclusion of LD students. Rashid et al., (2005) is the only study we know of that has investigated HLE as a predictor of reading achievement in children with identified LDs. Within middle elementary age children with reading disabilities (RD), they found mixed results as to if HLE predicted reading comprehension measured at a single time point. We found that HLE did positively predict reading in kindergarten, and this finding was equivalent for children with and without LDs. Thus, we conclude that HLE is important to the early reading achievement of children with LDs, but not any more important for LD students than it is for non-LD students.

HLE Prediction of Reading Development

There is a vast existing literature on the association between HLE (specifically informal HLE) and reading achievement as measured at single time points, with HLE being known to predict reading achievement not just in early elementary school but also reading achievement measured years later (Niklas & Schneider, 2017; Sénéchal, 2006). What has not been examined and is a needed area of investigation, is the extent to which HLE predicts reading development as measured by growth over time. Sénéchal and LeFevre (2014) found informal HLE to positively predict reading growth from kindergarten to first grade. We found that HLE predicts the slope of reading growth as measured from kindergarten through fifth grade. However, the direction of the results was unexpected. We found that higher HLE predicted a less steep slope in reading achievement. This result could indicate several possibilities. In our initial reading growth curve models, before HLE was entered as a predictor, we found a negative correlation between reading intercept and slope (-0.85). The finding of the negative prediction of HLE to slope, coupled with the negative correlation between reading intercept and slope, could suggest that children coming from a higher home literacy environment would have a higher intercept that children coming from a lower home literacy environment, and that higher intercept is associated with slower growth. Therefore, their HLE scores would be negatively correlated with growth. **Comparing HLE in Children with and without LDs**

A primary aim of this study was to compare the strength with which HLE predicts reading achievement across children with and without LDs. We found the strength at which HLE predicts reading growth throughout elementary school (kindergarten through fifth grade) was the same for both groups. This suggests that HLE is equally important to the reading achievement of students with and without LDs. What is of interest and should be noted is that while HLE is equally important for both groups, LD children had lower HLE scores. As found in our prior research on this sample (see Author et al., under review), the components that make up the HLE of both groups are the same, but the mean of the HLE factor is lower for the LD group.

Socioeconomic Status

In any study of HLE it is important to check for SES as a potential confound. With a high association between SES and HLE, there have been concerns and investigations into if HLE is just a quasi-measure of SES and if HLE is just capturing the SES that is already in place in the home (Van Steensel, 2006; Carroll et al., 2019). In some of the previous literature, the relation of HLE with reading was found to be not statistically significant once SES was controlled for. For example, Hamilton et. al. (2016) found that children with (as compared to without) a reading disabled family member had lower HLE, however this group difference was not significant once SES was controlled for in the model. We found that SES did account for some, but not all, of the shared variance in HLE's prediction of reading achievement. When SES was included as a covariate, HLE was still a significant predictor of reading intercept and slope, and this was equivalent for the LD and non-LD group. Thus, we conclude that SES is not the entire explanation for the association between HLE and reading achievement in this sample.

Limitations

Our reading measure was a computer adaptive IRT theta measure that was a composite measure of reading skills. Thus, we cannot make conclusions about specific reading skills, but instead reading achievement as a broader concept. This was helpful for the study because the types of reading skills that children are learning and thus being tested on in school changes over the elementary grades. Having an adaptive composite measure allowed us to investigate reading achievement from kindergarten through fifth grade, across which time the components of reading most appropriate for each grade would change. However, this limits the ability to draw conclusions about specific components of reading achievement. Future research should investigate how HLE predicts the development of different parts of reading achievement (e.g., fluency, word reading accuracy, comprehension).

It should be noted that the measure of HLE only captured informal HLE and did not include components of formal HLE. Sénéchal and

LeFevre's (2002) Home Literacy Model suggests that HLE is broken into the formal and informal HLE and that these two operate differently. The results of this paper are specific to the informal HLE and not that of the HLE that is captured by the formal HLE. Future research is needed into the formal HLE children with and without LDs experience and how formal HLE predicts reading growth in elementary school.

