

**This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.**

**Author(s):** Torppa, Minna; Vasalampi, Kati; Eklund, Kenneth; Niemi, Pekka

**Title:** Long-term effects of the home literacy environment on reading development : Familial risk for dyslexia as a moderator

**Year:** 2022

**Version:** Published version

**Copyright:** © 2021 The Author(s). Published by Elsevier Inc.

**Rights:** CC BY 4.0

**Rights url:** <https://creativecommons.org/licenses/by/4.0/>

**Please cite the original version:**

Torppa, M., Vasalampi, K., Eklund, K., & Niemi, P. (2022). Long-term effects of the home literacy environment on reading development : Familial risk for dyslexia as a moderator. *Journal of Experimental Child Psychology*, 215, Article 105314. <https://doi.org/10.1016/j.jecp.2021.105314>



Contents lists available at ScienceDirect

# Journal of Experimental Child Psychology

journal homepage: [www.elsevier.com/locate/jecp](http://www.elsevier.com/locate/jecp)



## Long-term effects of the home literacy environment on reading development: Familial risk for dyslexia as a moderator



Minna Torppa<sup>a,\*</sup>, Kati Vasalampi<sup>b</sup>, Kenneth Eklund<sup>c</sup>, Pekka Niemi<sup>d</sup>

<sup>a</sup> Department of Teacher Education, University of Jyväskylä, FI-40014 Jyväskylä, Finland

<sup>b</sup> Department of Psychology, University of Jyväskylä, FI-40014 Jyväskylä, Finland

<sup>c</sup> Faculty of Education and Psychology, University of Jyväskylä, FI-40014 Jyväskylä, Finland

<sup>d</sup> Department of Psychology, University of Turku, FI-20014 Turku, Finland

### ARTICLE INFO

#### Article history:

Received 31 March 2021

Revised 10 October 2021

#### Keywords:

Home literacy environment (HLE)

Family risk for dyslexia

Protective and promotive factors

Reading comprehension

Reading fluency

Reading motivation

Vocabulary

### ABSTRACT

This study aimed to gain better understanding of the associations between literacy activities at home and long-term language and literacy development. We extended the home literacy environment (HLE) model of Sénéchal and LeFevre (*Child Development* [2002], Vol. 73, pp. 445–460) by including repeated assessments of shared reading, oral language, and reading comprehension development, including examination of familial risk for dyslexia as a moderator, and following development over time from ages 2 to 15 years. Of the 198 Finnish participants, 106 have familial risk for dyslexia due to parental dyslexia. Our path models include development in vocabulary (2–5.5 years), emerging literacy (5.5 years), reading fluency (8 and 9 years), and reading comprehension (8, 9, and 15 years) as well as shared book reading with parents (2, 4, 5, 8, and 9 years), teaching literacy at home (4.5 years), and reading motivation (8–9 years). The results supported the HLE model in that teaching literacy at home predicted stronger emerging literacy skills, whereas shared book reading predicted vocabulary development and reading motivation. Both emerging literacy and vocabulary predicted reading development. Familial risk for dyslexia was a significant moderator regarding several paths; vocabulary, reading fluency, and shared reading were stronger predictors of reading comprehension among children with familial risk for dyslexia, whereas reading motivation was a stronger predictor of reading comprehension among adolescents with no familial risk. The

\* Corresponding author.

E-mail address: [minna.p.torppa@jyu.fi](mailto:minna.p.torppa@jyu.fi) (M. Torppa).

findings underline the importance of shared reading and suggest a long-standing impact of shared reading on reading development both directly and through oral language development and reading motivation.

© 2021 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

## Introduction

With due credit given to the efforts of educators and day-care professionals in promoting children's reading development before attending school, a quintessential route is the home literacy environment (HLE) provided by parents (Bus, van Ijzendoorn, & Pellegrini, 1995; Flack, Field, & Horst, 2018; Scarborough & Dobrich, 1994). In fact, literacy activities at home could be more influential than intervention programs because the amount of exposure can be massive and span several years and the exposure can be more flexibly timed and child-initiated as well as being delivered by close family members who also provide emotional support. In HLE, there are multiple potentially influential factors such as shared reading with children, teaching literacy skills, access to books and other print, and parental modeling of reading (e.g., Burgess, Hecht, & Lonigan, 2002; Lundberg, 1991; Scarborough & Dobrich, 1994; Sénéchal & LeFevre, 2002). The most influential HLE factors in regard to children's skills seem to be the ones requiring active interaction between parents and children, that is, shared reading and the teaching of literacy skills such as letter names and reading (Mol & Bus, 2011; Scarborough & Dobrich, 1994). In addition, parental language has been found to be more sophisticated (in terms of vocabulary diversity and syntactic complexity) during shared reading interactions than otherwise (Demir-Lira, Applebaum, Goldin-Meadow, & Levine, 2019).

Despite the vast amount of literature on the correlation between HLE factors and children's language and literacy development, there are two major shortcomings that we addressed in the current study: the scarcity of long-term longitudinal studies and the scarcity of studies investigating the moderating role of parental dyslexia (Snowling & Melby-Lervåg, 2016). These gaps in knowledge are conspicuous because, first, the identification of the HLE effects may in fact require long-term follow-up because literacy interaction at home often starts very early and its importance may lie in the accumulated effects over several years and, second, parental dyslexia is a risk factor for children's language and literacy development (e.g., Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010) and it may also be associated with how parent-child literacy interaction at home affects children's reading development. To add to the current literature, this study examined whether HLE can act as a promotive or protective factor for children in the long run, that is, when children are followed up from ages 2 to 15 years. The previous studies on HLE have not followed children for such a long time. Importantly, they have rarely included autoregressive effects in the longitudinal models, which we aimed to do to give a more stringent test for the direction of the associations. In addition, previous HLE studies have not examined whether the HLE effects on children's skills are promotive or protective. The difference between promotive and protective factors is that the promotive factors have an impact on development for all, whereas the protective factors are particularly important for those at risk (e.g., McGrath, Peterson, & Pennington, 2020). In this study, parental dyslexia is a risk factor because it is shown to predict a higher probability of language and literacy difficulties among children (e.g., Lohvansuu et al., 2021; Snowling & Melby-Lervåg, 2016). Comparisons of the at-risk and not at-risk group HLE models give us insight into the protective/promotive role of HLE in language and literacy development. If the HLE effects are promotive, we should see longitudinal associations among children with and without parental dyslexia; if the effects are protective (i.e., something that mitigates risks), the effects of HLE on skills should be even stronger in families with parental dyslexia.

Extending the HLE model

Sénéchal and LeFevre (2002) published a path-breaking 5-year-long study of how parental print-focused and meaning-focused activities with prereading children predict reading development in the primary grades. Their home literacy model suggests that shared reading of storybooks (a meaning-focused activity), on the one hand, is predictive of oral language development in particular, which then predicts subsequent reading comprehension. Early teaching of reading and writing (a print-focused activity), on the other hand, predicts word reading ability in Grade 1 and, through that, subsequent reading comprehension.

By virtue of suggesting two separate paths for parental influence, the model of Sénéchal and LeFevre (2002) is in line with the influential *simple view of reading* (Florit & Cain, 2011; Gough & Tunmer, 1986; Kirby & Savage, 2008) by showing how HLE practices may differentially contribute to the two components of reading comprehension: decoding and oral comprehension. Subsequently, the pathways in the HLE model have gained support in multiple language and educational contexts such as English (Hood, Conlon, & Andrews, 2008; Sénéchal & LeFevre, 2002, 2014), French (Sénéchal, 2006), Greek (Manolitsis, Georgiou, & Parrila, 2011; Manolitsis, Georgiou, & Tziraki, 2013), German (Niklas & Schneider, 2013, 2017), and Finnish (Silinskas et al., 2020).

In the current study, we extended the HLE model of Sénéchal and LeFevre (2002) by including an examination of the long-term roles of the print-focused and meaning-focused HLE activities in language and reading development (see Fig. 1). We provided an assessment time window extension toward both younger and older age and included more assessment points to shared reading, vocabulary, and reading comprehension. Therefore, we can replace some of the correlational concurrent pathways in previous HLE model examinations with cross-lagged reciprocal pathways across time. Such a model provides a stronger test of the directions of influences between the model constructs than models with concurrent correlations or longitudinal models with a single assessment of each indicator. In our model, the correlational pathways in the HLE model, and in previous studies testing the model, were changed to unidirectional predictive pathways with autoregressors (shared reading, vocabulary, and reading comprehension) controlled whenever possible.

The hypothesized model depicted in Fig. 1 is based on the robust finding that learning to read is preceded by oral language skills and emerging literacy skills, letter knowledge, and phonological awareness (e.g., Castles, Rastle, & Nation, 2018; Pennington & Lefly, 2001; Scarborough, 1990, 2001;

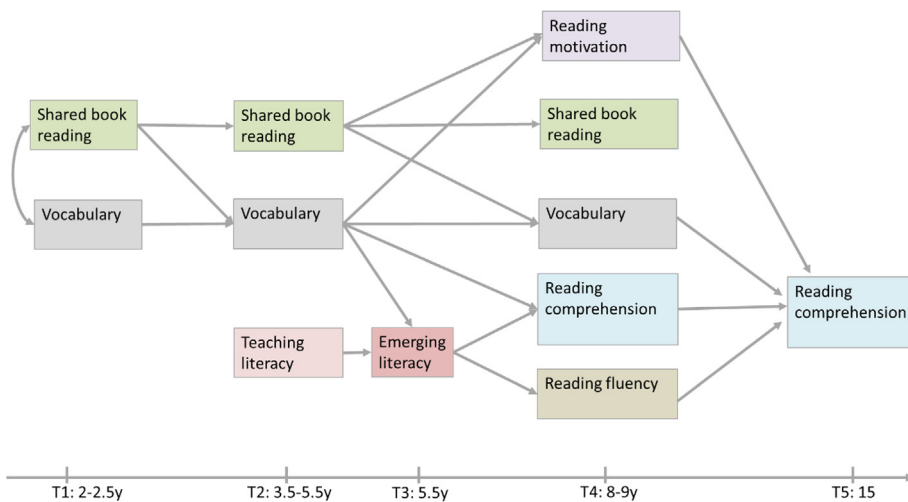


Fig. 1. The hypothesized developmental home literacy environment model (Sénéchal & LeFevre, 2002) from age 2 to 15 years. T1/2/3/4/5, Time 1/2/3/4/5; y, years.

