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Reading Development from Kindergarten to Age 18: The Role of Gender and Parental Education

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ABSTRACT

The gender difference in reading achievement in favor of adolescent girls is a robust finding in the literature, but the evidence is mixed when considering younger children. The present study followed the development of reading skills among Finnish children ($N=1867$) from kindergarten age (6 years) to 18 years of age to determine the onset of gender differences and to identify the subskills which present gender differences. Additionally, associations between parents' educational levels and children's reading development from kindergarten to the end of comprehensive school were examined to determine whether the effect of parental education varied by child's gender. The results showed that girls outperformed boys in almost all prereading and reading skills from kindergarten age onwards. The gender difference in reading fluency increased steadily across the school years (Cohen's $d=.26-.59$) and remained evident also among 18-year-olds ($d=.42$). In terms of reading comprehension, the gender difference was small but increased with age ($d=.17-.36$). Parents' education levels were associated with children's reading development and children of higher educated parents manifested the best performance. Interaction effects were found between child's gender and their fathers' education levels: lower education levels were associated with poorer PISA reading performance among boys, but not among girls. The results suggest that gender differences in reading performance have an early onset, they increase throughout the school years, and boys of fathers with low education are particularly at risk of falling behind in their development of reading comprehension skill.

Introduction

A robust international finding in the literature on adolescents' reading achievement is the gender difference favoring girls (Brozo et al., 2014; Organisation for Economic Co-operation and Development [OECD], 2019a). Although the gap has been shown in childhood as well (Mullis et al., 2017), it is unclear when exactly it emerges, and how the developmental pathways for reading subskills (accuracy, fluency, and comprehension) may differ between boys and girls. Previous research has provided information on gender-related differences in young children's prereading skills (e.g., Below et al., 2010; Chatterji, 2006; Manu et al., 2021), and large-scale studies such as the Progress in International Reading Literacy Study (PIRLS) of 10-year-olds and the Programme for International Student Assessment (PISA) of 15-year-olds have offered comparative data on reading performance of boys and girls at certain timepoints. However, follow-up studies are very scarce of the development across the critical time period from kindergarten age to late adolescence. Therefore, both the age at which gender differences in reading performance first occur and how the gender gap develops across the years of schooling

are still unclear. Moreover, most of the previous studies on gender differences in reading have been cross-sectional. Longitudinal research involving large samples is needed to answer these developmentally relevant questions.

The present longitudinal study followed Finnish children across 13 years—that is, from the kindergarten age of 6 years to the age of 18 years—to examine development of reading accuracy, fluency, and comprehension including the PISA reading test conducted at age 15. This long-term follow-up provided a unique possibility to analyze the development of reading performance and the potential varying paths of boys and girls. Finnish adolescents have shown good reading performance overall, but the gender difference among Finnish 15-year-olds is one of the largest among countries that have participated in PISA (OECD, 2016, 2019a). For instance, the findings of the PISA 2018 reading assessment showed that 20% of Finnish boys, but only 7% of girls, did not have reading levels sufficient for their full participation in education and society (Ahonen, 2021; OECD, 2019b). Since parental education is known to have a strong association with children's reading skills (e.g., Guo et al., 2018; OECD, 2019a; Scheiber et al., 2015), we examined whether it plays a role in the different reading skills of boys and girls.

The present study contributes a novel insight into the gender gap in reading by examining the differences in reading comprehension, reading fluency, and in several linguistic and cognitive skills that are known to predict reading development in a large longitudinal sample of Finnish children followed from kindergarten to age 18. Previous research has mainly focused on the importance of mothers' education, but the role of fathers' education should be equally explored. Therefore, a separate examination of mothers' and fathers' education helps to identify whether they affect differently their children's reading skills at different ages, and whether these associations differ by the child's gender. The aims of the study were to determine the onset of gender differences in reading skills, to identify subskills that show gender differences, and to examine associations between parental education and children's reading skills.

Gender Differences in Reading Skills at Different Ages

The age of children in the study sample has been shown to play a role in the extent to which gender differences have been observed in reading performance. A robust finding across studies in the literature (Brozo et al., 2014; Lietz, 2006; Lynn & Mikk, 2009; Manu et al., 2021; OECD, 2016, 2019a; Reilly et al., 2019; Torppa et al., 2018; Vettenranta et al., 2016) is that reading performance of adolescent girls is better than that of adolescent boys. Lietz (2006) conducted a meta-analysis of large-scale

studies on the reading achievement levels of students aged 12–18 years and showed that, on average, girls outperformed boys (Cohen's $d = .19$). Cross-sectional research has also shown the widening of the gender gap with age. In a recent meta-analysis, data from 14 National Assessment of Educational Progress (NAEP) US surveys between the years 1988 and 2015 were analyzed. The results for Grades 4 to 12 showed a steady increase in the gender gap with age, and the effect sizes were as follows: 0.19 in Grade 4, 0.30 in Grade 8, and 0.32 in Grade 12 (Reilly et al., 2019). In addition, the comparison of the effect sizes of the PIRLS and PISA by Baye and Monseur (2016) showed that the gender gap was larger among 15-year-olds than 10-year-olds ($d = .23-.40$). A meta-analysis of the PIRLS and PISA data revealed similar findings ($d = .23-.42$) (Lynn & Mikk, 2009).

Interestingly, findings related to gender differences in primary school years' reading performance have been mixed. At school entry, girls have been found to outperform boys in basic literacy skills, such as letter recognition, letter-sound knowledge, phonemic awareness, word reading accuracy, and spelling (McTigue et al., 2021; Sigmundsson et al., 2017; Soderman et al., 1999; Vasilyeva et al., 2021), but the effect sizes have typically been small. With respect to children who have already acquired basic reading skills, studies on gender differences have typically assessed reading via comprehension measures. For example, in the PIRLS, Grade 4 girls outperformed boys in literary reading in 48 of the 50 participating countries and in informational reading in 38 countries (Mullis et al., 2017). In line with this strong trend, Grade 4 Finnish girls scored better than boys in both PIRLS reading task types (Leino et al., 2017). Better performance of Finnish girls was also found in reading comprehension in Grade 6 (Lehto et al., 2001). The literature is not, however, uniform regarding the effect of gender as some studies have reported no gender differences in reading comprehension (McGeown et al., 2012) or reading fluency (McIntosh et al., 2013) among primary school children. For instance, Below et al. (2010) used a cross-sectional design to examine reading fluency among children from kindergarten to Grade 5 and found a gender difference favoring girls only in Grade 4.

Gender differences favoring girls have been documented in several prereading skills, including vocabulary production and listening comprehension (Berglund et al., 2005), identification of the initial sound of a spoken word, letter naming fluency, phoneme segmentation fluency, nonsense word fluency (Below et al., 2010), phonological awareness (Lundberg et al., 2010), receptive language (Locke et al., 2002), and early word reading accuracy (Silinskas et al., 2010). However, a caveat is that the effect sizes in these studies were typically small, and some studies failed to find gender differences prior to school entry (e.g., Harper & Pelletier, 2008).

Thus far, few longitudinal studies have shed light on the development of the gender gap in reading. Of note is the study of Robinson and Lubienski (2011) who found a significant gender gap in a US follow-up sample, with girls performing better than boys in language and literacy assessments (print familiarity, letter recognition, beginning and ending sound recognition, rhyming sounds, word recognition, receptive vocabulary, listening comprehension, words in context, literal inference, extrapolation, and evaluation) from the beginning of kindergarten until Grade 8 except for Grade 5. Further, Wei et al. (2015) used a different subsample from the same dataset and found a small but significant gender difference in the growth patterns indicating faster reading development among girls than boys. However, in another US-based study with a different dataset, no gender differences were found in children's letter naming fluency and oral reading fluency across the period from kindergarten to Grade 5 (McIntosh et al., 2013). Thus, the findings on the onset and development of the gender gap are, so far, inconclusive. In addition, as previous longitudinal studies have been conducted only in the English language context, there is a lack of information on the emergence and development of gender differences in reading skills for more transparent languages (i.e., close grapheme-phoneme correspondence) such as Finnish.

Parental Education and Children's Reading Skills

Previous studies have shown that higher parental education, particularly that of mothers, is associated with better reading achievements among children (e.g., Guo et al., 2018; İnce & Gözütok, 2018; Khanolainen et al., 2020; Leppänen et al., 2008; OECD, 2019a; Pan et al., 2016; Scheiber et al., 2015). Specifically, a mother's higher education has been shown to predict her child's better phonological awareness, letter knowledge, and word reading prior to school entry (Leppänen et al., 2004; Silinskas et al., 2010; West et al., 2000). Silinskas et al. (2010) found that Finnish children of highly educated mothers were more likely than children of less educated mothers to learn to read during their kindergarten year, even though it does not yet include formal reading instruction.

However, studies on the effects of fathers' educational level are fewer in number than those of mothers, although both parent's roles appear to be relevant regarding the development of children's reading performance. Using the same sample as the present study, Khanolainen et al. (2020) found that Finnish fathers' educational levels predicted children's reading comprehension in Grades 1 and 2. Turkish fathers' educational levels have been shown to predict adolescents' PISA reading scores (İnce & Gözütok, 2018). Moreover, Hakkarainen et al. (2015) showed that low education levels among fathers were associated

with word reading difficulties among both Finnish boys and girls in Grade 9.

The mechanism behind the predictive effect of parental education on children's reading skills is not clear. In fact, it can hardly be clarified by a single study. One possible explanation is that parents with higher education levels provide a richer home learning environment for their children (e.g., Chiu & McBride-Chang, 2006; Khanolainen et al., 2020; Salminen et al., 2021; Sirin, 2005), which supports language and literacy development (e.g., Sénéchal, 2006). On the other hand, as reading difficulties run in families mainly through the genetic route (e.g., Lohvansuu et al., 2021; Snowling & Melby-Lervåg, 2016), the association between parental education and child's skills may be linked to deficiencies in parents' reading skills impacting both parents' educational levels and children's higher risk for reading difficulties. Finally, the educational system may fail to respond adequately to both the assets and needs that students from different backgrounds bring to school, thus increasing the odds for a performance gap during the school years (for a discussion, see e.g., Williams et al., 2019).