As this is a correlational study, we cannot make claims of direction or causation between the HLE and reading achievement. It is possible that HLE could lead to later reading achievement, early reading achievement could lead to the HLE a child experiences, or a causal effect could be occurring in both directions. Outside of a causal explanation, an alternative explanation for the association between HLE and reading achievement could be gene-environment correlation (van Bergen et al., 2017; Hart et al., 2021). There are shared genes between children and their parents, including shared genes involved in reading achievement. Parents with LDs and low reading achievement are more likely to have children with LDs and low reading achievement (Snowling et. al. 2005). In a passive gene-environment correlation, the parent’s genes related to reading achievement influence both the environment that they create associated with literacy and the reading characteristics of the child (Hart et al., 2021). Thus, shared genetics is thought to, at least in part, explain the association between children’s HLE and reading achievement. Multiple studies have found support for this explanation (Puglisi et al., 2017; van Bergen et al., 2017; Snowling & Hulme, 2021).

Conclusions

This paper expands our understanding of HLE to children with learning disabilities, the population of children most at risk of experiencing barriers to achieving functional reading skills (Chan, 1994; Pintrich et al., 1994). Furthermore, this paper uncovers the role of HLE in children's long-term reading development, beyond single time points of reading ability. A critical pursuit in the field of reading research is not just to know what predicts children's mean reading scores but more importantly what factors predict how children's reading grows with time (Fuchs & Fuchs, 1999). Answering the first research question, we found that for LD children, informal HLE positively predicts their reading achievement in kindergarten and negatively predicts the slope of their reading development through fifth grade. These results remained true even when controlling for SES. Answering the second research question, we found that the strength of these predictions operated at the same strength for both children with and without LDs. With these findings we conclude that HLE is associated with the early reading achievement of both children with and without learning disabilities.

References

Aikens, N. L., & Barbarin, O. (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. *Journal of Educational Psychology*, *100*(2), 235–251. https://doi.org/10.1037/0022-0663.100.2.235

Bhattacharya, A. (2010). Children and adolescents from poverty and reading development: A research review. *Reading & Writing Quarterly*, *26*(2), 115–139. https://doi.org/10.1080/10573560903547445

Burris, P. W., Phillips, B. M., & Lonigan, C. J. (2019). Examining the relations of the home literacy environments of families of low SES with children's early literacy skills. *Journal of Education for Students Placed at Risk (JESPAR)*, *24*(2), 154–173. https://doi.org/10.1080/10824669.2019.1602473

Carroll, J. M., Holliman, A. J., Weir, F., & Baroody, A. E. (2019). Literacy interest, home literacy environment and emergent literacy skills in preschoolers. *Journal of Research in Reading*, *42*(1), 150–161. https://doi.org/10.1111/1467-9817.12255

Chall, J. S. (1983). *Stages of reading development*. McGraw-Hill.

Chan, L. K. S. (1994). Relationship of motivation, strategic learning, and reading achievement in grades 5, 7, and 9. *The Journal of Experimental Education*, *62*(4), 319–339. https://doi.org/10.1080/00220973.1994.9944138

Compton, D. L., Fuchs, L. S., Fuchs, D., Lambert, W., & Hamlett, C. (2012). The cognitive and academic profiles of reading and mathematics learning disabilities. *Journal of Learning Disabilities*, *45*(1), 79–95. https://doi.org/10.1177/0022219410393012

Cortiella, C., & Horowitz, S. H. (2014). *The state of learning disabilities: Facts, trends, and emerging issues*. National Center for Learning Disabilities. https://www.ncld.org

Data Accountability Center. (2012). *Individuals with Disabilities Education Act data*. http://ideadata.org

Dong, Y., Wu, S. X.-Y., Dong, W.-Y., & Tang, Y. (2020). The effects of home literacy environment on children’s reading comprehension development: A meta-analysis. *Educational Sciences: Theory & Practice*, *20*(2), 63–82. https://doi.org/10.12738/jestp.2020.2.005

Foorman, B. R., Francis, D. J., Fletcher, J. M., Schatschneider, C., & Mehta, P. (1998). The role of instruction in learning to read: Preventing reading failure in at-risk children. *Journal of Educational Psychology*, *90*(1), 37–55. https://doi.org/10.1037/0022-0663.90.1.37