Snowling & Melby-Lervåg, 2016; Torppa et al., 2010). Years before school entry, children typically start to learn the key elements of written language, letter names, and sounds and become aware of the sounds of spoken language (phonological awareness). Connection building between the two lays the foundation for acquiring decoding skills (Byrne, 1998; Castles et al., 2018; Puolakanoaho et al., 2007). Reading comprehension, however, is predicted not only by decoding ability but also by several other skills such as listening comprehension, vocabulary, and working memory (e.g., Florit & Cain, 2011; Nation, 2019; Nation & Snowling, 2004). Of the early skills, listening comprehension and vocabulary have been shown to be particularly strong predictors of reading comprehension in later grades when decoding has been automatized (e.g., Eklund, Torppa, Sulkunen, Niemi, & Ahonen, 2018; Florit & Cain, 2011; Torppa et al., 2016). In the early phases of reading acquisition, reading accuracy and fluency play a major role in reading comprehension as slow and laborious decoding absorbs cognitive resources hindering comprehension processes (e.g., Nation, 2019; Perfetti, 1985). Regarding the emerging literacy skills, our hypothesized model merges phonological awareness and letter knowledge into a single emerging literacy construct. This is justifiable because the nearly one-to-one letter-sound correspondence in the transparent Finnish orthography, in which the current study was conducted, results in letter-sound associations that are consistent for both reading and spelling, with each letter always representing the same one phoneme except for only one bigraph (ng for /ŋ/) (e.g., Aro, 2017).

In line with the HLE model (Sénéchal & LeFevre, 2002, 2014), our hypothesized model further posits that there are two key means to support children's language and literacy development at home: print-focused activities (teaching letter names and reading) and meaning-focused activities (parent-child shared book reading). Drawing on previous evidence, we expect to find that teaching activities support emerging reading and that the emerging literacy skills mediate the effect of teaching at home on reading (e.g., Hamilton, Hayiou-Thomas, Hulme, & Snowling, 2016; Hood et al., 2008; Inoue, Georgiou, Parrila, & Kirby, 2018; Inoue et al., 2020). The effect of shared book reading on reading development, however, is expected to support language skills, and its effect on reading is expected to be mediated via oral language. Numerous studies have reported significant concurrent correlations between various measures of shared reading and language (e.g., Hood et al., 2008; Sénéchal & LeFevre, 2014; Silinskas et al., 2019). Meta-analyses have suggested that shared reading accounts for about 8% of children's language and literacy development (Bus et al., 1995; Scarborough & Dobrich, 1994) even after controlling for socioeconomic status and parental education (Flack et al., 2018). Furthermore, some studies have suggested that oral language acts as a mediator between shared reading and reading comprehension (e.g., Hamilton et al., 2016). However, there is a conspicuous lack of studies including more than a single assessment of oral language skills and shared reading. This is problematic because concurrent correlations or even a longitudinal correlation between single assessments of early shared reading and later language and literacy development do not allow for considering the direction of the effect.

Finally, the hypothesized model proposes that shared reading may have a positive effect on reading skills through enhancing the intrinsic motivation to read. Intrinsic reading motivation is present when children are interested in reading and engage in reading activities for their own sake rather than because of external pressure to read (Ryan & Deci, 2000; Wigfield & Guthrie, 1997). An association between shared reading and children's intrinsic reading motivation has been reported before (Baker, Scher, & Mackler, 1997; Hume, Lonigan, & McQueen, 2015; Morrow, 1983; Sénéchal, 2006; Silinskas, 2020). Furthermore, Demir-Lira et al. (2019) showed recently that shared reading during the second and third years of life can predict children's intrinsic reading motivation until about Grade 4. The hypothesized model proposes further that intrinsic reading motivation supports reading comprehension. Those who are intrinsically motivated are expected to read more frequently and therefore, through practice, gain the various skills and knowledge needed in reading (e.g., Cox & Guthrie, 2001; Torppa et al., 2020; Wigfield & Guthrie, 1997). Wigfield and Guthrie (1997), for example, showed that children high in intrinsic reading motivation spent three times longer reading during a day than their peers with low intrinsic reading motivation. Torppa et al. (2020) showed recently in another Finnish sample with a follow-up from Grade 1 to Grade 9 (ages 7–16 years) that leisure time book reading, in particular, predicted improvement in reading comprehension.

### *HLE model and familial risk for dyslexia*

One key risk factor for children's reading development is not included in the original HLE model, namely parental dyslexia. There is strong evidence that dyslexia is heritable (e.g., Kere, 2011; Snowling & Melby-Lervåg, 2016; Olson, Keenan, Byrne, & Samuelsson 2019), and children of parents with dyslexia are estimated to be at a 4–10 times heightened risk for developing dyslexia themselves (e.g., Snowling & Melby-Lervåg, 2016; Pennington & Lefly, 2001; Scarborough, 1990; Torppa, Eklund, van Bergen, & Lyytinen, 2015).

Children with a family risk for dyslexia show difficulties in oral language and emerging literacy development years before school entry (e.g., Gallagher, Frith, & Snowling, 2000; Snowling & Melby-Lervåg, 2016; Pennington & Lefly, 2001; Scarborough, 1990; Torppa et al., 2010; van Viersen et al., 2018). Due to gene–environment interaction mechanisms (e.g., Hart, Little, & van Bergen, 2021; Pennington, 2006; Plomin, 2013; Plomin, DeFries, & Loehlin, 1977; Rutter, Moffitt, & Caspi, 2006), reading difficulties of parents and their children may affect HLE or moderate the associations between HLE and reading development. Some studies even suggest that the correlations between HLE factors and children's skills disappear after controlling for parental skills, which may suggest that the correlations do not actually reflect environmental effect but that both HLE and children's skills are related to familial risk (Puglisi, Hulme, Hamilton, & Snowling, 2017; van Bergen, van Zuijlen, Bishop, & de Jong, 2017).

Regrettably, studies on the HLE of children with familial risk for dyslexia, especially concerning its role of risk in the associations between HLE and reading development, are scarce (see Snowling & Melby-Lervåg, 2016). There are studies that have examined whether the effect of familial risk for dyslexia on children's skill development is mediated via environmental factors, but the available evidence is mixed. Some studies comparing HLE factors between children with and without familial risk for dyslexia have found group differences, suggesting that familial risk is at least partially mediated via home environment (Dilnot, Hamilton, Maughan, & Snowling, 2017; Esmaeeli, Lundetræ, & Kyle, 2018; Scarborough, 1991). However, there are also studies reporting no clear HLE differences between children with and without familial risk for dyslexia (Caglar-Ryeng, Eklund, & Nergård-Nilssen, 2020; Elbro, Borstrøm, & Petersen, 1998; van Bergen, de Jong, Maassen, & van der Leij, 2014). Previous studies from the current sample found no differences between families with and without family risk for dyslexia in either meaning-focused or print-focused activities in their homes (Laakso, Poikkeus, Eklund, & Lyytinen, 2004; Laakso, Poikkeus, & Lyytinen, 1999; Torppa et al., 2007). This suggests that, in the current sample, the risk of children's poor reading development due to parental dyslexia is not mediated via HLE.

To complicate things further, it seems possible that HLE is a protective factor closing the gap between children with and without familial risk for dyslexia. This would be suggested if family risk for dyslexia moderated the association between HLE factors and children's skill development in such a way that the correlations between HLE factors and children's skills were stronger in the familial risk group. In fact, Hamilton et al. (2016) found that storybook exposure at age 4 years had a significantly stronger predictive effect on phonological awareness at age 5 among children with familial risk for dyslexia than among children with no familial risk. Similarly, Caglar-Ryeng et al. (2020) found that book exposure at age 4 years contributed to vocabulary at age 6 only in the group with familial risk. Torppa et al. (2007) analyzed the current sample at ages 2–5 years and reported higher correlations between shared reading and vocabulary among children with familial risk for dyslexia than among children without such risk. They did not, however, conduct multigroup models to test the statistical significance of the group differences or examine the associations with further reading development.

### *The current study*

The current study set out to examine whether promoting children's reading development at home through meaning-focused activities (shared reading) or print-focused activities (teaching letters and reading) predicts children's reading development in the long run through oral language development, emerging reading skills development, and/or reading motivation. The participants were native speakers of Finnish. The study was framed with the hypotheses derived from the HLE model (Sénéchal &

LeFevre, 2002), which was extended to fit to the longitudinal assessment timeline of the current study across ages 2–15 years and to include autoregressive controls to provide a stronger test of the hypothesized associations than in the previous studies. Fig. 1 specifies the hypothesized model. Furthermore, we examined whether familial risk for dyslexia moderates the associations in the model. This is an important addition to the current literature because it allows the examination of both promotive factors (supportive for all) and protective factors (supportive for those at risk).

## Method

### Participants

The participants ( $N = 198$ ) came from the Jyväskylä Longitudinal Study of Dyslexia (Lohvansuu et al., 2021). The sample has been followed from birth to age 23 years. In this study, we include data from age 2 years to the end of Grade 9 (age 15). There were two groups in the sample: a group with familial risk for dyslexia due to parental dyslexia ( $n = 106$ ) and a group without familial risk for dyslexia ( $n = 92$ ).

The children were originally selected from among 9368 newborns in the province of Central Finland between April 1993 and July 1996. The selection was made using a three-stage procedure: (a) a short parental questionnaire consisting of three questions concerning difficulties in learning to read and spell among parents and their close relatives (8417 respondents); (b) a detailed parental questionnaire concerning the reading history, persistence of reading and spelling difficulties, and reading habits of parents and their close relatives (3130 respondents); and (c) testing of the reading and spelling skills (410 parents). A child was identified as having a familial risk for dyslexia if either of the parents had dyslexia based on the individual assessment (oral text reading, spelling, and word recognition), reported difficulties in learning to read, and reported difficulties in another first-degree relative. In the group without a familial risk, neither of the parents reported a personal or family history of reading or spelling difficulties and had an average performance in the reading and spelling assessments (not more than 1 standard deviation below mean). Finally, the intelligence quotient (IQ) of all parents, assessed with the Raven B, C, and D matrices (Raven, Court, & Raven, 1992), needed to be equal to or above 80. (For full details of recruitment, see Leinonen et al., 2001.) The parental education level did not differ between the groups.

The children spoke Finnish as their first language and had no mental, physical, or sensory impairments. None of the children performed below 80 in verbal IQ (VIQ) and performance IQ (PIQ), assessed in Grade 2 using the Wechsler Intelligence Scale for Children–Third Edition (WISC-III; Wechsler, 1991). Four performance scale subtests (Picture Completion, Block Design, Object Assembly, and Coding) and five verbal scale subtests (Similarities, Vocabulary, Comprehension, Series of Numbers, and Arithmetic) were used to estimate the PIQ and VIQ, respectively. All participants attended regular classroom education. The study has received a positive ethical statement from the ethical board of the Central Finland hospital district.