Present Study

The aim of the present study was to provide novel knowledge on the development of gender gap in reading in the transparent language context of Finnish and the educational context of Finland. The reading development patterns of boys and girls from kindergarten (6 years of age) to the end of upper secondary education (18 years of age) were compared in terms of accuracy, fluency, and comprehension. Based on the measures collected in this longitudinal study, we examined when and in which reading subskills gender differences begin to emerge. We further examined whether mothers' and fathers' educational levels were associated with the development of reading performance of boys and girls. The research questions were as follows:

1. Are there any gender differences in the reading skills (reading accuracy, reading fluency, and reading comprehension) of children from kindergarten (age 6) to the end of upper secondary education (age 18)?
2. Do mothers' and fathers' educational levels predict boys' and girls' reading skills? Do these associations vary as a function of the child's gender?

Based on the literature, we expected to see significant gender differences in kindergarteners' prereading skills with girls manifesting higher skill levels than boys (Below et al., 2010; Berglund et al., 2005; Chatterji, 2006; Locke et al., 2002; Lundberg et al., 2010; Silinskas et al., 2010). In addition, we expected to find a widening of the gender gap over time (Baye & Monseur, 2016; Lynn & Mikk, 2009;

Reilly et al., 2019). However, considering past evidence, it was unclear which reading subskills would show a more pronounced effect of gender and at which time point the gender gap would emerge in different reading skill domains. In addition, we expected the educational levels of both mothers and fathers to be positively associated with children's reading development (Guo et al., 2018; İnce & Gözütok, 2018; Khanolainen et al., 2020; Leppänen et al., 2008; OECD, 2019a; Pan et al., 2016; Scheiber et al., 2015).

The present study was conducted in the Finnish educational context. Finnish children attend kindergarten (in Finland referred to as a pre-primary education year) at the age of six. Kindergarten education was not compulsory at the time of data collection (i.e., prior to 2015); nevertheless, almost all children attended kindergarten already at that time (Kartovaara & Sauli, 2007). In kindergarten, children are not systematically taught to read but are provided an environment that supports and promotes their language development (in particular phonological awareness, letter knowledge and vocabulary growth via shared reading, listening, speaking activities, and discussions) and encourages to play with letters and words. During the year when they turn 7 years of age, children enter the nine-year comprehensive school, which includes 6 years of primary grades and 3 years of lower secondary grades. Formal reading instruction begins in Grade 1.

The Finnish language is orthographically close to being fully transparent. Its grapheme-to-phoneme correspondence is consistent to the degree that a given vowel phoneme and, with a few exceptions, a given consonant phoneme is always written with the same grapheme. Orthographically different words are never pronounced similarly (c.f., *brake/break* in English). Due to this regularity, the process of learning to read Finnish is faster than that of learning to read in the context of orthographically deeper or less transparent languages (Seymour et al., 2003). Thus, reading development in Grade 1 tends to be rapid, particularly among children who are nonreaders at school entry (Leppänen et al., 2004): after only a few months of reading instruction, or by the end of Grade 1, 95% of Finnish first graders typically reach the level of accurate decoding (Holopainen et al., 2001; Lerkkanen et al., 2004). Due to this fast pace of early reading development in transparent orthographies, individual differences in reading performance manifest themselves in reading speed rather than in accuracy after the phase when basic decoding skills have been acquired (e.g., Bekebrede et al., 2009; Eklund et al., 2015).

Material and Methods

Participants and Procedure

The data were obtained from a longitudinal study where the same participants were assessed from

kindergarten to Grade 9, The First Steps Study (see Lerkkanen et al., 2006–2016), and its extension to upper secondary education, The School Path: From First Steps to Secondary and Higher Education study (see Vasalampi & Aunola, 2016–2023). The data included a community sample of children born in the year 2000, whose academic development was followed in school and family contexts from age 6 to age 18. The children were from four municipalities: two in Central Finland, one in Western Finland, and one in Eastern Finland. A total of 1867 children participated in prereading skill assessments at the beginning of kindergarten. At the time of the first kindergarten assessment (September 2006), the mean age of the children was 6.2 years ($SD=0.29$). The sample was followed throughout Grades 1, 2, 3, 4, 6 (primary school grades), 7, and 9 (lower secondary school grades). A small sample of 18-year-olds ($N=117$) was also assessed at the time they were attending upper secondary education. The children who participated in the kindergarten assessments as well as all their classmates from each grade were invited to participate. Therefore, the sample size varied somewhat across time (see Appendix A). The First Steps Study and the School Path study were reviewed by the University of Jyväskylä Ethical Committee in 2006 and 2018. Informed written consent was obtained from the participants' parents or guardians for data collection during kindergarten and comprehensive schooling and by the participants themselves after comprehensive school (age 18). Trained research assistants administered the reading skill tests in the classrooms during normal school lessons (during group learning periods in kindergarten). The parents filled in a questionnaire concerning the participants' backgrounds and home environments.

In fall of the kindergarten year, the assessments included initial phoneme identification, letter knowledge, and word reading accuracy. In spring, rapid naming, vocabulary, and listening comprehension were assessed in addition to the prior measures. The assessments in fall of Grade 1 included initial phoneme identification, phoneme blending, letter writing, and word reading accuracy. From spring of Grade 1 onwards, throughout Grades 2, 3, 4, 6, 7, and 9, three reading fluency tests and one reading comprehension test were conducted. In Grade 9, the PISA reading test was also administered. One reading fluency test was administered to assess the subsample of 18-year-old participants. The summary of the measures across time is given in Table 1.

Measures

Letter Knowledge

In the kindergarten year, children were asked to name all 29 Finnish letters, which were displayed in three

TABLE 1
Summary of the Measures from Kindergarten to Age 18

Measure	Timepoint
Prereading skills	
Initial phoneme identification	Kindergarten fall, Kindergarten spring, Grade 1 fall
Letter knowledge	Kindergarten fall, Kindergarten spring, Grade 1 fall
Word reading accuracy	Kindergarten fall, Kindergarten spring, Grade 1 fall
Rapid naming	Kindergarten spring
Vocabulary	Kindergarten spring
Listening comprehension	Kindergarten spring
Phoneme blending	Grade 1 fall
Reading fluency	
Word reading fluency	Grades 1, 2, 3, 4, 6, 7, 9
Word-chain	Grades 1, 2, 3, 4, 6, 7, 9
Sentence reading	Grades 1, 2, 3, 4, 6, 7, 9, and age 18
Reading comprehension	
Reading comprehension test	Grades 1, 2, 3, 4, 6, 7, 9
PISA reading	Grade 9

rows on a sheet (Lerkkanen et al., 2006). Children had to name the letters one row at a time while the other rows were covered. They were scored according to the number of correctly named letters (maximum value of 29). Cronbach's alpha reliability coefficient of the kindergarten assessment was 0.96 in fall and 0.94 in spring. In fall of Grade 1, a letter writing test was conducted (Lerkkanen et al., 2006); the children were asked to write out all 29 letters, one at a time. The score represented the number of correctly written letters (max = 29). Cronbach's alpha coefficient was 0.78.

Word Reading Accuracy

Word reading accuracy was assessed using an individually administered wordlist reading test (a subtest of ARMI—A Tool for Assessing Reading and Writing Skills in Grade 1; Lerkkanen et al., 2006). For the kindergarten assessments, the list included 6 words in fall—4 two-syllabic, 1 three-syllabic, and 1 five-syllabic—and 10 words in spring—7 two-syllabic, 2 three-syllabic, and 1 five-syllabic. The score for each test represented the number of correctly read words (max = 6 in fall and 10 in spring). Cronbach's alpha coefficient was 0.84 in fall and 0.85 in spring.

Rapid Automatized Naming

The rapid automatized naming (RAN) assessment was performed using the standard procedure (Denckla & Rudel, 1976) in kindergarten spring. Children were asked to name each object in a semi-randomly arranged series of five pictures of objects as fast as possible. The children's familiarity with the names of the objects was ensured via practice trials. The score represented the completion time of the total matrix (5 rows of 10) in seconds.

Vocabulary

Receptive language was assessed using a 30-item shortened version of the Peabody Picture Vocabulary Test-Revised (PPVT-R, Form L; Dunn & Dunn, 1981) in kindergarten spring. Children were asked to point out, from four alternatives, the picture that correctly represented the word spoken by the tester. The items for the shortened version were selected based on data from the full-scale administration of the PPVT-R in the Jyväskylä Longitudinal Study of Dyslexia (Lyytinen et al., 2004). The score represented the number of correct responses (max = 30). Cronbach's alpha reliability coefficient was 0.61.

Listening Comprehension

A group-administered test (Vauras et al., 1995) was used to assess listening comprehension in the classroom setting in kindergarten spring. The children listened to a story consisting of 130 words twice, after which they each answered six multiple-choice questions accompanied by pictures in a test booklet (four questions consisted of three choices, and two questions consisted of four choices). The children were asked to select the picture that was the best fit for the story. Two points were allocated for each correct answer (max = 12). Cronbach's alpha reliability coefficient was 0.30.

Initial Phoneme Identification

The initial phoneme identification test (a sub-test of the ARMI; Lerkkanen et al., 2006) involved 10 items. The tester first named the four pictures of objects given in the row of each item and asked, "At the beginning of which word do you hear the sound /?/" The children had to point out the correct picture accordingly. All sounds were single phonemes. The score represented the number of correct responses (max = 10). Cronbach's alpha reliability coefficients were .078, 0.76, and 0.71, respectively, for the kindergarten fall, kindergarten spring, and Grade 1 fall assessments.

Phoneme Blending

The phoneme blending test (Poskiparta et al., 1994) administered in fall of Grade 1 consisted of 10 rows, each containing four pictures of objects. For each item, the tester sounded out the phonemes of a word corresponding to

a picture in the row. Children were asked to recognize the resulting word and choose the correct picture. The words were one-syllabic (one word), two-syllabic (seven words), and three-syllabic (two words). The score represented the number of correct responses (max = 10). Cronbach's alpha reliability coefficient was 0.67.

Reading Fluency

Three group-administered reading fluency tests were used: a word reading fluency test, a word-chain test, and a sentence reading test.

The word reading fluency test, a subtest of the nationally normed reading test battery (ALLU—Reading Test for Primary School; Lindeman, 2000), was administered to children in Grades 1–6. Each of the 80 items consisted of four phonologically similar words and a picture. The children read the four words silently and connected the picture to the semantically corresponding word by drawing a line between them. The words were familiar to the children. The score represented the number of correct answers within the time limit of 2 min (max = 80). To complete the test, the children needed to be fluent in decoding the words and accurate in choosing the correct word from the alternatives. In fall of Grade 1, the score was computed by subtracting the incorrect responses from correct responses. A similarly structured word reading fluency task with phonologically more difficult words was used for children in Grades 7 and 9 (YKÄ—Reading test for lower secondary school; Lerkkanen et al., 2018).