Francis, D. J., Fletcher, J. M., Shaywitz, B. A., Shaywitz, S. E., & Rourke, B. P. (1996). Defining learning and language disabilities: Conceptual and psychometric issues with the use of IQ tests. *Language, Speech, and Hearing Services in Schools*, *27*(2), 132–143. https://doi.org/10.1044/0161-1461.2702.132

Fuchs, L. S., & Fuchs, D. (1999). Monitoring student progress toward the development of reading competence: A review of three forms of classroom-based assessment. *School Psychology Review*, *28*, 659–672.

Grigorenko, E. L., Compton, D. L., Fuchs, L. S., Wagner, R. K., Willcutt, E. G., & Fletcher, J. M. (2020). Understanding, educating, and supporting children with specific learning disabilities: 50 years of science and practice. *American Psychologist*, *75*(1), 37–51. https://doi.org/10.1037/amp0000452

Hamilton, L. G., Hayiou-Thomas, M. E., Hulme, C., & Snowling, M. J. (2016). The home literacy environment as a predictor of the early literacy development of children at family-risk of dyslexia. *Scientific Studies of Reading*, *20*(5), 401–419. https://doi.org/10.1080/10888438.2016.1213266

Hill, C. J., Bloom, H. S., Black, A. R., & Lipsey, M. W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives*, *2*(3), 172–177. https://doi.org/10.1111/j.1750-8606.2008.00061.x

Inoue, T., Georgiou, G. K., Parrila, R., & Kirby, J. R. (2018). Examining an extended home literacy model: The mediating roles of emergent literacy skills and reading fluency. *Scientific Studies of Reading*, *22*(4), 273–288. https://doi.org/10.1080/10888438.2018.1435663

Johnson, R. M., & Hart, S. A. (2022). Home literacy environment onto the longitudinal reading development of children with and without learning disabilities. https://doi.org/10.17605/OSF.IO/VU65W

Johnson, R. M., Wagner, R. K., & Hart, S. A. (2024). Comparing the home literacy environments of children with and without learning disabilities. *PsyArXiv*. https://doi.org/10.31234/osf.io/m32gj

Joyner, R. E., & Wagner, R. K. (2020). Co-occurrence of reading disabilities and math disabilities: A meta-analysis. *Scientific Studies of Reading*, *24*(1), 14–22. https://doi.org/10.1080/10888438.2019.1593420

Leslie, L., & Allen, L. (1999). Factors that predict success in an early literacy intervention project. *Reading Research Quarterly*, *34*(4), 404–424. https://doi.org/10.1598/RRQ.34.4.2

McCoach, D. B., O'Connell, A. A., Reis, S. M., & Levitt, H. A. (2006). Growing readers: A hierarchical linear model of children's reading growth during the first 2 years of school. *Journal of Educational Psychology*, *98*(1), 14–28. https://doi.org/10.1037/0022-0663.98.1.14

Molfese, V. J., Modglin, A., & Molfese, D. L. (2003). The role of environment in the development of reading skills: A longitudinal study of preschool and school-age measures. *Journal of Learning Disabilities*, *36*(1), 59–67. https://doi.org/10.1177/00222194030360010701

Niklas, F., & Schneider, W. (2017). Home learning environment and development of child competencies from kindergarten until the end of elementary school. *Contemporary Educational Psychology*, *49*, 263–274. https://doi.org/10.1016/j.cedpsych.2017.03.006

Parrila, R., Aunola, K., Leskinen, E., Nurmi, J.-E., & Kirby, J. R. (2005). Development of individual differences in reading: Results from longitudinal studies in English and Finnish. *Journal of Educational Psychology*, *97*(3), 299–319. https://doi.org/10.1037/0022-0663.97.3.299

Pintrich, P. R., Anderman, E. M., & Klobucar, C. (1994). Intraindividual differences in motivation and cognition in students with and without learning disabilities. *Journal of Learning Disabilities*, *27*(6), 360–370. https://doi.org/10.1177/002221949402700603