The children entered school in August of the year they turned 7 years old. Their reading instruction started in Grade 1. Reading instruction in Finland is guided by a national curriculum and is phonics based. The associations between the letters and the sounds attached to them is very consistent in Finnish, and instruction starts from learning the letter–sound associations and continues to blending letters and sounds together in syllables or short words, gradually building toward longer words, sentences, and texts.

### Measures

#### Shared book reading

Shared reading was assessed with parental questionnaires when children were ages 2, 4, 5, 8, and 9 years. At age 2, there were 4 items measuring shared reading amount. Of these items, 3 tapped frequency: how often (a) a storybook is read to the child, (b) the mother reads to the child, and (c) the father reads to the child. Parents responded to the items using a 4-point Likert scale (1 = *not*



at *all/seldom*, 4 = *several times a day*). The fourth item focused on the time spent with print materials: What is the typical duration of a reading episode when the child is reading with an adult? Parents responded to the item using a 4-point Likert scale (1 = *less than 5 min*, 4 = *more than 15 min*). The measure for shared reading at age 2 years was the mean of the 4 items. The Cronbach's alpha reliability coefficient was .68.

At ages 4 and 5 years, the same items were used as at age 2, but parents responded to the items covering shared reading frequency using a 5-point Likert scale (1 = *not at all/seldom*, 5 = *several times a day*). The fourth item on time spent on shared reading was responded to using a 5-point Likert scale (1 = *5 min*, 5 = *more than 45 min*). The measure for shared reading at ages 4 and 5 years was the mean of the 8 items. The Cronbach's alpha reliability coefficient was .82.

At ages 8 and 9 years, shared reading was assessed using 3 of the 4 items that were used at ages 2, 4, and 5: how often (a) the mother and (b) the father reads to the child. Parents responded to the items using a 5-point Likert scale (1 = *not at all/seldom*, 5 = *several times a day*). The third item focused on the time spent with print materials: What is the typical duration of a reading episode when the child is reading with an adult? Parents responded to the item using a 3-point Likert scale (1 = *less than 5 min*, 3 = *more than 45 min*). The measure for shared reading at ages 8 and 9 years was the mean of the 6 items. The Cronbach's alpha reliability coefficient was .79.

#### Teaching at home

At age 4.5 years, the parents were asked to estimate how often they taught letter names, phonemes, and blending of letters and phonemes to their child at home. The 4 items were as follows:

1. How often do you teach your child letter names?
2. How often do you teach your child phonemes?
3. How often do you teach your child to blend letters?
4. How often do you teach your child to blend phonemes?

Parents responded using a 5-point Likert scale (1 = *not at all*, 5 = *every day*). However, an additional alternative (6 = *not anymore because the child already knows most or all letters*) was also provided. The alternative rating was problematic for scoring because it did not tap the same scale as the other five choices. Therefore, values of 6 were coded as missing information for 23 children. A composite variable was the mean of the 4 items. Cronbach's alpha reliability coefficient was .77.

#### Reading motivation

Reading motivation was assessed using parental questionnaires when the children were ages 8 and 9 years with 3 items at each age:

1. How often does your child read books or magazines independently? (Parents responded to the item using a 5-point Likert scale: 1 = *never*, 5 = *many times per day*.)
2. What is the typical duration of your child's independent reading episode? (Parents responded to the item using a 5-point Likert scale: 1 = *5 min*, 5 = *more than 45 min*.)
3. How interested is your child in book reading? (Parents responded to the item using a 5-point Likert scale: 1 = *not at all interested*, 5 = *very interested*.)

The measure for reading motivation at ages 8 and 9 years was the mean of the 6 items. The Cronbach's alpha reliability coefficient was .87.

#### Parental education

Parental education was reported by the parents at the entry stage of the project with two questionnaire items: one for comprehensive education and the other for vocational and university degrees. The responses were classified using a 7-point scale: 1 = *comprehensive school education without any vocational education*, 2 = *comprehensive school education combined with short-term vocational courses*, 3 = *comprehensive school education combined with a vocational school degree*, 4 = *comprehensive school education combined with a vocational college degree*, 5 = *comprehensive school education combined with a*



lower university degree (bachelor's) or a degree from a polytechnic, 6 = upper secondary general school diploma combined with a lower university degree (bachelor's) or a degree from a polytechnic, 7 = comprehensive school or upper secondary general school diploma combined with a higher university degree (master's or doctorate-level degree).

### Vocabulary

Vocabulary was assessed via parental questionnaires and individual tests conducted by trained research assistants in the university lab at ages 24 months, 30 months, 3.5 years, 5 years, 5.5 years, and 8 years.

At age 2 years, a composite score of expressive and receptive vocabulary was calculated as a mean of the following measures: (a) the Finnish adaptation of the MacArthur Communicative Development Inventory (MCDI; Fenson et al., 1993) at ages 24 and 30 months (in the MCDI, parents are asked to report the words their child produces, the child's longest sentence, and the child's use of inflections), (b) the expressive score of the Reynell Developmental Language Scale (RDLS; Reynell & Huntley, 1987) at 30 months, and (c) the Reynell Receptive Language Scale (RRLS) at 30 months. The Reynell scales were individually assessed by trained researchers during home visits. For the calculation of the measure for vocabulary, the subscales were first z-scored. The Cronbach's alpha reliability coefficient for the composite at age 2 years was .72.

At ages 3.5–5.5 years, a composite score of expressive and receptive tests was calculated. Tests were conducted in the university lab by trained research assistants. Expressive vocabulary was assessed with the Boston Naming Test (BNT) at ages 3.5 and 5.5, and receptive vocabulary was assessed with the Peabody Picture Vocabulary Test–Revised (PPVT-R) at ages 3.5 and 5. The BNT (Kaplan, Goodglass, & Weintraub, 1983) measures visual confrontation naming. The Finnish translation of the BNT (Laine, Koivuselkä-Sallinen, Hänninen, & Niemi, 1997; for the process of adaptation, see Laine et al., 1993) contains 60 pictured items that the child is asked to name. If the child gives 6 wrong answers in a row, testing is stopped. The score for the task is calculated as the sum of the correct responses, including correct responses after a semantic stimulus cue (e.g., violin—an instrument; tennis racket—you play a game with it). The PPVT-R (Dunn & Dunn, 1981) is a measure of receptive vocabulary. The child is shown pictures, and a word is presented orally. The child is asked to point to the picture that best represents the meaning of the word. There are 166 items in the Finnish version. The test is interrupted after 6 errors in 8 consecutive items. The score is a raw sum score of correct items (Form L). For the calculation of the vocabulary, the composite mean scores of the two BNT and two PPVT scores were first standardized. The vocabulary score was the mean of the standardized scores for the measures. The Cronbach's alpha reliability coefficient was .84.

At age 8 years, the Vocabulary subscale of the WISC–III (Wechsler, 1991) was used. Testing was conducted in the university lab by trained research assistants. In this test, the child is presented with words and is asked to define them. The Cronbach's alpha reliability coefficient for this scale is .91, according to the manual (Wechsler, 1991).

### Emerging literacy skills

Emerging literacy skills were assessed in the university lab by trained research assistants at age 5.5 years using letter knowledge and phonological awareness tasks. *Letter knowledge* was assessed by asking the child to identify, one by one, the 23 most common letters in the Finnish alphabet (uppercase) starting from the first letter of the child's own name and continuing in the order of alphabet book (approximately the letter frequency order). The score for letter knowledge was the number of letters identified correctly. *Phonological awareness* was assessed with four tasks: first phoneme identification, first phoneme production, segment identification, and synthesis. In the *segment identification task*, the child viewed three pictures of objects on a computer screen. Each object was named (e.g., *koira* [dog], *kissa* [cat], *kukko* [rooster]), and the child heard a subword segment (syllable or phoneme). The child was asked to identify on a touchscreen the picture that contained the segment the child heard (e.g., the “koi” in the word “koira”). The size of the segment varied from one to four phonemes and came from the beginning, end, or middle part of the word. There were 3 practice items and 14 test items. In the *synthesis task*, the child heard segments of words (syllables or phonemes), each separated by 750 ms. The child was asked to blend the segments to produce a word, for example,

*per-ho-nen* (butterfly) or *m-u-n-a* (egg). The items were three to nine phonemes long, each divided into three or four segments. There were 2 practice items and 12 test items. In the *first phoneme identification task*, the child viewed four pictures of objects. Each object was first named, and then the child heard a phoneme that was the first phoneme of one of the objects. The child was asked to select the picture of the word beginning with that phoneme (e.g., "In the beginning of which word do you hear 'k'?"). There were 2 practice items and 9 test items. In the *first phoneme production task*, the child was shown a picture of an object and was asked to articulate the first sound (phoneme or letter name) of the object. There were 2 practice items and 8 test items. A composite score was calculated for phonological awareness by averaging the z-scored scores (sums of correct answers). A composite score for emerging literacy skills was calculated by averaging the z-scored scores for letter knowledge and the phonological awareness composite. The Cronbach's alpha reliability coefficient for the emerging literacy skills composite was .83.

### Reading fluency

Reading fluency was individually assessed once in Grade 2 and once in Grade 3 in the university lab by trained research assistants. The text consisted of 19 sentences in five paragraphs (124 words/877 letters) in Grade 2 and 18 sentences in four paragraphs (189 words/1154 letters) in Grade 3. The score was the number of words read correctly per minute. A composite was calculated for Grades 2 and 3. The Cronbach's alpha reliability coefficient was .92.

### Reading comprehension

Reading comprehension was assessed in participants' classrooms twice in Grade 2 and twice in Grade 3 with the nationally normed reading test battery (ALLU; Lindeman, 2000). The child silently read an informative text. The text contained 144 words in Grade 2 fall, 114 words in Grade 2 spring, 139 words in Grade 3 fall, and 213 words in Grade 3 spring. The child then answered 11 multiple-choice questions (with four answer options) and one question in which the child needed to arrange five statements in the correct sequence based on the information gathered from the text. The score was the number of correct answers, ranging from 0 to 12. The Cronbach's alpha reliability coefficient for the composite of the four assessments was .81.

In Grade 9 spring, reading comprehension was assessed with the PISA reading test items (e.g., Organization for Economic Cooperation and Development [OECD], 2010). There was a booklet with eight different reading materials. The student was asked to read each material before answering the associated questions. The reading materials not only were continuous text but also included tables, graphs, and figures. Altogether, the test included 15 multiple-choice questions and 16 questions that required written responses. Of the questions, 12 required the student to access and retrieve information, 12 to integrate and interpret information, and 7 to reflect and evaluate information. The student had 60 min to complete the task. The total score consisted of the number of correct items (ranging from 0 to 31). The Cronbach's alpha reliability coefficient for the total score in the current sample was .80.