The word-chain test (Nevala & Lyytinen, 2000) was used to assess reading fluency among children in Grades 1–6. The test included 10 rows of word-chains, with four to six words written together without spaces. The children had to read the words forming the chains silently and mark the word boundaries by drawing lines between words within a time limit (1 min 25s for Grades 1 and 2; 1 min 20s for Grade 3; 1 min 5s for Grade 4; 1 min for Grade 6). A similarly structured word-chain test comprising 10 rows was used for participants in Grade 7, and a test with 25 rows and four words in each row was used in Grade 9 (YKÄ-test; Lerkkanen et al., 2018). The time limit was 1 min for participants in Grade 7 and 1 min 30s for those in Grade 9. The score represented the number of correct responses in each test (max = 40 in Grades 1–7 and 75 in Grade 9).

The Test of Silent Reading Efficiency and Comprehension (TOSREC; Wagner et al., 2010; Finnish version by Lerkkanen et al., 2008) was used to assess the silent reading efficiency of children in Grades 1–4. Each child was given 3 min to read 60 sentences silently and mark as many sentences as possible as true or false. In Grade 6, a similar task (the Salzburg Sentence Reading Test; Mayringer & Wimmer, 2003; Finnish version by Huemer) comprising 69 sentences

was used, and each child was given 2 min to complete the task. A similar task (YKÄ-test; Lerkkanen et al., 2018) consisting of 70 sentences and a time limit of 2 min was administered to participants in Grades 7 and 9 as well as those aged 18 years. For each task, the score represented the number of correct answers (max = 60 for Grades 1–4, 69 for Grade 6, and 70 for Grades 7 and 9 and age 18).

The raw scores of the reading fluency tests for each grade were converted into standardized scores (z-scores) to compare the scores of the different scales. Next, the overall reading fluency score was calculated by averaging the standardized scores for each reading fluency test. Cronbach's alpha coefficients of the fluency composites were 0.83 for Grade 1, 0.80 for Grade 2, 0.82 for Grade 3, 0.82 for Grade 4, 0.79 for Grade 6, 0.84 for Grade 7, and 0.84 for Grade 9. A sample of 18-year-old participants (N = 117) completed the sentence reading task administered in Grade 9 once again, and the raw scores were converted to standardized scores.

Reading Comprehension

A group-administered subtest of the nationally normed reading test battery (ALLU; Lindeman, 2000) was used to assess the reading comprehension of children in Grades 1–6. In Grades 7 and 9, a similar standardized reading comprehension test (YKÄ; Lerkkanen et al., 2018) was used. Factual texts of 124 words in Grade 1, 114 words in Grade 2, 139 words in Grade 3, 263 words in Grade 4, 567 words in Grade 6, 460 words in Grade 7, and 504 words in Grade 9 were used. The children were given 45 min to read the text silently and then answer 12 questions. For Grades 1–3, 7, and 9, the tests consisted of 11 multiple-choice questions and one question that required arranging 5–8 statements into the correct sequence. For Grades 4 and 6, there were 12 multiple-choice questions. Most questions required retrieving information, and some of them also involved making inferences and interpreting and evaluating information. Each score represented the number of correct answers (max = 12). Cronbach's alpha reliability coefficients of the assessments were 0.71 for Grade 1, 0.79 for Grade 2, 0.63 for Grade 3, 0.67 for Grade 4, 0.65 for Grade 6, 0.67 for Grade 7, and 0.60 for Grade 9.

PISA Reading

The reading comprehension test for 15-year-olds (Grade 9) included the so-called link items from the PISA reading test, which are used in each cycle of PISA assessments to ensure the comparability of the measurements. A booklet was given to each student participating in the study, and it consisted of eight texts with

graphs, tables, and figures. The total length of the booklet was 30 A4 pages, and the estimated length of the text alone was approximately 10 pages. The participants had to answer 15 multiple-choice questions and 16 questions that required written responses. Among all these questions, 12 required accessing and retrieving information, 12 involved integrating and interpreting information, and 7 required reflecting on and evaluating information. The time limit for completing the tasks was 60 min. The total sum score was calculated to represent all the PISA reading subscores. Cronbach's alpha reliability coefficient was 0.94.

Parental Education

The children's parents (1563 mothers; 1117 fathers) indicated their educational levels on a seven-point scale from one (no vocational education) to seven (licentiate or doctoral degree). The scale was recoded into four categories to form larger group sizes for a two-way analysis of variance (ANOVA). The recoded scale was as follows: 1 = comprehensive school only or comprehensive school and some vocational courses (8.2% of mothers and 8.1% of fathers); 2 = vocational school or high school degree (30.6% and 33.3%); 3 = vocational college degree, polytechnic degree, or lower university degree (bachelor's) (32.9% and 33.6%); 4 = higher university degree (i.e., master's, licentiate, or doctoral; 28.3% and 25.1%). The sample was homogeneous in terms of ethnicity, language, and cultural background, which is typical of nonmetropolitan school populations in Finland. The distribution of parents' educational levels was close to the national distribution of education in Finland (Statistics Finland, 2007). There were no differences in the parents' educational levels based on the children's gender. The descriptive statistics of parental education are displayed in Appendix A.

Statistical Analysis

The data were analyzed with IBM SPSS Statistics 26 (IBM, Armonk, NY, USA). First, the distributions of the measures were examined. The distributions of many kindergarten and Grade 1 fall measures were skewed, and there were some outliers. Therefore, group comparisons were conducted using the nonparametric Mann–Whitney *U* test. Most measures used from Grade 1 spring to Grade 9 were close to being normally distributed; only the word-chain test used in Grade 1 and the reading comprehension test used in Grade 3 were slightly skewed to the left. There was one extreme outlier (3 SDs from the mean) in the Grade 1 word-chain task, as one child obtained the maximum score of 32 points. The outlier was moved to the right tail of the distribution by recoding the score to 31. Gender

comparisons for Grade 1 spring onwards were conducted using the independent samples *t*-test. It should be noted that from Grade 7 onwards, children could mark their gender as “other” (previously either “boy” or “girl”); 11 participants whose gender was “other” were excluded from the gender comparison analyses.

Two-way ANOVAs were conducted to examine the effects of parental education, gender, and the interaction between gender and parental education on children's prereading and reading skills. Separate analyses were conducted for each kindergarten and Grade 1 fall skill, each grade's reading fluency and reading comprehension skills, and the Grade 9 PISA reading subscores. Levene's test of equality of variances showed that the assumption of the homogeneity of variances was violated in some gender comparisons. Therefore, either Tukey's or Dunnett's T3 post hoc test was used in further analyses for determining the interaction effects (separate one-way ANOVAs for boys and girls) depending on the assumption of homogeneity of variances.

Results

Gender Comparisons of Kindergarten and Grade 1 Fall Skills

The descriptive statistics of all measures are given in Appendix A. Gender comparisons based on the kindergarten and Grade 1 fall measures are given in Table 2. In the kindergarten fall assessment, girls outperformed boys in initial phoneme identification, letter knowledge, and word reading accuracy. The effect sizes were small (Cohen's $d = .20-.25$). In the kindergarten spring assessment, girls outperformed boys in the same measures, and the effect sizes were somewhat bigger but still small overall ($d = .30-.34$). In addition, the gender gap was significantly in favor of girls in listening comprehension and RAN, but the effect sizes were negligible. No gender difference was seen in the children's vocabulary. In the Grade 1 fall assessment, girls outperformed boys in initial phoneme identification, phoneme blending, word reading accuracy, and letter writing. Similar to the kindergarten results, the effect sizes were small ($d = .22-.40$). Overall, the gender differences were small across the kindergarten and Grade 1 fall period, but there was an increasing trend.

Gender Comparisons of Reading Fluency and Reading Comprehension in Grades 1–9 and at Age 18

Findings on the gender comparisons of reading fluency, reading comprehension, and PISA reading scores across time are reported in Table 3. The gender comparison results and the raw scores of each reading fluency test are reported

TABLE 2
Gender Comparisons of Kindergarten and Grade 1 Fall Skills

	Girls			Boys			U	d ^a
	n	M	SD	n	M	SD		
Kindergarten fall								
Initial phoneme identification	881	7.71	2.39	978	7.22	2.49	378,613.00***	.20
Letter knowledge	881	18.09	8.62	978	15.87	9.24	372,271.00***	.25
Word reading accuracy	881	1.22	2.14	978	0.79	1.82	381,414.00***	.22
Kindergarten spring								
Initial phoneme identification	867	9.23	1.43	961	8.66	1.91	348,090.50***	.34
Letter knowledge	866	24.23	5.50	962	22.25	7.36	362,355.00***	.30
Word reading accuracy	865	4.69	4.30	950	3.39	4.17	336,814.50***	.31
Rapid naming	867	69.38	18.38	960	71.17	17.20	453,764.00***	.10
Vocabulary	868	19.78	3.22	963	19.84	3.51	425,783.00	.02
Listening comprehension	866	7.86	2.35	958	7.58	2.34	385,393.00**	.12
Grade 1 fall								
Initial phoneme identification	959	9.53	1.13	1054	9.24	1.44	452,471.50***	.22
Phoneme blending	959	8.01	1.52	1054	7.50	1.75	411,426.00***	.31
Letter writing	959	24.69	4.70	1053	22.48	6.27	398,905.50***	.40
Word reading accuracy	959	8.08	7.54	1054	5.64	8.30	411,836.50***	.31

^aEffect sizes were estimated with Cohen's *d* computed using pooled standard deviation.

p* ≤ .01, *p* ≤ .001.

in Appendix B. Figures 1–3 show the *z*-scores (Mean=0, SD=1) by gender for the reading fluency composite, reading comprehension across grades, and PISA reading subscores, respectively. In terms of reading fluency, the results showed a trend of increasing superiority of girls' reading performance over time. The effect size increased steadily and was the largest in Grade 9 (*d* = .59). Furthermore, the gender difference was significant in the subsample of 18-year-olds (*d* = .42).

In terms of reading comprehension, the gender differences were significantly in favor of girls in each grade, but the effect sizes were small or even negligible (*d* = .17–.36). Finally, the gender differences were significantly in favor of girls when considering the PISA reading subscores, but the effect sizes were small or of medium size (*d* = .21–.47). The largest gender differences were found in the PISA subscores for information evaluation and open-ended questions.