Puglisi, M. L., Hulme, C., Hamilton, L. G., & Snowling, M. J. (2017). The home literacy environment is a correlate, but perhaps not a cause, of variations in children’s language and literacy development. *Scientific Studies of Reading*, *21*(6), 498–514. https://doi.org/10.1080/10888438.2017.1346660

Rashid, F. L., Morris, R. D., & Sevcik, R. A. (2005). Relationship between home literacy environment and reading achievement in children with reading disabilities. *Journal of Learning Disabilities*, *38*(1), 2–11. https://doi.org/10.1177/00222194050380010101

Sanfilippo, J., Ness, M., Petscher, Y., Rappaport, L., Zuckerman, B., & Gaab, N. (2020). Reintroducing dyslexia: Early identification and implications for pediatric practice. *Pediatrics*, *146*(1), e20193046. https://doi.org/10.1542/peds.2019-3046

Sénéchal, M. (2006). Testing the home literacy model: Parent involvement in kindergarten is differentially related to grade 4 reading comprehension, fluency, spelling, and reading for pleasure. *Scientific Studies of Reading*, *10*(1), 59–87. https://doi.org/10.1207/s1532799xssr1001_4

Sénéchal, M., & LeFevre, J.-A. (2002). Parental involvement in the development of children's reading skill: A five-year longitudinal study. *Child Development*, *73*(2), 445–460. https://doi.org/10.1111/1467-8624.00417

Sénéchal, M., & LeFevre, J.-A. (2014). Continuity and change in the home literacy environment as predictors of growth in vocabulary and reading. *Child Development*, *85*(4), 1552–1568. https://doi.org/10.1111/cdev.12222

Skibbe, L. E., Grimm, K. J., Stanton-Chapman, T. L., Justice, L. M., Pence, K. L., & Bowles, R. P. (2008). Reading trajectories of children with language difficulties from preschool through fifth grade. *Language, Speech, and Hearing Services in Schools*, *39*(4), 475–486. https://doi.org/10.1044/0161-1461(2008/07-0016)

Snowling, M. J., & Hulme, C. (Eds.). (2005). *The science of reading: A handbook*. Blackwell Pub.

Sullivan, A. L., Kohli, N., Farnsworth, E. M., Sadeh, S., & Jones, L. (2017). Longitudinal models of reading achievement of students with learning disabilities and without disabilities. *School Psychology Quarterly*, *32*(3), 336–349. https://doi.org/10.1037/spq0000170

Tichnor-Wagner, A., Garwood, J. D., Bratsch-Hines, M., & Vernon-Feagans, L. (2016). Home literacy environments and foundational literacy skills for struggling and nonstruggling readers in rural early elementary schools. *Learning Disabilities Research & Practice*, *31*(1), 6–21. https://doi.org/10.1111/ldrp.12090

Tourangeau, K., Nord, C., Le, T., Wallner-Allen, K., Vaden-Kiernan, N., Blaker, L., & Najarian, M. (2017). *Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011) User's Manual for the ECLS-K:2011 Kindergarten–Second Grade Data File and Electronic Codebook, Public Version* (NCES 2017–285). U.S. Department of Education.

Tourangeau, K., Nord, C., Lê, T., Wallner-Allen, K., Vaden-Kiernan, N., Blaker, L., & Najarian, M. (2019). *Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011) user's manual for the ECLS-K:2011 kindergarten–fifth grade data file and electronic codebook, public version (NCES 2019-051)*. U.S. Department of Education. Washington, DC: National Center for Education Statistics. https://nces.ed.gov/pubs2019/2019051.pdf

Van Steensel, R. (2006). Relations between socio-cultural factors, the home literacy environment and children's literacy development in the first years of primary education. *Journal of Research in Reading*, *29*(4), 367–382. https://doi.org/10.1111/j.1467-9817.2006.00301.x

Wagner, R. K., Edwards, A. A., Malkowski, A., Schatschneider, C., Joyner, R. E., Wood, S., & Zirps, F. A. (2019). Combining old and new for better understanding and predicting dyslexia. *New Directions for Child and Adolescent Development*, *2019*(165), 11–23. https://doi.org/10.1002/cad.20289