### Statistical analysis

The data were analyzed with path models using Mplus 8.4 software (Muthén & Muthén, 1998–2017) with the maximum likelihood estimator. The modeling started with testing the hypothesized model (Fig. 1) among family risk (FR) and no family risk (NoFR) groups separately. Next, modification indices (MIs) provided by Mplus were examined to identify reasons for model misfit with the data. The misfit indicates that the theoretical model we had developed based on hypotheses derived from previous studies with shorter follow-ups did not yield an acceptable fit to the data. Based on MIs and theoretical consideration of the suggested pathways, the additional pathways were added one by one. The MIs were evaluated carefully starting from the biggest MI. The remaining MIs did not significantly improve model fit (all MIs < 5) and were not considered theoretically relevant. The concurrent residual correlations were allowed within each time point from Time 2 to Time 5. Finally, the model path estimates, correlations, and error correlations were compared between the FR and NoFR groups to see whether the group acted as a moderator. In the group comparison process, all path estimates, correlation, and error covariance estimates were set equal, and the fit of the model was compared using chi-

**Table 1**  
Descriptive statistics and group comparisons.

	FR group			NoFR group			F	d
	N	M	SD	N	M	SD		
Mother's education	106	4.23	1.53	92	4.50	1.35	1.75	0.19
Father's education	106	3.68	1.25	92	3.79	1.39	0.37	0.08
Shared reading, age 2	99	3.00	0.69	90	3.01	0.56	0.00	0.02
Shared reading, ages 4–5 <sup>a</sup>	105	3.22	0.70	92	3.13	0.59	0.93	−0.14
Shared reading, ages 8–9 <sup>a</sup>	99	1.99	0.66	90	1.93	0.63	0.53	−0.09
Teaching literacy, age 4.5	97	2.07	0.86	89	2.33	0.91	3.96*	0.29
Reading motivation, ages 8–9 <sup>a</sup>	99	3.38	0.68	90	3.46	0.66	0.59	0.12
Vocabulary ages 2–2.5 <sup>b</sup>	103	−.12	.84	93	.04	.83	1.72	0.19
MCDI, vocab. prod., age 2	98	261.36	152.58	91	281.57	162.02	0.78	0.13
MCDI, sentence length, age 2	98	5.04	2.43	91	5.82	2.98	3.98*	0.29
MCDI, inflections, age 2	98	8.55	4.65	91	9.45	4.96	1.66	0.19
MCDI, vocab. prod., age 2.5	79	428.75	135.89	81	458.83	114.50	2.30	0.24
MCDI, sentence length, age 2.5	72	8.31	3.66	76	8.84	3.22	0.88	0.15
MCDI, inflections, age 2.5	78	13.19	3.76	79	13.91	3.44	1.56	0.20
Reynell expressive, age 2.5	102	34.12	6.33	88	34.16	6.60	0.00	0.01
Reynell receptive, age 2.5	102	36.11	6.21	88	37.44	5.70	2.36	0.22
Vocabulary ages 3.5–5.5 <sup>b</sup>	97	−.40	.99	92	.00	.89	8.49**	0.43
BNT, age 3.5	102	17.46	5.69	92	20.12	5.76	10.45**	0.46
PPVT, age 3.5	93	36.22	14.52	82	39.11	15.12	1.67	0.19
BNT, age 5.5	99	33.28	6.86	91	35.92	5.51	8.47**	0.42
PPVT, age 5	102	66.98	25.62	90	75.00	21.66	5.41*	0.34
WISC-III, age 8	106	18.42	7.30	90	19.09	6.96	0.43	0.09
Emerging literacy, age 5.5 <sup>b</sup>	102	−.51	.99	92	.01	.78	15.99***	0.58
Letter knowledge	103	11.31	7.91	92	14.83	6.81	10.94**	0.48
Phonological awareness <sup>b</sup>	103	−.45	.96	91	.00	.72	11.77***	0.52
First phoneme identification	103	6.18	2.26	91	7.56	1.50	24.33***	0.72
First phoneme production	97	2.47	2.69	88	2.74	2.25	0.52	0.11
Segment identification	101	12.62	3.10	90	13.84	2.71	8.30**	0.42
Synthesis	99	6.10	2.50	87	7.10	2.57	7.25**	0.39
Reading								
Reading fluency, ages 8–9 <sup>a</sup>	106	60.13	24.45	92	74.64	23.27	18.12***	0.61
Reading comprehension, ages 8–9 <sup>a</sup>	102	9.21	2.10	87	9.71	1.67	3.28	0.26
Reading comprehension, age 15	87	23.03	6.78	71	25.13	6.88	3.68	0.31

Note. Ages are in years. FR, with family risk for dyslexia; NoFR, without family risk for dyslexia; MCDI, MacArthur Communicative Development Inventory; vocab. prod., vocabulary production; BNT, Boston Naming Test; PPVT, Peabody Picture Vocabulary Test; WISC-III, Wechsler Intelligence Scale for Children–Third Edition.

<sup>a</sup> Average across age.

<sup>b</sup> Standardized score average.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

square difference testing with the baseline model, where all estimates were allowed to be freely estimated. Because the test suggested that there was a group difference, all estimates were compared one by one.

The goodness of fit of the estimated models was evaluated using the following indicators:  $\chi^2$  test, comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Good model fit is indicated by a small, preferably nonsignificant  $\chi^2$ , CFI > .95, RMSEA < .06, and SRMR < .08 (Hu & Bentler, 1999).

## Results

### Descriptive statistics and family risk group comparisons

Table 1 reports means and standard deviations for all measures in the groups with and without familial risk (FR and NoFR, respectively) for dyslexia. All distributions were close to normal and had

skewness and kurtosis values below 1. No outliers with more than 3 standard deviations above or below the mean were identified. The FR group was found to perform more poorly than the NoFR group in sentence length at age 2 years, in most vocabulary measures at ages 3.5 to 5.5, in emerging literacy measures at age 5.5, and in reading fluency in Grades 2 and 3. There were no statistically significant differences between the groups in parental education, shared reading, reading motivation, vocabulary at ages 2 and 8 years, or reading comprehension.

#### *Hypothesized path model with FR group as a moderator*

**Table 2** reports Pearson correlation coefficients between the study measures in the two groups. Multiple significant correlations were identified between the constructs in both groups. To examine the longitudinal associations among shared reading, vocabulary development, and reading development, path models were estimated. The effects of mother's and father's education levels were at first included in the models but were eventually omitted because neither was a significant predictor of any of the variables in the path models.

To examine whether FR acts as a moderator, the model was run as a multigroup analysis. First, the model was estimated separately in the FR and NoFR groups, and the model fits were examined. The hypothesized model fit for the NoFR group was not considered adequate,  $\chi^2(35) = 60.55$ ,  $p = .005$ , RMSEA = .09 (90% confidence interval [CI] = .05–.13), CFI = .87, SRMR = .09. Therefore, the modification indices were inspected, and two paths were added that improved the model fit to the data. The final model with the two added paths, one from age 2 vocabulary to emerging reading and one from emerging reading to age 8 vocabulary, was considered to have adequate fit with data,  $\chi^2(33) = 46.01$ ,  $p = .07$ , RMSEA = .07 (90% CI = .00–.11), CFI = .93, SRMR = .08.

For the FR group the hypothesized model fit was not adequate either,  $\chi^2(35) = 71.69$ ,  $p < .001$ , RMSEA = .10 (90% CI = .07–.13), CFI = .91, SRMR = .10. Therefore, the modification indices were inspected, and three paths were added that improved the model fit to the data. The final model with the three added paths, one from age 2 vocabulary to age 15 reading comprehension, one from age 8 and 9 shared reading to age 15 reading comprehension, and one from emerging literacy to age 8 and 9 shared reading, was considered to have adequate fit with data,  $\chi^2(32) = 46.94$ ,  $p = .04$ , RMSEA = .07 (90% CI = .01–.10), CFI = .96, SRMR = .07. Therefore, the final multigroup model was assessed including the five additional pathways suggested by the FR and NoFR group models (Fig. 2).

In the multigroup models, the equality of the path estimates depicted in Fig. 2 and error covariances were tested between the FR and NoFR groups. First, all the estimates of the models were set equal in the groups. The model with all estimates set equal did not fit the data well,  $\chi^2(96) = 136.03$ ,  $p < .001$ , CFI = .93, RMSEA = .06 (90% CI = .04–.09), SRMR = .09. In addition, the chi-square difference test, which compared this model with another model with all estimates freely estimated in the two groups, suggested that the models of the two groups were not equal,  $\Delta\chi^2(36) = 52.20$ ,  $p = .006$ . Therefore, the equality of each estimate was examined by setting each of the estimates equal one by one and examining the significance of the model fit deterioration (chi-square difference testing) for each equality setting.

In the final model, all the paths and error correlations that differed significantly between the groups were estimated freely and the other estimates were fixed equal across the groups. The model fit the data well,  $\chi^2(90) = 112.23$ ,  $p < .06$ , CFI = .96, RMSEA = .05 (90% CI = .00–.08), SRMR = .08. The final model is depicted in Fig. 3. The multigroup model comparisons suggested that all but five paths and one error correlation were equal in the groups.