The Effects of Parental Education on Children's Kindergarten and Grade 1 Fall Skills

The associations between parental education and children's skills were examined to determine whether the

associations were similar for boys and girls. Tables 3–8 show the two-way ANOVA results. The means and standard deviations for boys and girls based on their mother's and father's educational levels are given in Appendices C and D, respectively.

The findings showed no significant child's gender × mother's education interaction effects on children's kindergarten and Grade 1 skills (Table 4). The main effects of child's gender and mother's education on child's skills (initial phoneme identification, phoneme blending, letter knowledge, letter writing, word reading accuracy, rapid naming, vocabulary, and listening comprehension) were significant for each skill at all three measurement points suggesting that mother's higher education was associated with child's better skills; the exception was vocabulary in the kindergarten spring assessment, for which child's gender was not significant.

There was a significant child's gender × father's education interaction effect only on word reading accuracy in kindergarten fall (Table 5). This interaction effect is depicted in Figure 4, suggesting that father's education has a larger effect on the early reading skill of girls than that of boys. To inspect the interaction effect further, the one-way ANOVAs were conducted separately for boys and girls, and children's

TABLE 3
Gender Comparisons of Reading Fluency and Reading Comprehension in Grades 1–9 and at Age 18

	Girls			Boys			<i>t</i>	Levene	<i>d</i> ^a
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>			
Reading fluency									
Grade 1	973	0.11	0.85	1061	−0.11	0.85	5.77***	0.00	.26
Grade 2	944	0.12	0.83	1040	−0.11	0.84	5.95***	0.01	.28
Grade 3	941	0.16	0.86	1039	−0.15	0.82	8.26***	3.52	.37
Grade 4	919	0.16	0.84	1023	−0.14	0.84	8.02***	0.08	.36
Grade 6	855	0.21	0.81	956	−0.19	0.82	10.38***	0.04	.49
Grade 7	833	0.20	0.84	917	−0.19	0.85	9.50***	0.36	.46
Grade 9	791	0.26	0.80	887	−0.23	0.86	12.03***	2.06	.59
Age 18	51	0.78	0.93	63	0.38	0.98	2.25*	0.20	.42
Reading comprehension									
Grade 1	972	5.77	3.07	1054	5.22	3.26	3.97***	9.82**	.17
Grade 2	934	8.89	2.53	1031	8.16	2.83	6.08***	14.16***	.27
Grade 3	940	9.42	1.85	1040	8.77	2.38	6.80***	36.40***	.30
Grade 4	919	8.52	2.37	1022	7.71	2.58	7.21***	6.72**	.33
Grade 6	855	7.39	2.40	957	6.92	2.65	4.00***	8.73**	.19
Grade 7	836	6.94	2.46	913	6.25	2.56	5.78***	2.45	.27
Grade 9	799	7.46	2.34	892	6.60	2.43	7.34***	0.65	.36
PISA reading									
Total score	731	21.51	5.66	774	19.08	6.42	7.80***	14.17***	.40
Multiple-choice questions	731	7.41	2.13	774	6.96	2.17	4.05***	0.59	.21
Open-ended questions	731	12.29	3.93	774	10.48	4.52	8.31***	22.19***	.43
Information retrieval	731	5.14	1.32	774	4.70	1.52	6.00***	19.97***	.31
Interpretation	731	8.63	2.82	774	7.93	3.00	4.68***	2.53	.24
Evaluation	731	5.93	2.29	774	4.81	2.52	9.00***	16.40***	.47

^aEffect sizes were estimated with Cohen's *d* computed using pooled standard deviation.

p* ≤ .05, *p* ≤ .01, ****p* ≤ .001.

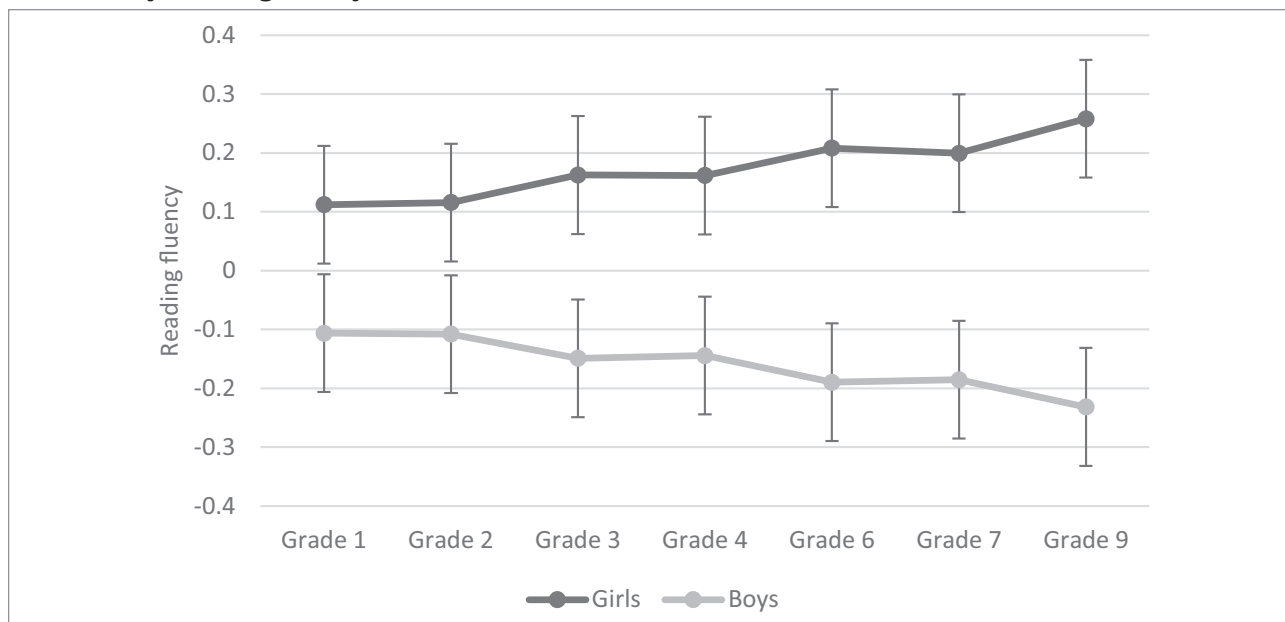
kindergarten word reading accuracy scores were compared by fathers' education levels. The analyses suggested that girls whose fathers had attained the highest educational level were better readers than the other girls in kindergarten fall ($F(3,500) = 12.851$, $p < .001$, Dunnett's $T3 < 0.001$). With respect to boys, there was also a significant difference in word reading accuracy considering the fathers' highest and the second-lowest educational levels ($F(3,599) = 4.300$, $p = .005$, Dunnett's $T3 < 0.01$). In addition to the above interaction effect, the main effects of child's gender and father's

education on each skill were significant at each measurement point except for vocabulary and listening comprehension in kindergarten spring, for which child's gender was not significant.

The Effects of Parental Education on Children's Reading Fluency in Grades 1–9

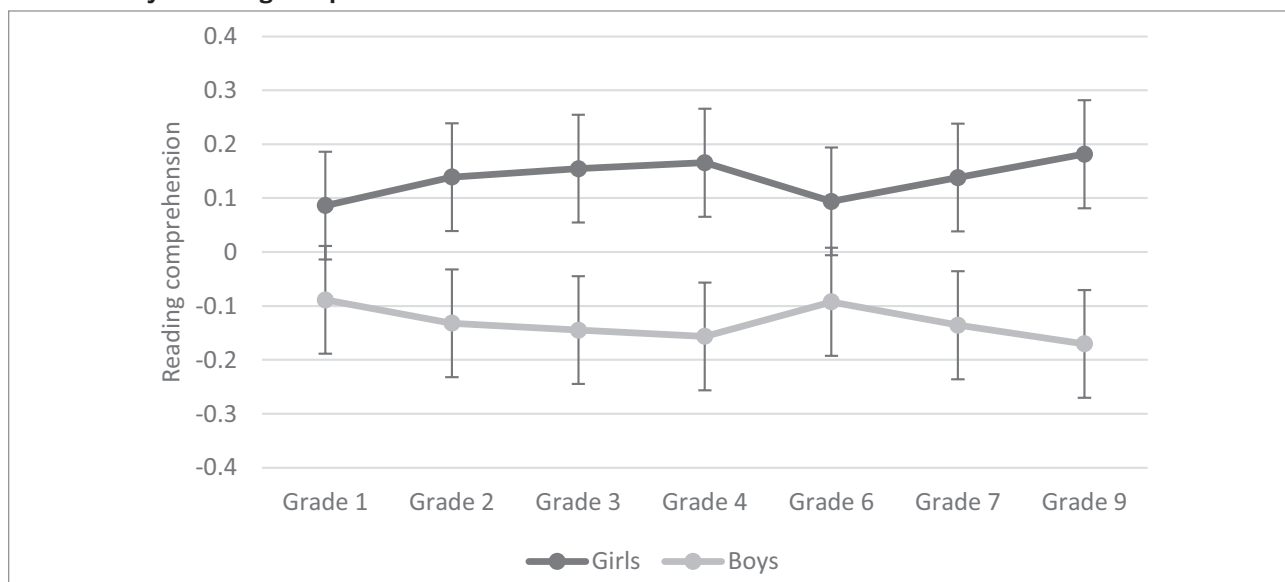
There was a significant child's gender × mother's education interaction effect on reading fluency only in Grade 2

FIGURE 1
Girls' and Boys' Reading Fluency in Grades 1–9



Note. Scores are standardized. Error bars on each estimated gap are 95% confidence intervals.