Willcutt, E. G., Petrill, S. A., Wu, S., Boada, R., DeFries, J. C., Olson, R. K., & Pennington, B. F. (2013). Comorbidity between reading disability and math disability: Concurrent psychopathology, functional impairment, and neuropsychological functioning. *Journal of Learning Disabilities*, *46*(6), 500–516. https://doi.org/10.1177/0022219413477476

Yeo, L. S., Ong, W. W., & Ng, C. M. (2014). The home literacy environment and preschool children's reading skills and interest. *Early Education and Development*, *25*(6), 791–814. https://doi.org/10.1080/10409289.2014.862147

Zadeh, Z. Y., Farnia, F., & Ungerleider, C. (2010). How home enrichment mediates the relationship between maternal education and children's achievement in reading and math. *Early Education & Development*, *21*(4), 568–594. https://doi.org/10.1080/10409280903118424

Table 1.
Model Fit Statistics

	χ^2	df	p-value	CFI	TLI	RMSEA	SRMR
Reading growth curve	586.052	28	< .001	0.940	0.936	0.140	0.098
HLE predicting reading	796.210	103	< .001	0.933	0.929	0.081	0.081
Controlling for SES	1047.425	123	< .001	0.908	0.902	0.090	0.102

Note: CFA = confirmatory factor analysis. HLE = home literacy environment. SES = socioeconomic status. CFI = Comparative Fit Index. TLI = Tucker-Lewis Index. RMSEA = Root Mean Square Error of Approximation. SRMR = Standardized Root Mean Square Residual.

Table 2.
Multigroup Reading Growth Curve for the Freeloading Model

	LD group			Non-LD group		
	Unstandardized		Standardized	Unstandardized		Standardized
	Loadings (p-value)	Standard error	Estimate (p-value)	Loadings (p-value)	Standard error	Estimate (p-value)
Intercept loadings						
Read K	1.000 (999.000)	< .001	0.855 (<.001)	1.000 (999.000)	< .001	0.860 (<.001)
Read G1	1.000 (999.000)	< .001	1.260 (<.001)	1.000 (999.000)	< .001	1.244 (<.001)
Read G2	1.000 (999.000)	< .001	1.550 (<.001)	1.000 (999.000)	< .001	1.526 (<.001)
Read G3	1.000 (999.000)	< .001	1.660 (<.001)	1.000 (999.000)	< .001	1.587 (<.001)
Read G4	1.000 (999.000)	< .001	1.758 (<.001)	1.000 (999.000)	< .001	1.686 (<.001)
Read G5	1.000 (999.000)	< .001	1.564 (<.001)	1.000 (999.000)	< .001	1.535 (<.001)
Slope loadings						
Read K	0.000 (999.000)	<.001	0.000 (999.000)	0.000 (999.000)	<.001	0.000 (999.000)
Read G1	1.000 (999.000)	<.001	0.503 (<.001)	1.000 (999.000)	<.001	0.432 (<.001)
Read G2	1.546 (<.001)	.009	0.957 (<.001)	1.546 (<.001)	.009	0.819 (<.001)
Read G3	1.793 (<.001)	.011	1.189 (<.001)	1.793 (<.001)	.011	0.988 (<.001)
Read G4	2.003 (<.001)	.013	1.407 (<.001)	2.003 (<.001)	.013	1.172 (<.001)
Read G5	2.149 (<.001)	.015	1.343 (<.001)	2.149 (<.001)	.015	1.145 (<.001)

Mean intercept	-0.885 (<.001)	.016	-1.980 (<.001)	-0.173 (<.001)	.017	-0.371 (<.001)
Mean slope	0.900 (<.001)	.010	5.039 (<.001)	0.743 (<.001)	.009	4.588 (<.001)
Slope and intercept covariance	-0.068 (<.001)	.005	-0.849 (<.001)	-0.064 (<.001)	.005	-0.850 (<.001)
Residual variances						
Read K	0.073 (<.001)	.006	0.268 (<.001)	0.077 (<.001)	.006	0.261 (<.001)
Read G1	0.030 (<.001)	.002	0.236 (<.001)	0.025 (<.001)	.002	0.178 (<.001)
Read G2	0.017 (<.001)	.001	0.200 (<.001)	0.012 (<.001)	.001	0.123 (<.001)
Read G3	0.013 (<.001)	.001	0.182 (<.001)	0.015 (<.001)	.001	0.169 (<.001)
Read G4	0.008 (<.001)	.001	0.129 (<.001)	0.011 (<.001)	.001	0.141 (<.001)
Read G5	0.026 (<.001)	.002	0.316 (<.001)	0.029 (<.001)	.002	0.319 (<.001)

Note: LD = learning disability. G = grade.