First, regarding the associations between the skills, the stability estimates of vocabulary and reading comprehension, the associations between emerging literacy skills and vocabulary, as well as between emerging literacy and reading, were equal in the groups. In both groups, vocabulary predicted emerging literacy skills and emerging literacy skills predicted reading skills. Age 8 vocabulary did not predict age 15 reading comprehension in either group. However, there were also group differences. Age 3.5–5.5 vocabulary predicted age 8 and 9 reading comprehension only in the FR group. Furthermore, age 2 vocabulary predicted age 15 reading comprehension only in the FR group. Finally, age 8 and 9 reading fluency predicted age 15 reading comprehension only in the FR group. Examination of indirect effects (Table 3) suggested significant indirect effects from early vocabulary to reading. Age 2

**Table 2**  
Correlation table with FR group below the diagonal and NoFR group above the diagonal.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Shared reading, age 2		.44**	.28**	.16	.25*	.33**	.24*	-.01	.13	.27**	.34**	.07
2. Shared reading, ages 4–5	.63***		.44***	.01	.22*	.16	.26*	.08	.12	.18	.14	.05
3. Shared reading, ages 8–9	.25*	.54**		.11	.03	.01	.25*	-.07	-.04	-.18	-.01	-.12
4. Teaching literacy	.18	.28**	.12		.13	-.07	-.07	.02	.20	.07	.02	-.04
5. Reading motivation, ages 8–9	.32**	.52**	.27**	.21*		.17	.16	.10	.21*	.38***	.13	.33**
6. Vocabulary, age 2	.38**	.32**	.10	.26*	.33**		.46**	.16	.49**	.26*	.38**	.12
7. Vocabulary, ages 3.5–5.5	.37**	.39**	.25*	.09	.38**	.67***		.36**	.45**	.25*	.43**	.15
8. Vocabulary, age 8	.20*	.22*	.02	.18	.29**	.43**	.55**		.43**	.29**	.42**	.28*
9. Emerging literacy, age 5.5	.08	.20*	-.02	.20	.28**	.47**	.51**	.47**		.46**	.43**	.18
10. Reading fluency, ages 8–9	-.02	.07	-.21*	.11	.34**	.19	.16	.31**	.51**		.56**	.35**
11. Reading comprehension, ages 8–9	.12	.28**	-.01	.08	.41**	.39**	.46**	.47**	.52**	.50**		.40**
12. Reading comprehension, age 15	.24*	.36**	.25*	.18	.32**	.54**	.50**	.41**	.54**	.37**	.49**	

Note. Ages are in years. FR, with family risk for dyslexia; NoFR, without family risk for dyslexia.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

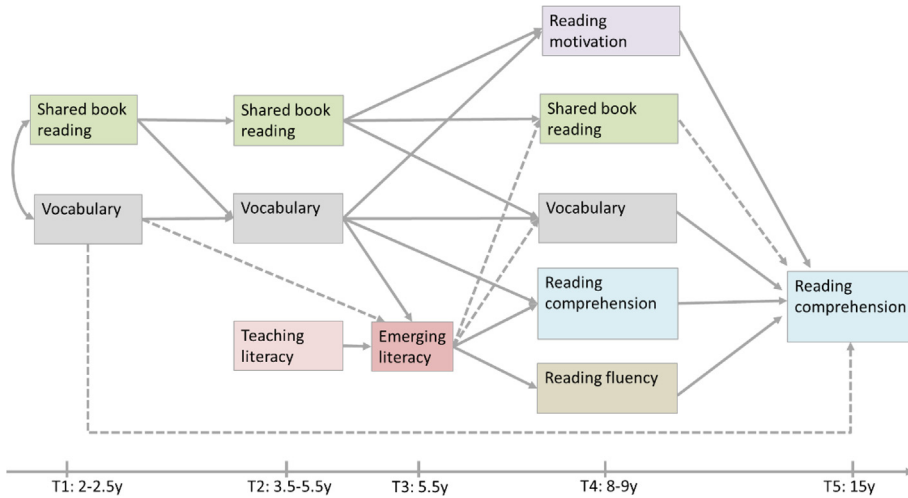


Fig. 2. The path model tested in the multigroup model. The dashed paths were added to the theoretical model based on the models estimated in the groups with family risk and without family risk for dyslexia. T1/2/3/4/5, Time 1/2/3/4/5; y, years.

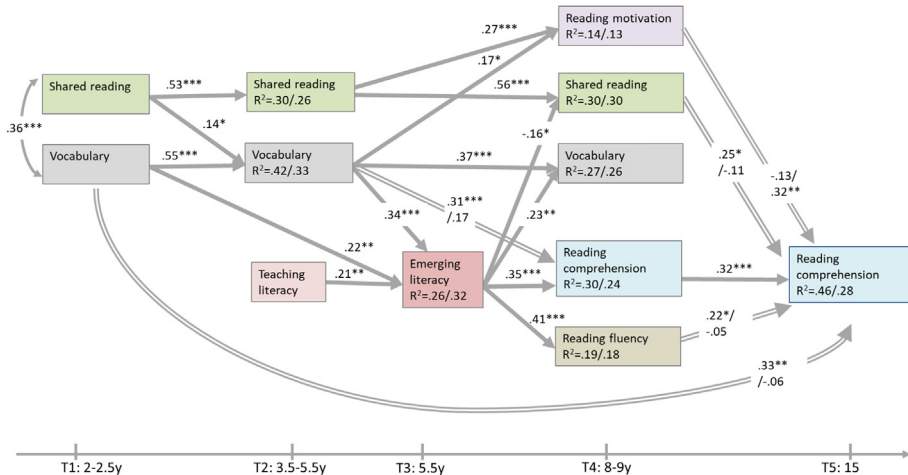


Fig. 3. The final home literacy environment model with family risk for dyslexia as a moderator. For the paths, which were different in the family risk (FR) and no family risk (NoFR) groups, the standardized estimates are given separately for the groups with FR group estimate first and NoFR group estimate second (FR/NoFR). Similarly, R<sup>2</sup> values are given separately for FR/NoFR groups. Note that for clarity of the figure, error covariances and two nonsignificant paths are omitted (from age 3–5 years shared reading to age 8 vocabulary with standardized path estimate .00 and a path from age 8 vocabulary to age 15 reading comprehension with standardized path estimate .08). In addition to the paths and correlation coefficient presented, there were seven significant error correlations that were equal in the groups: shared reading at ages 8 and 9 and reading fluency (–.20\*\*), reading comprehension and vocabulary at ages 8 and 9 (.34\*\*\*), reading comprehension and reading motivation (.15\*), reading comprehension and vocabulary (.14\*), reading fluency and reading motivation (.34\*\*\*), reading fluency and vocabulary (.13\*), and shared reading at ages 3–5 and vocabulary (.14\*\*). There also was one that was different in the groups: The correlation between shared reading at ages 3–5 and teaching at home was stronger in the FR group (.21\* in the FR group and –.09 in the NoFR group). \*p < .05; \*\*p < .01; \*\*\*p < .001. T1/2/3/4/5, Time 1/2/3/4/5; y, years.

**Table 3**

Significant indirect effects to reading skills in the final model.

Indirect effect pathways	FR group Outcome			NoFR group Outcome		
	Reading comprehension, age 15	Reading comprehension, ages 8–9	Reading fluency, ages 8–9	Reading comprehension, age 15	Reading comprehension, ages 8–9	Reading fluency, ages 8–9
Shared reading, age 2 → Shared reading, ages 4–5 → Shared reading, age 8 →	.07*					
Shared reading, age 2 → Shared reading, ages 4–5 → Reading motivation, ages 8–9 →				.05*		
Shared reading, ages 4–5 → Shared reading, age 8 →	.13*					
Shared reading, ages 4–5 → Reading motivation, ages 8–9 →				.10*		
Vocabulary, age 2 → Vocabulary, ages 3–5 → Reading comprehension, ages 8–9 →	.06*					
Vocabulary, age 2 → Emerging literacy → Reading comprehension, ages 8–9 →	.02*					
Vocabulary, age 2 → Vocabulary, ages 3–5 → Emerging literacy → Reading comprehension, ages 8–9 →	.02*			.02*		
Vocabulary, ages 3–5 → Reading comprehension, ages 8–9 →	.10*			.04*		
Vocabulary, ages 3–5 → Emerging literacy → Reading comprehension, ages 8–9 →	.04*					
Vocabulary, age 2 → Vocabulary, ages 3–5 →		.17**				
Vocabulary, age 2 → Vocabulary, ages 3–5 → Emerging literacy →		.07**	.08**		.07**	.08**
Vocabulary, age 2 → Emerging literacy →		.07*	.09*		.07**	.09*
Teaching literacy → Emerging literacy → Reading comprehension, ages 8–9 →	.02*			.03*		
Teaching literacy → Emerging literacy →		.07**	.09**		.08**	.09**

Note. Ages are in years. FR, with family risk for dyslexia; NoFR, without family risk for dyslexia.

\*  $p < .05$ .

\*\*  $p < .01$ .



vocabulary predicted reading comprehension through vocabulary stability and emerging literacy skills and reading fluency through emerging literacy skills.

Second, regarding the hypotheses on the effects of HLE (shared reading and teaching literacy) on skills, most of the paths were equal in the groups. Age 2 shared book reading predicted age 3.5–5.5 vocabulary in both groups, and age 4 and 5 shared reading did not predict age 8 vocabulary in either of the groups. Teaching literacy predicted emerging literacy in both groups. A group difference emerged, however, with age 8 and 9 shared reading significantly predicting age 15 reading comprehension only in the FR group. Third, regarding the hypothesis that shared reading may have a positive effect on reading skills through enhancing intrinsic motivation to read, a significant positive pathway was identified from age 8 and 9 reading motivation to age 15 reading comprehension. Examination of indirect effects (Table 3) suggested significant indirect effects from the early age shared reading to reading comprehension through shared reading stability in the FR group and through reading motivation in the NoFR group. The teaching of literacy skills at home had significant indirect effects on reading fluency and comprehension through emerging literacy skills in both groups. Altogether, the model explained 28% of age 15 reading comprehension in the NoFR group and 46% of age 15 reading in the FR group (see all  $R^2$  values in Fig. 3).

Finally, we estimated the Fig. 3 model for the full sample ( $N = 204$ ) with all the other variables regressed on FR (see Appendix Fig. A1). This model was included to examine whether FR effects on children's reading skills are mediated via earlier skill assessments, reading motivation, or HLE. In addition, this model was used to examine whether controlling for FR changes the results regarding the impact of HLE on children's development. The resulting model fitted the data well,  $\chi^2(30) = 40.19$ ,  $p = .10$ , CFI = .98, RMSEA = .04 (90% CI = .00–.07), SRMR = .05, and is depicted in Appendix Fig. A1. Note that again the nonsignificant paths are not included in the figure for clarity. The resulting model was not essentially different from the model in Fig. 3. As can be expected, some of the paths that were significant only in the NoFR group or only in the FR group did not reach the level of significance in the combined model. More specifically, the path from reading motivation to PISA reading that was significant only among the NoFR group was not significant in the full sample. Similarly, the paths from reading fluency and shared reading to PISA that were significant only in the FR group were no longer significant. However, the paths from age 3 to 5 vocabulary to reading comprehension and age 2 vocabulary on PISA were also significant in the full model. FR status had significant effects, albeit modest ones, on literacy teaching at home, age 2 and age 3–5 vocabulary, and Grade 2 and 3 reading fluency.

## Discussion

We set out to examine long-term pathways through which early meaning-focused activities (shared reading) or print-focused activities (teaching letters and reading) at home could support children's reading development all the way to adolescence. Our model was framed with the hypotheses and developmental mediators derived from the HLE model (Sénéchal & LeFevre, 2002) and other previous research: oral language development, emerging literacy skills, and reading motivation. We provided an extension to the HLE model by (a) including a longer timeframe from ages 2 to 15 years, (b) adding autoregressive controls to some of the key measures to yield a stronger test of the HLE model, and (c) adding an examination of familial risk for dyslexia as a moderator on the HLE model associations. The latter is also important because it allows a differentiation between promotive and protective factors (e.g., McGrath et al., 2020). Overall, the findings suggested that the HLE can have a long-standing effect on reading comprehension development through multiple pathways. Importantly, the effects started from very early on and were significant over the broad time window even after controlling for autoregressors. Furthermore, despite specific dissimilarities between the models for the children with and without familial risk for dyslexia, the paths from the preschool HLE activities to children's prereading and reading skills were equal in the two study groups, suggesting promotive effects for teaching literacy and early shared reading. In addition, continued shared reading until age 8 years was found to support reading comprehension only in the FR group, suggesting that it can be a protective factor.