FIGURE 2
Girls' and Boys' Reading Comprehension in Grades 1–9

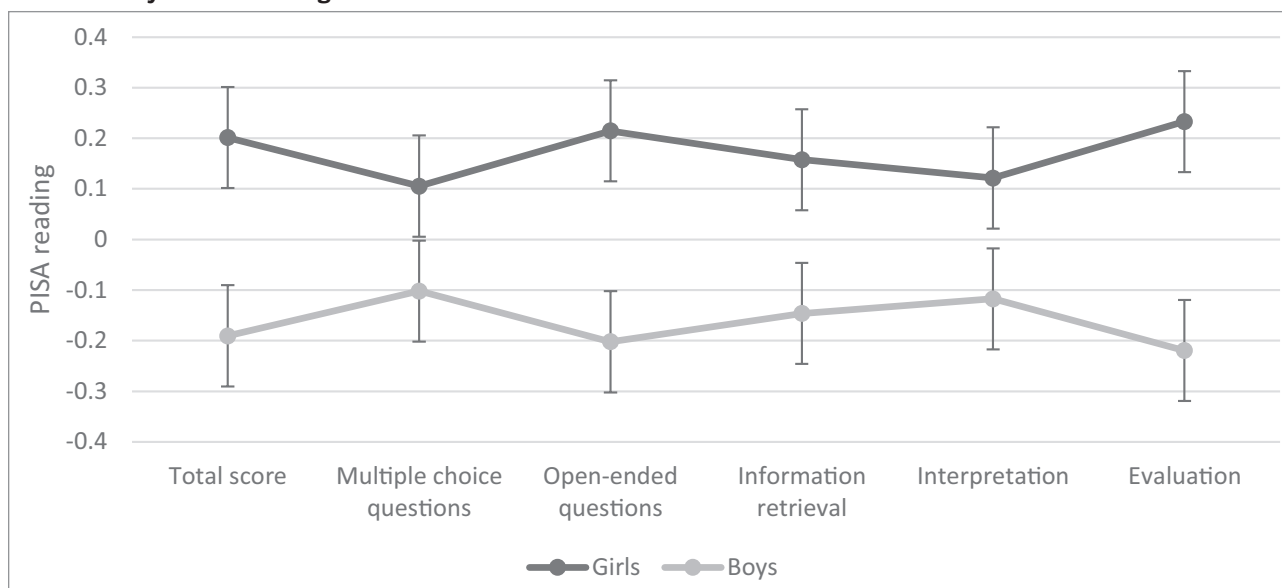


Note. Scores are standardized. Error bars on each estimated gap are 95% confidence intervals.

(Table 6). The interaction effect is illustrated in Figure 5. Separate ANOVAs for boys and girls suggested that the highest educational level among mothers differed from the other educational levels in terms of the reading fluency of both boys ($F(3,737) = 7.308, p < .001$, all Tukey $p < .05$), and girls ($F(3,661) = 12.693, p < .001$, all Tukey $p < .05$), but the second- and third-highest educational levels were in

the different order for boys and girls. Additionally, the main effects of child's gender and mother's education on children's reading fluency were significant for each grade. There were no significant child's gender \times father's education interaction effects on reading fluency (Table 7). The main effects of child's gender and father's education were significant for each grade.

FIGURE 3
Girls' and Boys' PISA Reading Performance



Note. Scores are standardized. Error bars on each estimated gap are 95% confidence intervals.

The Effects of Parental Education on Children's Reading Comprehension in Grades 1–9

There were no significant child's gender \times mother's education interaction effects on reading comprehension or PISA reading scores (Table 8). The main effects of child's gender and mother's education were significant for each grade and all PISA reading subscores.

There were no significant child's gender \times father's education interaction effects on reading comprehension (Table 9). The main effects of child's gender and father's education were significant for each grade. However, there were significant child's gender \times father's education interaction effects on all PISA reading subscores. The interaction effects for each subscore (total score, multiple-choice questions, open-ended questions, information retrieval, interpretation, and evaluation) are illustrated in Figures 6–11. Interestingly, the ANOVA analyses comparing the PISA reading subscores of the boys and girls did not show any differences within the girls' group. Within the boys' group, however, the analyses suggested significant differences between those boys whose fathers had attained the highest educational level and those boys whose fathers had attained the lowest or second-lowest educational level in terms of the total score ($F(3,352)=10.011$, $p<.001$, both Tukey $p<.001$), multiple-choice questions ($F(3,352)=5.272$, $p=.001$, both Tukey $p\leq.01$), open-ended questions ($F(3,352)=9.348$, $p<.001$, both Dunnett's T3 $p<.01$), information retrieval questions ($F(3,352)=6.317$, $p=.001$, both Dunnett's T3 $p<.05$), interpretation questions ($F(3,352)=6.268$, $p<.001$, both Tukey $p<.05$), and

evaluation questions ($F(3,352)=8.390$, $p<.001$, both Dunnett's T3 $p<.05$).

Discussion

The aim of this study was to provide novel longitudinal knowledge on the time of emergence and development of the gender gap in children's reading skills. The focus was on gender differences in the reading development from kindergarten age to age 18 as well as on the associations between parents' educational levels and the development of different subskills of reading across the years. The study was conducted in the transparent language context of Finnish and the educational context of Finland. The results showed that girls outperformed boys in almost all prereading and reading skills across the study period. The gender difference in reading fluency increased steadily over the school years, with the largest difference being documented at the end of Grade 9. Among the 18-year-olds, the gender difference was smaller; however, it should be noted that the number of participants was also considerably smaller than at the earlier measurement points. With respect to reading comprehension, a slight increase was found in the gender gap toward the end of Grade 9, albeit not as consistent as the gap in reading fluency. Girls outperformed boys also in the PISA reading test. Higher parental education was associated with better prereading skills and higher reading performance among school-age children. In addition, interactions between child's gender and father's education were documented with father's education having stronger effects on the PISA reading performance of boys than that of girls.

TABLE 4
Effects of Child's Gender and Mother's Education and Interaction Effects on Kindergarten and Grade 1 Fall Skills

Variable	df	F	p	η^2
Kindergarten fall				
Initial phoneme identification				
Gender	1	9.99	.002**	.006
Education	3	23.73	.001***	.044
Gender \times education	3	0.86	.460	.002
Letter knowledge				
Gender	1	22.67	.001***	.015
Education	3	34.17	.001***	.062
Gender \times education	3	0.01	1.00	.000
Word reading accuracy				
Gender	1	22.04	.001***	.014
Education	3	22.58	.001***	.042
Gender \times education	3	2.53	.056	.005
Kindergarten spring				
Initial phoneme identification				
Gender	1	39.62	.001***	.025
Education	3	18.68	.001***	.035
Gender \times education	3	1.30	.274	.003
Letter knowledge				
Gender	1	34.31	.001***	.022
Education	3	19.48	.001***	.037
Gender \times education	3	0.76	.515	.001
Word reading accuracy				
Gender	1	35.33	.001***	.023
Education	3	26.07	.001***	.049
Gender \times education	3	0.67	.573	.001
Rapid naming				
Gender	1	10.89	.001***	.007
Education	3	10.01	.001***	.019
Gender \times education	3	2.06	.104	.004
Vocabulary				
Gender	1	0.06	.806	.000
Education	3	20.23	.001***	.038
Gender \times education	3	0.55	.647	.001

(continued)

TABLE 4
Effects of Child's Gender and Mother's Education and Interaction Effects on Kindergarten and Grade 1 Fall Skills (continued)

Variable	df	F	p	η^2
Listening comprehension				
Gender	1	8.37	.004**	.005
Education	3	11.67	.001***	.022
Gender \times education	3	1.22	.300	.002
Grade 1 fall				
Initial phoneme identification				
Gender	1	26.95	.001***	.018
Education	3	9.67	.001***	.020
Gender \times education	3	1.23	.299	.003
Phoneme blending				
Gender	1	34.70	.001***	.023
Education	3	9.72	.001***	.020
Gender \times education	3	0.25	.860	.001
Letter writing				
Gender	1	45.59	.001***	.031
Education	3	13.06	.001***	.026
Gender \times education	3	0.10	.958	.000
Word reading accuracy				
Gender	1	29.86	.001***	.020
Education	3	19.96	.001***	.040
Gender \times education	3	0.57	.634	.001

** $p \leq .01$, *** $p \leq .001$.

The findings indicate an early onset of gender differences as a small but reliable gap emerged already prior to school entry at kindergarten age. Similar findings regarding the higher prereading skills of girls have been reported in prior studies for phonological awareness (Lundberg et al., 2010), letter naming fluency (Below et al., 2010), and early reading skill (Chatterji, 2006; McTigue et al., 2021; Sigmundsson et al., 2017; Silinskas et al., 2010; Soderman et al., 1999; Vasilyeva et al., 2021). However, no gender difference was found in vocabulary skills among the kindergarteners which is in line with McTigue et al.'s (2021) findings of Norwegian children at school entry.

Gender differences in reading skills tended to increase by time and up to Grade 9, particularly in reading fluency. The findings that the effect sizes for reading fluency and comprehension did not decrease during school years suggest that despite the overarching goals of diminishing prereading skill

TABLE 5
Effects of Child's Gender and Father's Education and Interaction Effects on Kindergarten and Grade 1 Fall Skills

Variable	df	F	p	η^2
Kindergarten fall				
Initial phoneme identification				
Gender	1	7.87	.005**	.007
Education	3	11.84	.001***	.031
Gender \times education	3	0.17	.920	.000
Letter knowledge				
Gender	1	9.75	.002**	.009
Education	3	15.79	.001***	.041
Gender \times education	3	1.46	.225	.004
Word reading accuracy				
Gender	1	14.06	.001***	.013
Education	3	16.29	.001***	.043
Gender \times education	3	3.57	.014*	.010
Kindergarten spring				
Initial phoneme identification				
Gender	1	27.23	.001***	.024
Education	3	9.60	.001***	.026
Gender \times education	3	1.30	.273	.004
Letter knowledge				
Gender	1	20.37	.001***	.018
Education	3	12.50	.001***	.033
Gender \times education	3	0.75	.525	.002
Word reading accuracy				
Gender	1	19.61	.001***	.018
Education	3	15.53	.001***	.041
Gender \times education	3	0.95	.417	.003
Rapid naming				
Gender	1	6.89	.009**	.006
Education	3	6.04	.001***	.016
Gender \times education	3	0.12	.950	.000
Vocabulary				
Gender	1	1.88	.171	.002
Education	3	10.29	.001***	.027
Gender \times education	3	0.34	.799	.001

(continued)

TABLE 5
Effects of Child's Gender and Father's Education and Interaction Effects on Kindergarten and Grade 1 Fall Skills (continued)