Table 3
Full Model Results

	Unstandardized		Standardized
	Estimate (p-value)	Standard error	Estimate (p-value)
Intercept on HLE	0.302 (<.001)	.041	0.260 (<.001)
Slope on HLE	-0.069 (<.001)	.017	-0.170 (<.001)
Residual variances			
Intercept	0.200 (<.001)	.012	0.932 (<.001)
Slope	0.025 (<.001)	.002	0.971 (<.001)

Note: HLE = home literacy environment.

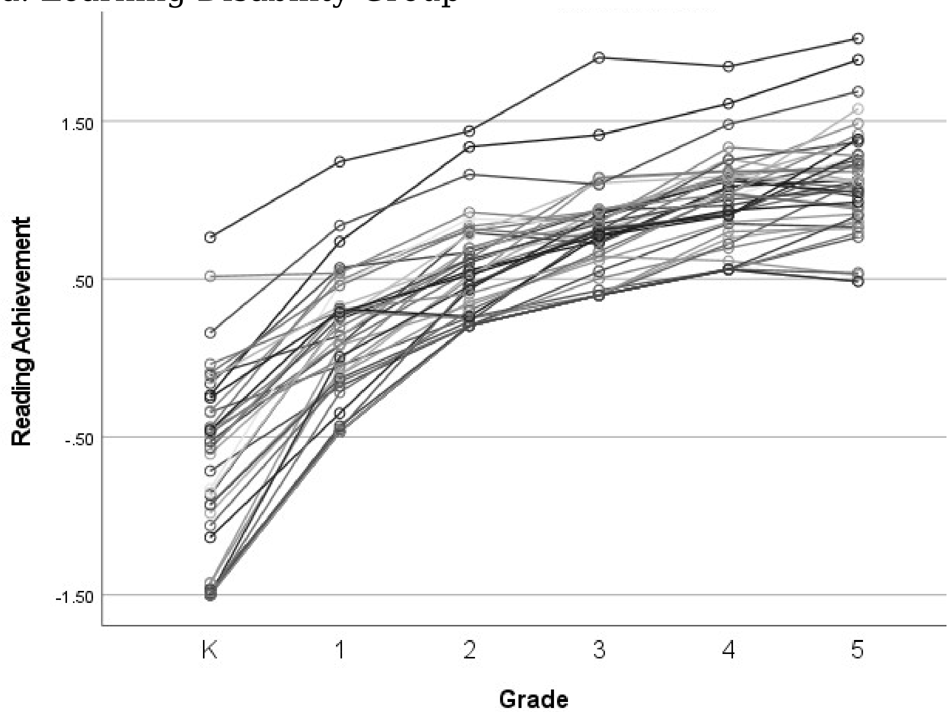
Table 4.
Full Model with SES Results

	Unstandardized		Standardized
	Estimate (p-value)	Standard error	Estimate (p-value)
Intercept on HLE	0.182 (<.001)	.032	0.189 (<.001)
Slope on HLE	-0.036 (<.001)	.006	-0.134 (<.001)
Intercept on SES	0.201 (<.001)	.015	0.372 (<.001)
Slope on SES	-0.036 (<.001)	.006	-0.198 (<.001)
Residual variances			
Intercept	0.172 (<.001)	.011	0.826 (<.001)
Slope	0.024 (<.001)	.002	0.943 (<.001)

Note: HLE = home literacy environment. SES = socioeconomic status.

Figure 1. Spaghetti Plots of the Reading Achievement of 50 Randomly Selected Children in each Group

a. Learning Disability Group



b. Non-Learning Disability Group