The findings supported the basic assumptions of the HLE model (Sénéchal & LeFevre, 2002, 2014). First, the print-focused activities at home (teaching letter names and reading) predicted emerging literacy skills. In addition, there were significant indirect effects from teaching activities to reading fluency and comprehension through the emerging literacy skills, which is in line with previous studies (Hamilton et al., 2016; Hood et al., 2008; Inoue et al., 2018). It is noteworthy that the teaching of literacy was predictive of emerging literacy skills even when controlling for the effect of vocabulary on emerging literacy in our models. This suggests that although language development is an important precursor of emerging literacy, specific activities focusing on print also support emerging literacy development. Interestingly, we found that the teaching of literacy was not associated with parent-child shared reading, which is a further finding in line with the HLE model. From the promotive versus protective point of view, teaching literacy was a promotive factor because it had a similar predictive impact regardless of whether the children had FR or not. These outcomes suggest that the teaching of literacy skills and its association with emerging literacy comprise a promotive route to literacy that is independent from children's language skills and parental shared reading. However, it should be noted that emergent literacy skills negatively predicted shared reading at school age. That is, the children with better emergent literacy skills received less shared reading at school age, whereas the children with poorer emergent literacy skills received more shared reading. This finding can be interpreted to reflect the decline in parent-child shared reading once children have learned to read well enough to read themselves (e.g., Manolitsis et al., 2011). On the other hand, the children with reading difficulties also had lower emergent reading skills and seemed to evoke more shared reading with parents also at school age, possibly due to feedback from schools.

Second, the meaning-focused activities (parent-child shared book reading) predicted reading comprehension through vocabulary, which is in line with the HLE model and previous studies (e.g., Hamilton et al., 2016; Scarborough & Dobrich, 1994; Sénéchal & LeFevre, 2014; Silinskas et al., 2019). Our models confirmed this pathway in an extended timeframe, although we conducted a stricter test than most previous studies by including multiple assessments and autoregressors of oral language and reading comprehension. This suggests that children who experienced more shared reading at home from as early as age 2 years will have better vocabulary than those who had fewer shared reading experiences. Because vocabulary, in turn, predicted future development of reading comprehension, these early experiences seem to have long-lasting associations with subsequent literacy development. The effect of early shared reading on vocabulary was similar in the FR and NoFR groups, suggesting that the effect was promotive instead of protective. This finding and the finding of the promotive role of teaching literacy thus validates the HLE model in the FR and NoFR groups.

Further in line with the HLE model, shared reading and the teaching of prereading skills at home predicted reading development through oral language skills and emerging literacy skills, which are early predictors of reading skills (e.g., Castles et al., 2018; Pennington & Lefly, 2001; Scarborough, 1990, 2001; Snowling & Melby-Lervåg, 2016; Torppa et al., 2010). These findings underscore the developmental importance of early oral language skills, which predicted both emerging literacy skills and reading comprehension. Language and emerging literacy skills thus were entangled from early on, and although the two types of HLE activities seem to be quite independent from each other and have quite independent supportive roles in reading development, the skills they bolster are closely connected in development.

Perhaps the most striking finding, however, was the significant predictive association between age 2 years vocabulary and age 15 PISA reading comprehension above and beyond all the other measures in the model for the children with familial risk for dyslexia (see also Eklund, Torppa, Aro, Leppänen, & Lyytinen, 2015). This suggests that among the family risk for dyslexia (FR) children, having no difficulties in early oral language development may act as a protective factor against reading comprehension difficulties. This means that despite their increased risk for problems in accurate and automatized decoding ability, they may perform well in reading comprehension tasks once they establish a good enough fluency in decoding. Conversely, this also means that the FR children with weaker early oral language skills are at a particularly strong risk for developing reading comprehension difficulties. It is common that the children who have FR for reading difficulties also have oral language difficulties (e.g., Snowling & Melby-Lervåg, 2016; Torppa et al., 2010), and it may be useful to track the language development particularly carefully among the FR children from early on. Difficulties in oral language

and reading often co-occur (Adlof, 2020; Catts, Adlof, Hogan, & Weismer, 2005; Snowling, Hayiou-Thomas, Nash, & Hulme, 2020), and this double risk may lead to combined decoding and reading comprehension difficulties (e.g., Psyridou, Eklund, Poikkeus, & Torppa, 2018). However, the impact of oral language difficulties on reading development may also be limited to reading comprehension difficulties (e.g., Duff, Reen, Plunkett, & Nation, 2015; Psyridou et al., 2018; Rescorla, 2009; Snowling et al., 2020). In samples of children with developmental language disorder (DLD) or specific language impairment (SLI), it has been shown that decoding often develops at grade level (Bishop, McDonald, Bird, & Hayiou-Thomas, 2009; Catts et al., 2005; Snowling et al., 2020), whereas reading comprehension difficulties emerge only later on when decoding is no longer such a strong driver of reading comprehension (Catts, Compton, Tomblin, & Bridges, 2012). From the perspective of educational and clinical practice, the late-emerging reading comprehension difficulty is problematic because it can be difficult to identify when decoding develops at average speed (Adlof, 2020). This suggests a need for evaluation and support that targets language and reading comprehension and continues beyond the decoding acquisition phase. Furthermore, such support may need to be tailored individually. It has been suggested recently (Adlof, 2020; Snowling et al., 2020) that efficient support for reading comprehension may be different for children with dyslexia or DLD because their reading comprehension problems are due to a different underlying cause (weak decoding vs. weak oral language).

The findings are also in general agreement with the simple view of reading (e.g., Florit & Cain, 2011; Gough & Tunmer, 1986) in that both vocabulary and emerging literacy skills were significant predictors of reading comprehension at ages 8 and 9 years. Interestingly, however, age 15 reading comprehension was not predicted by age 8 vocabulary, and only a weak predictive path estimate was identified from reading fluency and only in the FR group. This is likely due to the inclusion of the earlier assessment of reading comprehension in the model. Indeed, age 8 vocabulary and reading fluency did correlate with age 15 reading comprehension positively and significantly, but controlling earlier reading comprehension measures likely also accounted for the effect of vocabulary and reading fluency. The negligible effect of reading fluency on reading comprehension in the NoFR group is understandable in the current timeframe because, after the first few elementary grades, decoding is typically automatized in the context of transparent orthographies such as Finnish and thus does not strain comprehension processes any further (e.g., Florit & Cain 2011; Torppa et al., 2016). However, among the familial risk group, there are more participants with reading difficulties (~40%; Torppa et al., 2015), and thus it is plausible that there are more participants whose slow and laborious decoding absorbs cognitive resources, hindering comprehension processes (e.g., Nation, 2019; Perfetti, 1985). Overall, we were able to predict nearly half of the FR group variance in PISA reading and nearly a third of the NoFR group variance in PISA reading. These predictions are not as strong as in some previous studies predicting reading comprehension with latent factors of language, listening comprehension, and word decoding (e.g., Lervåg, Hulme, & Melby-Lervåg, 2018), but they are quite high considering that the predictors were assessed 6–13 years prior to PISA assessment.

Finally, our findings that shared reading also directly predicted reading motivation (NoFR group only) and reading comprehension (FR group only) suggest that the effect of shared reading is not limited to vocabulary development. Moreover, shared reading indirectly predicted age 15 years reading comprehension through reading motivation in the NoFR group, suggesting another supportive route for meaning-related activities. Thus, it seems that the preschool shared reading experiences at home may support children's intrinsic reading motivation at school age (see also Baker et al., 1997; Demir-Lira et al., 2019; Hume et al., 2015; Sénéchal, 2006; Silinskas et al., 2020) and consequently also support reading comprehension years later. Children who engage more often in reading activities get plenty of practice in reading and learn various skills needed in reading comprehension tasks (e.g., language, syntax, inferencing). This finding accords with previous studies suggesting that whereas in the early grades reading development predicts leisure reading more than vice versa, in the later grades leisure reading supports reading comprehension development (Torppa et al., 2020; van Bergen, Vasalampi, & Torppa, 2020). Interestingly, however, among the FR group the association between reading motivation and age 15 reading comprehension was not significant, whereas there was a significant direct path from age 8 and 9 shared reading to age 15 reading comprehension. Thus, for

children with FR, the continued shared reading at school age appeared to play an important role in reading comprehension development. From a theoretical perspective, this finding suggests that continued shared reading may be a protective factor and, as such, may be particularly important when children are at risk for reading difficulties. Furthermore, these findings suggest that the HLE model could be extended to include continued assessment of shared reading and a supportive pathway through children's reading motivation.

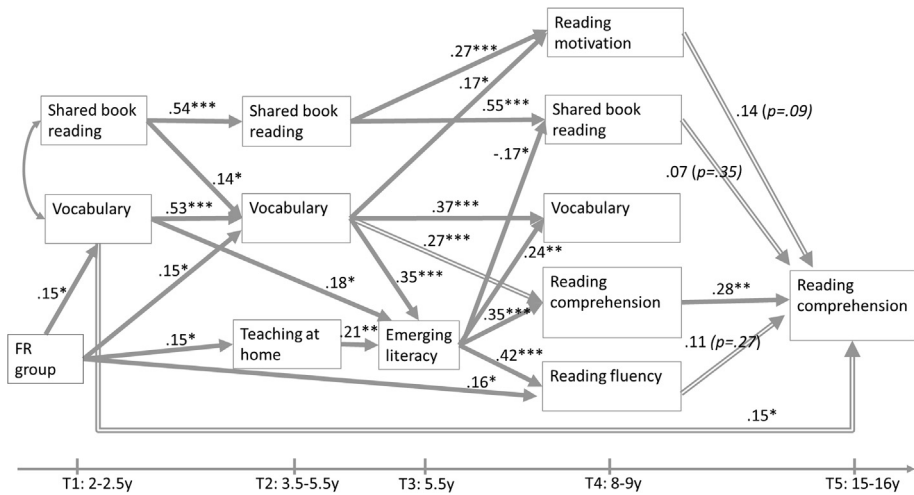
There are certain limitations to this study. First, the sample size was relatively small, and instead of latent factors that minimize measurement error, we needed to use observed variables in our models. The same limitation applies to most other HLE studies, however, and thus it would be important to confirm the findings using latent variable models. Second, children's reading motivation was assessed by a parental questionnaire and not directly asked of the children. It is possible that parents are not as good at evaluating their children's reading motivation as children themselves would be. However, the findings seem similar to those using child-reported reading motivation (Silinskas et al., 2020; Torppa et al., 2020). Third, the current study was carried out in Finland, which may limit the generalizability of the findings. It could be argued that the high orthographic transparency of Finnish might disproportionately facilitate parental efforts to teach literacy by virtue of direct transfer from speech to writing. However, in the absence of comparative studies, this possibility is merely based on a conjecture. In addition, the associations between oral language and book reading should not be affected by orthographic transparency. Fourth, this study focused only on the associations among home environment, reading motivation, and skills. To achieve a more complete understanding of the impact of learning environments on reading skill development, additional environmental effects should be included, for example, those of early childhood education and care environments, schools, and classroom membership. These factors should preferably be examined together (e.g., Kiuru et al., 2012). Overall, the limitations do not compromise the strengths of the study, that is, a longitudinal design covering a widespread time window, the use of autoregressors when examining the associations, and the examination of familial risk for dyslexia as a moderator.