Variable	df	F	p	η^2
Listening comprehension				
Gender	1	2.33	.127	.002
Education	3	9.36	.001***	.025
Gender \times education	3	0.62	.604	.002
Grade 1 fall				
Initial phoneme identification				
Gender	1	12.42	.001***	.012
Education	3	6.88	.001***	.019
Gender \times education	3	0.14	.934	.000
Phoneme blending				
Gender	1	17.59	.001***	.017
Education	3	8.06	.001***	.023
Gender \times education	3	0.74	.526	.002
Letter writing				
Gender	1	31.57	.001***	.029
Education	3	6.10	.001***	.017
Gender \times education	3	1.32	.266	.004
Word reading accuracy				
Gender	1	16.52	.001***	.016
Education	3	8.57	.001***	.024
Gender \times education	3	1.43	.233	.004

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

differences and promoting skills of all children, the school was not successful in alleviating the gender gap in reading performance. The present findings add to previous cross-sectional studies that have evidenced a widening gender gap during school years in other languages and educational contexts (Baye & Monseur, 2016; Lynn & Mikk, 2009; Reilly et al., 2019). Our finding that girls have better skills in reading comprehension than boys is consistent with earlier reports for 10–13-year-olds (Lehto et al., 2001; Leino et al., 2017; Logan & Johnston, 2009) and older adolescents (Brozo et al., 2014; Lietz, 2006; Lynn & Mikk, 2009; Manu et al., 2021; OECD, 2016, 2019a; Reilly et al., 2019; Torppa et al., 2018; Vetenranta et al., 2016) as well as with a previous longitudinal study conducted in the English language context (Robinson & Lubienski, 2011). In terms of the PISA reading scores at age 15, the Cohen d effect size for the gender difference in the present study's sample was .40, which is close to the effect

TABLE 6
Effects of Child's Gender and Mother's Education and Interaction Effects on Reading Fluency in Grades 1–9

Variable	df	F	p	η^2
Grade 1				
Gender	1	25.64	.001***	.017
Education	3	12.19	.001***	.025
Gender × education	3	1.16	.325	.002
Grade 2				
Gender	1	25.76	.001***	.018
Education	3	17.04	.001***	.035
Gender × education	3	2.88	.035*	.006
Grade 3				
Gender	1	35.35	.001***	.025
Education	3	10.22	.001***	.022
Gender × education	3	2.00	.112	.004
Grade 4				
Gender	1	34.90	.001***	.025
Education	3	17.67	.001***	.038
Gender × education	3	1.65	.177	.004
Grade 6				
Gender	1	37.11	.001***	.034
Education	3	9.45	.001***	.026
Gender × education	3	1.08	.357	.003
Grade 7				
Gender	1	42.00	.001***	.040
Education	3	9.05	.001***	.026
Gender × education	3	0.04	.991	.000
Grade 9				
Gender	1	82.15	.001***	.078
Education	3	16.71	.001***	.049
Gender × education	3	0.01	.999	.000

* $p \leq .05$, *** $p \leq .001$.

size of .51 in the national PISA reading sample that we calculated based on the reported mean scores and standard deviations (OECD, 2019a, 2019b). The evidence for the gender gap in reading comprehension, thus, received further corroboration and can be considered a well-established finding. Instead, the present finding that the gender difference in reading fluency was significant and increased with time is somewhat in contrast with previous longitudinal (McIntosh et al., 2013) as well as cross-sectional (Below et al., 2010)

TABLE 7
Effects of Child's Gender and Father's Education and Interaction Effects on Reading Fluency in Grades 1–9

Variable	df	F	p	η^2
Grade 1				
Gender	1	13.79	.001***	.013
Education	3	6.95	.001***	.020
Gender × education	3	0.91	.437	.003
Grade 2				
Gender	1	24.00	.001***	.023
Education	3	10.29	.001***	.029
Gender × education	3	1.13	.335	.003
Grade 3				
Gender	1	37.76	.001***	.036
Education	3	6.59	.001***	.019
Gender × education	3	1.10	.349	.003
Grade 4				
Gender	1	38.22	.001***	.037
Education	3	10.79	.001***	.031
Gender × education	3	2.30	.076	.007
Grade 6				
Gender	1	45.13	.001***	.053
Education	3	7.14	.001***	.026
Gender × education	3	0.28	.843	.001
Grade 7				
Gender	1	46.76	.001***	.058
Education	3	6.08	.001***	.023
Gender × education	3	1.89	.130	.007
Grade 9				
Gender	1	75.59	.001***	.093
Education	3	8.03	.001***	.032
Gender × education	3	1.12	.341	.005

*** $p \leq .001$.

studies that did not find any systematic gender differences in reading fluency in samples of English speakers. This discrepancy with prior literature may be due to differences in the assessment measures used. Both studies conducted with the US samples (Below et al., 2010; McIntosh et al., 2013) used a measure that focused on oral passage reading (Dynamic Indicators of Basic Early Literacy Skills [DIBELS]), and the scores represented the number of correctly read words in a minute. The DIBELS instructions (2021) do not emphasize

TABLE 8
Effects of Child's Gender and Mother's Education and Interaction Effects on Reading Comprehension in Grades 1–9

Variable	df	F	p	η^2
Grade 1				
Gender	1	8.20	.004**	.006
Education	3	22.68	.001***	.045
Gender × education	3	0.68	.563	.001
Grade 2				
Gender	1	25.95	.001***	.018
Education	3	20.86	.001***	.043
Gender × education	3	0.50	.681	.001
Grade 3				
Gender	1	42.24	.001***	.030
Education	3	20.14	.001***	.042
Gender × education	3	0.52	.667	.001
Grade 4				
Gender	1	21.98	.001***	.016
Education	3	31.38	.001***	.065
Gender × education	3	1.02	.383	.002
Grade 6				
Gender	1	11.38	.001***	.011
Education	3	22.78	.001***	.061
Gender × education	3	0.13	.943	.000
Grade 7				
Gender	1	13.70	.001***	.013
Education	3	17.29	.001***	.049
Gender × education	3	1.44	.229	.004
Grade 9				
Gender	1	36.77	.001***	.036
Education	3	21.35	.001***	.061
Gender × education	3	0.27	.846	.001
PISA reading				
Total score				
Gender	1	36.32	.001***	.040
Education	3	19.41	.001***	.063
Gender × education	3	0.27	.848	.001

(continued)

TABLE 8
Effects of Child's Gender and Mother's Education and Interaction Effects on Reading Comprehension in Grades 1–9 (continued)

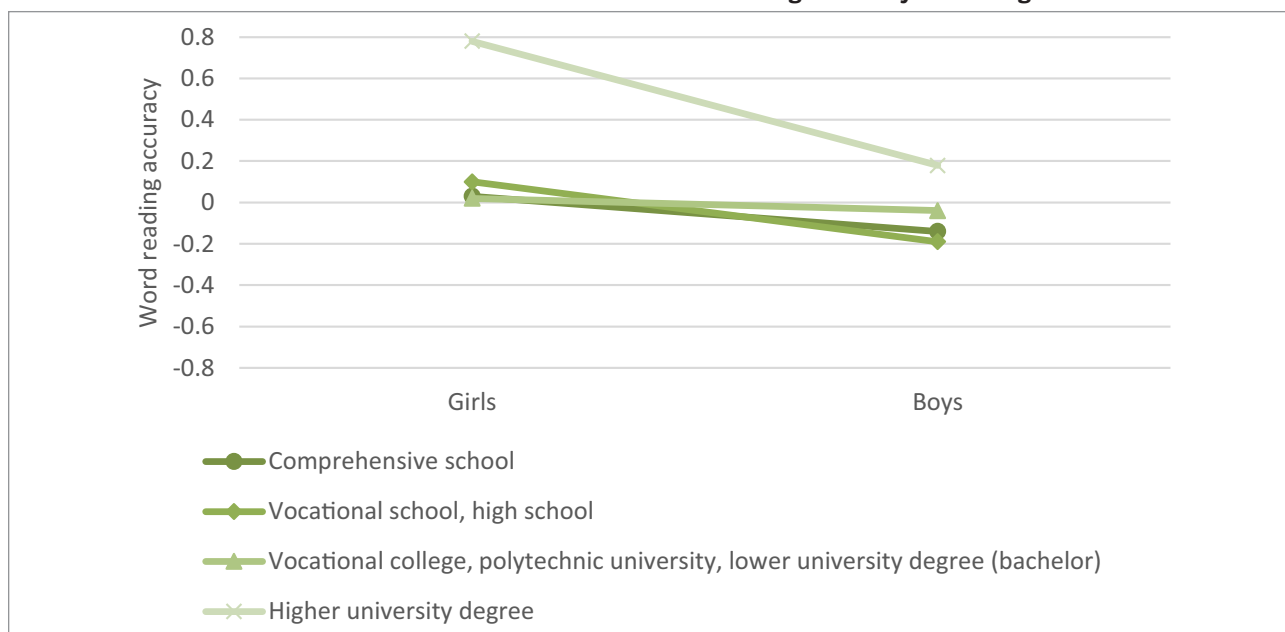
Variable	df	F	p	η^2
Multiple-choice questions				
Gender	1	10.46	.001***	.012
Education	3	6.62	.001***	.022
Gender × education	3	0.26	.852	.001
Open-ended questions				
Gender	1	38.67	.001***	.043
Education	3	20.68	.001***	.066
Gender × education	3	0.30	.825	.001
Information retrieval				
Gender	1	18.34	.001***	.021
Education	3	7.06	.001***	.024
Gender × education	3	0.66	.579	.002
Interpretation				
Gender	1	11.93	.001***	.014
Education	3	9.70	.001***	.032
Gender × education	3	0.40	.754	.001
Evaluation				
Gender	1	48.16	.001***	.052
Education	3	22.47	.001***	.072
Gender × education	3	1.62	.182	.006

** $p \leq .01$, *** $p \leq .001$.

reading speed. The fluency measures used in the present study, on the other hand, were based on silent reading fluency, and the children were instructed to respond to the items as accurately and as quickly as possible.

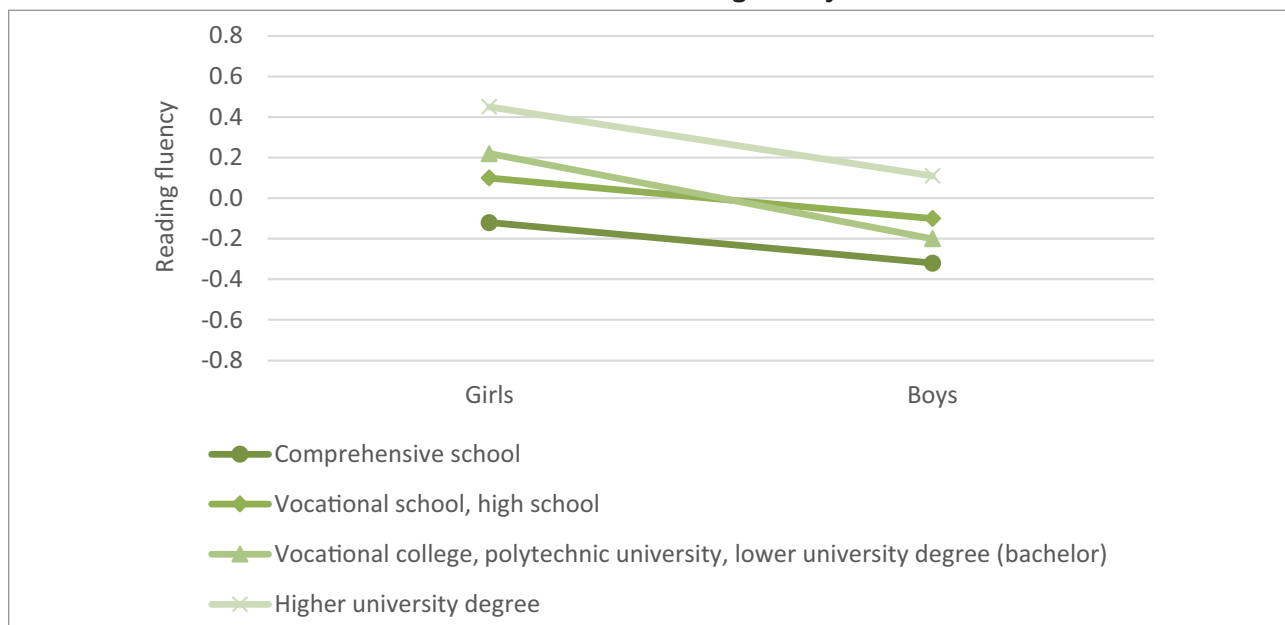
The reasons for boys' relative underachievement in reading are not well understood (e.g., Husain & Millimet, 2009; Logan & Johnston, 2010; van Hek et al., 2019; Watson et al., 2010; White, 2007). Theoretically, there are multiple possible reasons for the difference. It is, for example, worth considering whether the gender differences in reading fluency and comprehension in later ages could be explained by early cognitive skill differences in kindergarten. However, a previous study of Manu et al. (2021) using the same sample revealed that boys' slightly poorer performance in prereading skills did not explain the gender gap in PISA reading performance. In the present study, the kindergarten prereading measures do not seem to fully

FIGURE 4
Child's Gender × Father's Education Interaction Effect on Word Reading Accuracy in Kindergarten Fall



Note. Scores are standardized.

FIGURE 5
Child's Gender × Mother's Education Interaction Effect on Reading Fluency in Grade 2



Note. Scores are standardized.

explain the gender differences in reading fluency either. Interestingly, rapid naming, which is known to be a strong predictor of reading fluency development (e.g., Georgiou et al., 2008; Psyridou et al., 2021; Savage & Frederickson, 2005), showed a very small gender difference with only a negligible effect size.

The reasons for the gender gap may also relate to reading strategies, attitudes, or motivation. For example, the PISA reading assessment in 2018 has shown that girls recognize effective reading strategies better than boys (Leino et al., 2021). In addition, girls are reported to have a more favorable attitude toward reading in Grades 1–6

TABLE 9
Effects of Child's Gender and Father's Education and Interaction Effects on Reading Comprehension in Grades 1–9

Variable	df	F	p	η^2
Grade 1				
Gender	1	4.94	.026*	.005
Education	3	13.82	.001***	.038
Gender × education	3	1.69	.167	.005
Grade 2				
Gender	1	22.38	.001***	.022
Education	3	12.53	.001***	.036
Gender × education	3	0.34	.800	.001
Grade 3				
Gender	1	26.53	.001***	.026
Education	3	14.20	.001***	.040
Gender × education	3	1.06	.366	.003
Grade 4				
Gender	1	31.50	.001***	.031
Education	3	17.23	.001***	.049
Gender × education	3	2.33	.073	.007
Grade 6				
Gender	1	18.92	.001***	.023
Education	3	15.66	.001***	.055
Gender × education	3	2.47	.060	.009
Grade 7				
Gender	1	21.95	.001***	.028
Education	3	11.01	.001***	.042
Gender × education	3	2.28	.078	.009
Grade 9				
Gender	1	22.86	.001***	.030
Education	3	11.01	.001***	.043
Gender × education	3	0.74	.531	.003
PISA reading				
Total score				
Gender	1	47.13	.001***	.067
Education	3	7.33	.001***	.032
Gender × education	3	4.20	.006**	.019

(continued)

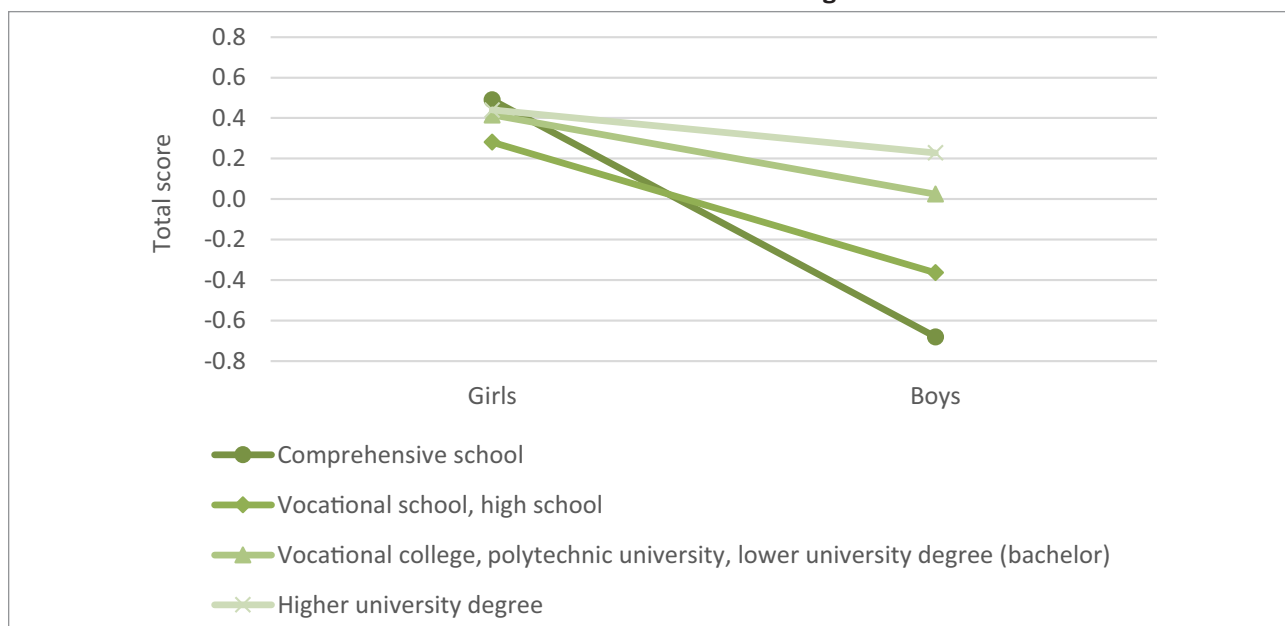
TABLE 9
Effects of Child's Gender and Father's Education and Interaction Effects on Reading Comprehension in Grades 1–9 (continued)

Variable	df	F	p	η^2
Multiple-choice questions				
Gender	1	11.85	.001**	.018
Education	3	2.60	.051	.012
Gender × education	3	3.05	.028*	.014
Open-ended questions				
Gender	1	54.90	.001***	.077
Education	3	8.08	.001***	.036
Gender × education	3	4.05	.007**	.018
Information retrieval				
Gender	1	38.64	.001***	.055
Education	3	2.90	.034*	.013
Gender × education	3	5.64	.001***	.025
Interpretation				
Gender	1	14.92	.001***	.022
Education	3	3.82	.010**	.017
Gender × education	3	2.87	.036*	.013
Evaluation				
Gender	1	57.43	.001***	.080
Education	3	7.90	.001***	.035
Gender × education	3	2.88	.035*	.013

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

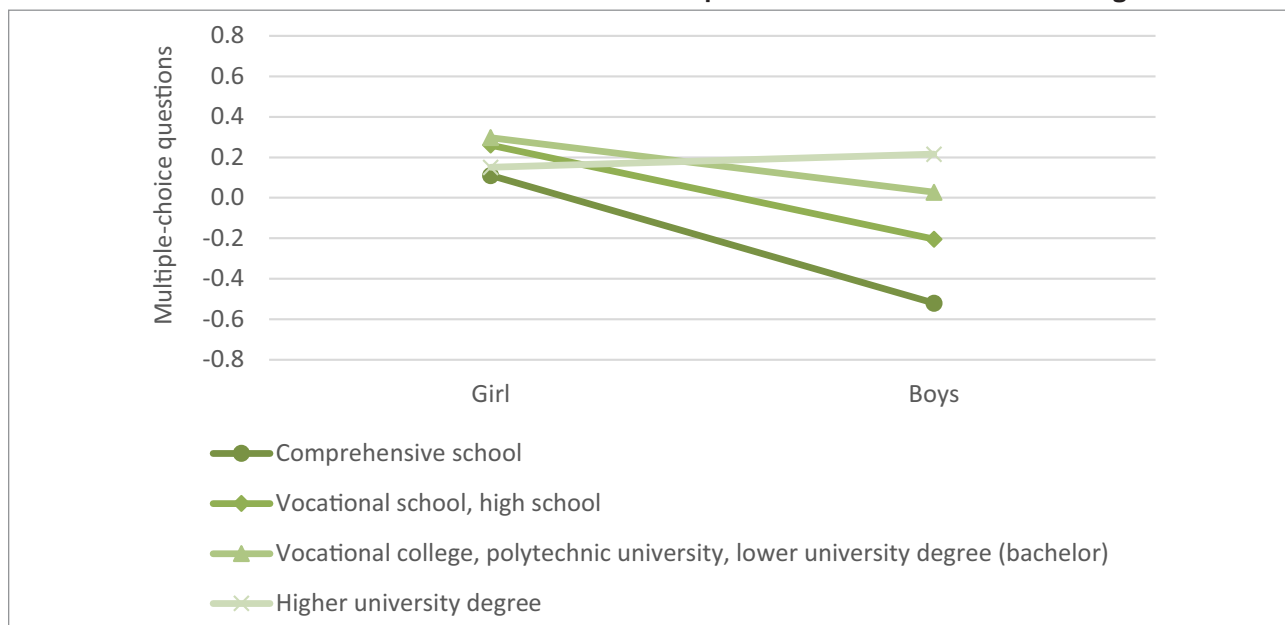
(McKenna et al., 1995). Furthermore, compared with boys, adolescent girls' greater interest in and more positive attitudes toward reading (e.g., OECD, 2010), greater enjoyment of reading, and more time spent on reading activities (Brozo et al., 2014; Chiu & McBride-Chang, 2006) have been suggested as critical factors to promote their better reading comprehension. Chiu and McBride-Chang (2006) showed that reading enjoyment partially mediated the effects of gender on PISA reading performance and accounted for 42% of the effects. Torppa et al. (2020) recently showed, using partly the same sample as in the present study, that active leisure reading (particularly reading books) is reciprocally associated with reading comprehension in later school grades but not with reading fluency. As Torppa et al. (2020) did not examine the effects of gender, it is not clear whether leisure reading contributes to the gender gap in reading fluency. This remains a

FIGURE 6
Child's Gender × Father's Education Interaction Effect on the PISA Reading Total Score



Note. Scores are standardized.