In conclusion, our findings suggest that the HLE supports preschool children's language and literacy development and, via the preschool skills and children's increased reading motivation, also supports reading comprehension even until adolescence. Such activities were also supportive for children who were at heightened risk for developing reading difficulties due to dyslexia running in the family. In fact, it seemed that continued shared reading with parents may be even more important for FR children because they need more support due to their typical difficulties in learning to decode. Theoretically, continued shared reading may be a protective factor, whereas teaching literacy and early shared reading are promotive factors. Shared reading at school age thus appeared to act as a protective factor in addition to being a promotive factor at a younger age. These findings suggest that continued shared reading may be particularly important in the long run for those who are at high risk for developing reading difficulties. However, because our study is a longitudinal follow-up, we can only describe what the associations over time were, but we cannot conclude what may happen in the case of an intervention. A recent meta-analysis by Noble et al. (2019) suggested that shared reading interventions might not have a large impact on young children's language development despite the correlations that are often found (see also Noble et al., 2020). They noted, however, that future intervention studies should be longer because interventions of a few weeks cannot provide a realistic test of the hypothesis that shared reading affects children's language skills. Our study is in line with the suggestion for the need for longer follow-up. It is indeed possible that the effects of shared reading on language skills become visible only after months or even years of shared reading activities. Effects on reading may take even longer and can be mediated or moderated by various factors such as FR and reading motivation. Although the roles of early childhood education and care environments are also very important in language and literacy development, homes can provide the necessary long-term day-to-day activities for young children. Importantly, it seems that the activities at home need not necessarily be only educational. Moments of interaction and enjoyment, such as shared reading, are also meaningful. In an ideal world, parents would have the possibility of investing considerable time in one-to-one activities, thereby bolstering the literacy development of their children.

**Acknowledgments**

The writing of this article was supported by grants from the Academy of Finland (299506 and 323773 to Kati Vasalampi; 276239, 313768, and 284439 to Minna Torppa). Over the years, this project has been supported by the Academy of Finland with multiple other grants. We thank all the participating children and families as well as all the many researchers and research assistants who participated in collecting these unique data.

**Appendix A**



**Fig. A1.** Final home literacy environment model with family risk for dyslexia (FR) as a mediator. \**p* < .05; \*\**p* < .01; \*\*\**p* < .001. T1/2/3/4/5, Time 1/2/3/4/5; y, years.

**References**

Adlof, S. M. (2020). Promoting reading achievement in children with developmental language disorders: What can we learn from research on specific language impairment and dyslexia?. *Journal of Speech, Language, and Hearing Research*, 63(10), 3277–3292.

Aro, M. (2017). Learning to read Finnish. In L. Verhoeven & C. Perfetti (Eds.), *Learning to read across languages and writing systems* (pp. 393–415). New York: Cambridge University Press.

Baker, L., Scher, D., & Mackler, K. (1997). Home and family influences on motivations for reading. *Educational Psychologist*, 32(2), 69–82.

Bishop, D. V. M., McDonald, D., Bird, S., & Hayiou-Thomas, M. E. (2009). Children who read words accurately despite language impairment: Who are they and how do they do it?. *Child Development*, 80(2), 593–605.

Burgess, S. R., Hecht, S. A., & Lonigan, C. J. (2002). Relations of the home literacy environment (HLE) to the development of reading-related abilities: A one-year longitudinal study. *Reading Research Quarterly*, 37, 408–426.

Bus, A. G., van Ijzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning to read: A meta-analysis on intergenerational transmission of literacy. *Review of Educational Research*, 65(1), 1–21.

Byrne, B. J. (1998). *The foundation of literacy: The child's acquisition of the alphabetic principle*. London: Psychology Press.

Caglar-Ryeng, Ø., Eklund, K., & Nergård-Nilssen, T. (2020). The effects of book exposure and reading interest on oral language skills of children with and without a familial risk of dyslexia. *Dyslexia*, 26(4), 394–410.

Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest*, 19(1), 5–51.

Catts, H. W., Adlof, S. M., Hogan, T. P., & Weismer, S. E. (2005). Are specific language impairment and dyslexia distinct disorders?. *Journal of Speech, Language, and Hearing Research*, 48(6), 1378–1396.

Catts, H. W., Compton, D., Tomblin, J. B., & Bridges, M. S. (2012). Prevalence and nature of late-emerging poor readers. *Journal of Educational Psychology*, 104(1), 166–181.



- Cox, K. E., & Guthrie, J. T. (2001). Motivational and cognitive contributions to students' amount of reading. *Contemporary Educational Psychology*, 26(1), 116–131.
- Demir-Lira, Ö. E., Applebaum, L. R., Goldin-Meadow, S., & Levine, S. C. (2019). Parents' early book reading to children: Relation to children's later language and literacy outcomes controlling for other parent language input. *Developmental Science*, 22, e12764.
- Dilnot, J., Hamilton, L., Maughan, B., & Snowling, M. J. (2017). Child and environmental risk factors predicting readiness for learning in children at high risk of dyslexia. *Development and Psychopathology*, 29(1), 235–244.
- Duff, F. J., Reen, G., Plunkett, K., & Nation, K. (2015). Do infant vocabulary skills predict school-age language and literacy outcomes?. *Journal of Child Psychology and Psychiatry*, 56(8), 848–856.
- Dunn, L. M., & Dunn, L. M. (1981). *Peabody picture vocabulary test-revised*. Circle Pines, MN: American Guidance Service.
- Eklund, K., Torppa, M., Aro, M., Leppänen, P. H. T., & Lyytinen, H. (2015). Literacy skill development of children with familial risk for dyslexia through Grades 2, 3, and 8. *Journal of Educational Psychology*, 107(1), 126–140.
- Eklund, K., Torppa, M., Sulkunen, S., Niemi, P., & Ahonen, T. (2018). Early cognitive predictors of PISA reading in children with and without family risk for dyslexia. *Learning and Individual Differences*, 64, 94–103.
- Elbro, C., Borstrøm, I., & Petersen, D. K. (1998). Predicting dyslexia from kindergarten: The importance of distinctness of phonological representations of lexical items. *Reading Research Quarterly*, 33, 36–60.
- Esmaeeli, Z., Lundström, K., & Kyle, F. E. (2018). What can parents' self-report of reading difficulties tell us about their children's emerging literacy at school entry?. *Dyslexia*, 24, 84–105.
- Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., ... Reilly, J. S. (1993). *The MacArthur communicative development inventories: User's guide and technical manual*. San Diego: Singular Publishing Group.
- Flack, Z. M., Field, A. P., & Horst, J. S. (2018). The effects of shared storybook reading on word learning: A meta-analysis. *Developmental Psychology*, 54(7), 1334–1346.
- Florit, E., & Cain, K. (2011). The simple view of reading: Is it valid for different types of alphabetic orthographies?. *Educational Psychology Review*, 23(4), 553–576.
- Gallagher, A., Frith, U., & Snowling, M. J. (2000). Precursors of literacy delay among children at genetic risk of dyslexia. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41(2), 203–213.
- Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial & Special Education*, 7(1), 6–10.
- Hamilton, L. G., Haiyou-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.
- Hart, S. A., Little, C., & van Bergen, E. (2021). Nurture might be nature: Cautionary tales and proposed solutions. *NPJ Science of Learning*, 6(1), 1–12.
- Hood, M., Conlon, E., & Andrews, G. (2008). Preschool home literacy practices and children's literacy development: A longitudinal analysis. *Journal of Educational Psychology*, 100(2), 252–271.
- Hu, L.-T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1–55.
- Hume, L. E., Lonigan, C. J., & McQueen, J. D. (2015). Children's literacy interest and its relation to parents' literacy promoting practices. *Journal of Research in Reading*, 38(2), 172–193.
- 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.
- Inoue, T., Manolitsis, G., de Jong, P. F., Landerl, K., Parrila, R., & Georgiou, G. K. (2020). Home literacy environment and early literacy development across languages varying in orthographic consistency. *Frontiers in Psychology*, 11. <https://doi.org/10.3389/fpsyg.2020.01923>.
- Kaplan, E. F., Goodglass, H., & Weintraub, S. (1983). *The Boston naming test* (2nd ed.). Philadelphia: Lea & Febiger.
- Kere, J. (2011). Molecular genetics and molecular biology of dyslexia. *Wiley Interdisciplinary Reviews: Cognitive Science*, 2(4), 441–448.
- Kirby, J. R., & Savage, R. S. (2008). Can the simple view deal with the complexities of reading?. *Literacy*, 42(2), 75–82.
- Kiuru, N., Aunola, K., Torppa, M., Lerkanen, M.-K., Poikkeus, A.-M., Niemi, P., Viljaranta, J., Lyyra, A.-L., Leskinen, E., Tolvanen, A., & Nurmi, J.-E. (2012). The role of parenting styles and teacher interactional styles in children's reading and spelling development. *Journal of School Psychology*, 799–823. <https://doi.org/10.1016/j.jsp.2012.07.001>.
- Laakso, M. L., Poikkeus, A. M., Eklund, K., & Lyytinen, P. (2004). Interest in early shared reading: Its relation to later language and letter knowledge in children with and without risk for reading difficulties. *First Language*, 24(3), 323–345.
- Laakso, M.-L., Poikkeus, A.-M., & Lyytinen, P. (1999). Shared reading interaction in families with and without genetic risk for dyslexia: Implications for toddlers' language development. *Infant and Child Development*, 8(4), 179–195.
- Laine, M., Goodglass, H., Niemi, J., Koivuselkä-sallinen, P., Tuomainen, J., & Marttila, R. (1993). Adaptation of the Boston diagnostic aphasia examination and the Boston naming test into Finnish. *Scandinavian Journal of Logopedics & Phoniatrics*, 18(2-3), 83–92.
- Laine, M., Koivuselkä-Sallinen, P., Hänninen, R., & Niemi, J. (1997). *Bostonin Nimentäestesti [Finnish translation of the Boston Naming Test]*. Helsinki, Finland: Psykologien Kustannus Oy.
- Leinonen, S., Müller, K., Leppänen, P. H. T., Aro, M., Ahonen, T., & Lyytinen, H. (2001). Heterogeneity in adult dyslexic readers: Relating processing skills to the speed and accuracy of oral text reading. *Reading and Writing*, 14, 265–296.
- Lervåg, A., Hulme, C., & Melby-Lervåg, M. (2018). Unpicking the developmental relationship between oral language skills and reading comprehension: It's simple, but complex. *Child Development*, 89(5), 1821–1838.
- Lindeman, J. (2000). *Ala-asteen lukutesti: Käyttäjän käsikirja [The comprehensive school reading test]*. Turku, Finland: Oppimistutkimuksen keskus, Turun yliopisto [Center for Learning Research, Turku University].
- Lohvasuu, K., Torppa, M., Ahonen, T., Eklund, K., Hämäläinen, J. A., Leppänen, P. H. T., & Lyytinen, H. (2021). Unveiling the mysteries of dyslexia: Lessons learned from the Prospective Jyväskylä Longitudinal Study of Dyslexia. *Brain Sciences*, 11(4), 427. <https://doi.org/10.3390/brainsci11040427>.
- Lundberg, I. (1991). Reading as an individual and social skill. In I. Lundberg & T. Høien (Eds.), *Literacy in a world of change* (pp. 14–22). Stavanger, Norway: Center for Reading Research, Stavanger/UNESCO.

- Manolitsis, G., Georgiou, G. K., & Parrila, R. (2011). Revisiting the home literacy model of reading development in an orthographically consistent language. *Learning and Instruction, 21*(4), 496–505.
- Manolitsis, G., Georgiou, G. K., & Tziraki, N. (2013). Examining the effects of home literacy and numeracy environment on early reading and math acquisition. *Early Childhood Research Quarterly, 28*(4), 692–703.
- McGrath, L. M., Peterson, R. L., & Pennington, B. F. (2020). The multiple deficit model: Progress, problems, and prospects. *Scientific Studies of Reading, 24*(1), 7–13.
- Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin, 137*(2), 267–296.
- Morrow, L. M. (1983). Home and school correlates of early interest in literature. *The Journal of Educational Research, 76*(4), 221–230 <http://www.jstor.org/stable/27539975>.
- Muthén, L. K., & Muthén, B. O. (1998–2017). *Mplus user's guide* (8th ed.). Los Angeles: Muthén & Muthén.
- Nation, K. (2019). Children's reading difficulties, language, and reflections on the simple view of reading. *Australian Journal of Learning Difficulties, 24*(1), 47–73.
- Nation, K., & Snowling, M. J. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. *Journal of Research in Reading, 27*(4), 342–356.
- Niklas, F., & Schneider, W. (2013). Home literacy environment and the beginning of reading and spelling. *Contemporary Educational Psychology, 38*(1), 40–50.
- 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.
- Noble, C., Sala, G., Peter, M., Lingwood, J., Rowland, C., Gobet, F., & Pine, J. (2019). The impact of shared book reading on children's language skills: A meta-analysis. *Educational Research Review, 28*, 100290. <https://doi.org/10.1016/j.edurev.2019.100290>.
- Olson, R. K., Keenan, J. M., Byrne, B., & Samuelsson, S. (2019). Etiology of developmental dyslexia. In L. Verhoeven, C. Perfetti, & K. Pugh (Eds.), *Developmental dyslexia across languages and writing systems* (pp. 391–412). Cambridge, UK: Cambridge University Press.
- Organization for Economic Cooperation and Development (2010). *PISA 2009 results: Learning trends: Changes in student performance since 2000, Vol. 5*. <https://doi.org/10.1787/9789264091580-en>.
- Pennington, B. (2006). From single to multiple deficit models of developmental disorders. *Cognition, 101*(2), 385–413.
- Pennington, B. F., & Lefly, D. L. (2001). Early reading development in children at family risk for dyslexia. *Child Development, 72*(3), 816–833.
- Perfetti, C. A. (1985). *Reading ability*. Oxford, UK: Oxford University Press.
- Plomin, R. (2013). Commentary: Missing heritability, polygenic scores, and gene–environment correlation. *Journal of Child Psychology and Psychiatry, 54*(10), 1147–1149.
- Plomin, R., DeFries, J. C., & Loehlin, J. C. (1977). Genotype–environment interaction and correlation in the analysis of human behavior. *Psychological Bulletin, 84*(2), 309–322.
- Psyridou, M., Eklund, K., Poikkeus, A.-M., & Torppa, M. (2018). Reading outcomes of children with delayed early vocabulary: A follow-up from age 2–16. *Research in Developmental Disabilities, 78*, 114–124.
- 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.
- Puolakanaho, A., Ahonen, T., Aro, M., Eklund, K., Leppänen, P. H. T., Poikkeus, A.-M., ... Lyytinen, H. (2007). Very early phonological and language skills: Estimating individual risk of reading disability. *Journal of Child Psychology and Psychiatry, 48*(9), 923–931.
- Raven, J. C., Court, J. H., & Raven, J. (1992). *Standard progressive matrices*. Oxford, UK: Oxford Psychologists Press.
- Rescorla, L. (2009). Age 17 language and reading outcomes in late-talking toddlers: Support for a dimensional perspective on language delay. *Journal of Speech, Language, & Hearing Research, 52*(1), 16–30.
- Reynell, J., & Huntley, M. (1987). *Reynell developmental language scales manual* (2nd ed.). Windsor, UK: NFER Publishing.
- Rutter, M., Moffitt, T. E., & Caspi, A. (2006). Gene–environment interplay and psychopathology: Multiple varieties but real effects. *Journal of Child Psychology and Psychiatry, 47*(3–4), 226–261.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*(1), 54–67.
- Scarborough, H. S. (1990). Very early language deficits in dyslexic children. *Child Development, 61*(6), 1728. <https://doi.org/10.2307/1130834>.
- Scarborough, H. S. (1991). Antecedents to reading disability: Preschool language development and literacy experiences of children from dyslexic families. *Reading and Writing: An Interdisciplinary Journal, 3*, 219–233. <https://doi.org/10.1007/BF00354959>.
- Scarborough, H. S. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. Neuman & D. Dickinson (Eds.), *Handbook for research in early literacy* (pp. 97–110). New York: Guilford.
- Scarborough, H. S., & Dobrich, W. (1994). On the efficacy of reading to preschoolers. *Developmental Review, 14*(3), 245–302.
- 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.
- Sénéchal, M., & LeFevre, J.-A. (2002). Parental involvement in the development of children's reading skills: A five-year longitudinal study. *Child Development, 73*, 445–460.
- 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.
- Silinskas, G., Sénéchal, M., Torppa, M., & Lerkkanen, M.-K. (2020). Home literacy activities and children's reading skills, independent reading, and interest in literacy activities from kindergarten to Grade 2. *Frontiers in Psychology, 11*. <https://doi.org/10.3389/fpsyg.2020.01508>.
- Silinskas, G., Torppa, M., Lerkkanen, M.-K., & Nurmi, J.-E. (2020). The home literacy model in a highly transparent orthography. *School Effectiveness and School Improvement, 31*(1), 80–101.



- Snowling, M. J., Hayiou-Thomas, M. E., Nash, H. M., & Hulme, C. (2020). Dyslexia and developmental language disorder: Comorbid disorders with distinct effects on reading comprehension. *Journal of Child Psychology and Psychiatry*, 61(6), 672–680.
- Snowling, M. J., & Melby-Lervåg, M. (2016). Oral language deficits in familial dyslexia: A meta-analysis and review. *Psychological Bulletin*, 142(5), 498–545.
- Torppa, M., Eklund, K., van Bergen, E., & Lyytinen, H. (2015). Late-emerging and resolving dyslexia: A follow-up study from age 3 to 14. *Journal of Abnormal Child Psychology*, 43(7), 1389–1401.
- Torppa, M., Georgiou, G. K., Lerkkanen, M.-K., Niemi, P., Poikkeus, A.-M., & Nurmi, J.-E. (2016). Examining the simple view of reading in a transparent orthography: A longitudinal study from kindergarten to Grade 3. *Merrill-Palmer Quarterly*, 62, 179–206.
- Torppa, M., Lyytinen, P., Erskine, J., Eklund, K., & Lyytinen, H. (2010). Language development, literacy skills, and predictive connections to reading in Finnish children with and without familial risk for dyslexia. *Journal of Learning Disabilities*, 43(4), 308–321.
- Torppa, M., Niemi, P., Vasalampi, K., Lerkkanen, M.-K., Tolvanen, A., & Poikkeus, A.-M. (2020). Leisure reading (but not any kind) and reading comprehension support each other—A longitudinal study across Grades 1 and 9. *Child Development*, 91(3), 876–900.
- Torppa, M., Poikkeus, A.-M., Laakso, M.-L., Leskinen, E., Tolvanen, A., Leppänen, P. H. T., ... Lyytinen, H. (2007). Modeling the early paths of phonological awareness and factors supporting its development in children with and without familial risk for dyslexia. *Scientific Studies of Reading*, 11, 73–103.
- van Bergen, E., van Zuijen, T., Bishop, D., & de Jong, P. F. (2017). Why are home literacy environment and children's reading skills associated? What parental skills reveal. *Reading Research Quarterly*, 52, 147–160.
- van Bergen, E., de Jong, P. F., Maassen, B., & van der Leij, A. (2014). The effect of parents' literacy skills and children's preliteracy skills on the risk of dyslexia. *Journal of Abnormal Child Psychology*, 42, 1187–1200.
- van Bergen, E., Vasalampi, K., & Torppa, M. (2020). Why are practice and performance related? Development of reading from age 5 to 15. *Reading Research Quarterly*, 56, 415–434.
- van Viersen, S., de Bree, E. H., Zee, M., Maassen, B., van der Leij, A., & de Jong, P. F. (2018). Pathways into literacy: The role of early oral language abilities and family risk for dyslexia. *Psychological Science*, 29, 418–428.
- Wechsler, D. (1991). *Manual for the Wechsler intelligence scale for children-third edition*. San Antonio, TX: Psychological Corporation.
- Wigfield, A., & Guthrie, J. T. (1997). Relations of children's motivation for reading to the amount and breadth of their reading. *Journal of Educational Psychology*, 89, 420–432.