FIGURE 7
Child's Gender × Father's Education Interaction Effect on Multiple-Choice Questions in PISA Reading



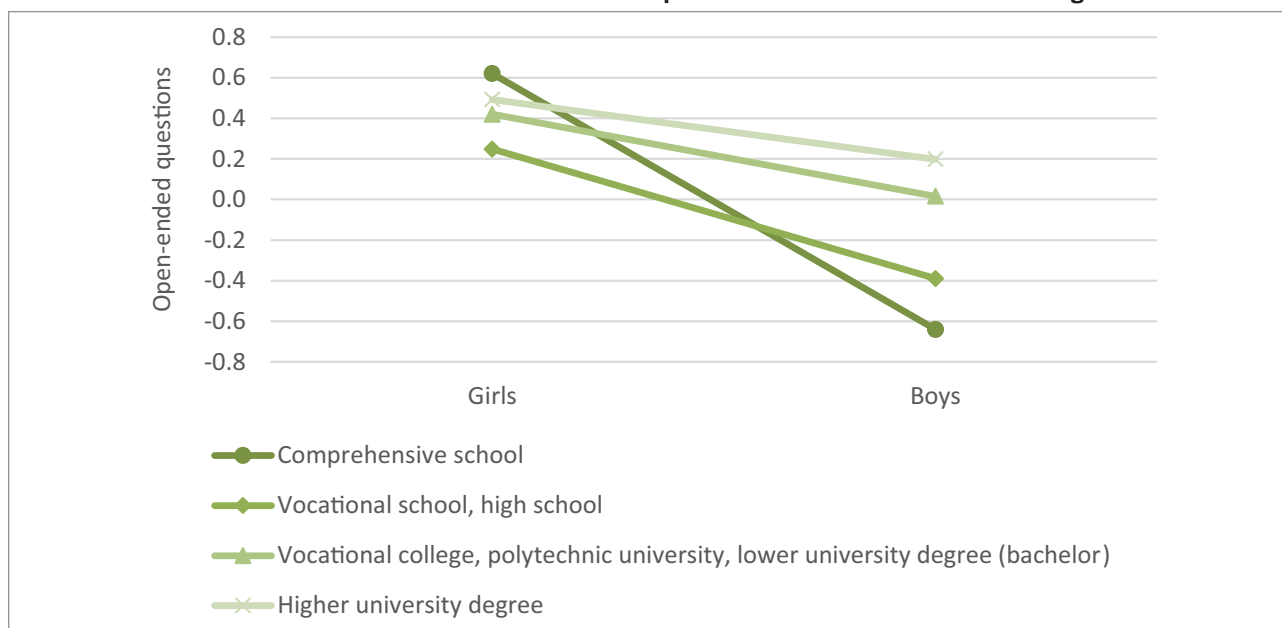
Note. Scores are standardized.

highly relevant topic for future studies. Further research and interpretative work are needed for an in-depth understanding of the development of gender differences in reading fluency and comprehension. Such work should include detailed examinations of cognitive skills but also move beyond the cognitive domain. In addition, the research needs to move beyond within-individual

measures and also observe the interactions in the school and family contexts to better understand how the differences develop (see e.g., Williams et al., 2019).

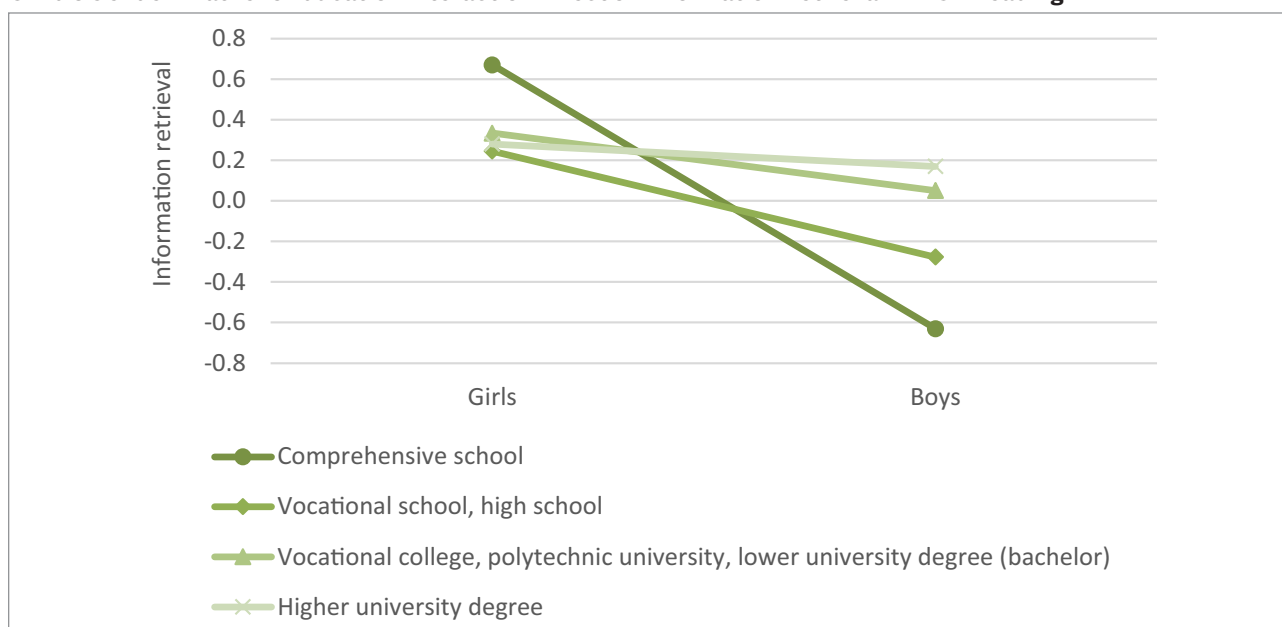
The present findings regarding the relation between parental education and children's reading development indicated that children of highly educated parents tend to have better prereading skills, accuracy, fluency, and

FIGURE 8
Child's Gender × Father's Education Interaction Effect on Open-Ended Questions in PISA Reading



Note. Scores are standardized.

FIGURE 9
Child's Gender × Father's Education Interaction Effect on Information Retrieval in PISA Reading

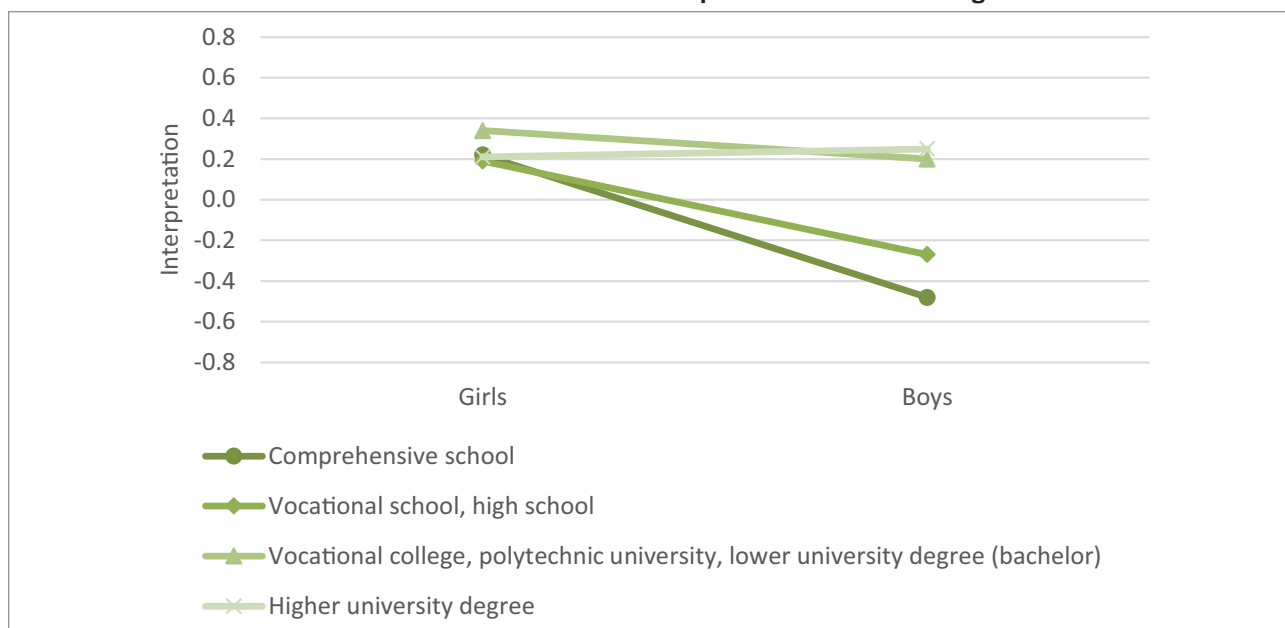


Note. Scores are standardized.

comprehension than children of less educated parents, which aligns well with previous findings (e.g., Guo et al., 2018; İnce & Gözütok, 2018; Leppänen et al., 2004, 2008; OECD, 2019a; Pan et al., 2016; Scheiber et al., 2015; West et al., 2000). In PISA, students report their parents' education levels (OECD, 2020). In this study, parents themselves reported their education and therefore, the present

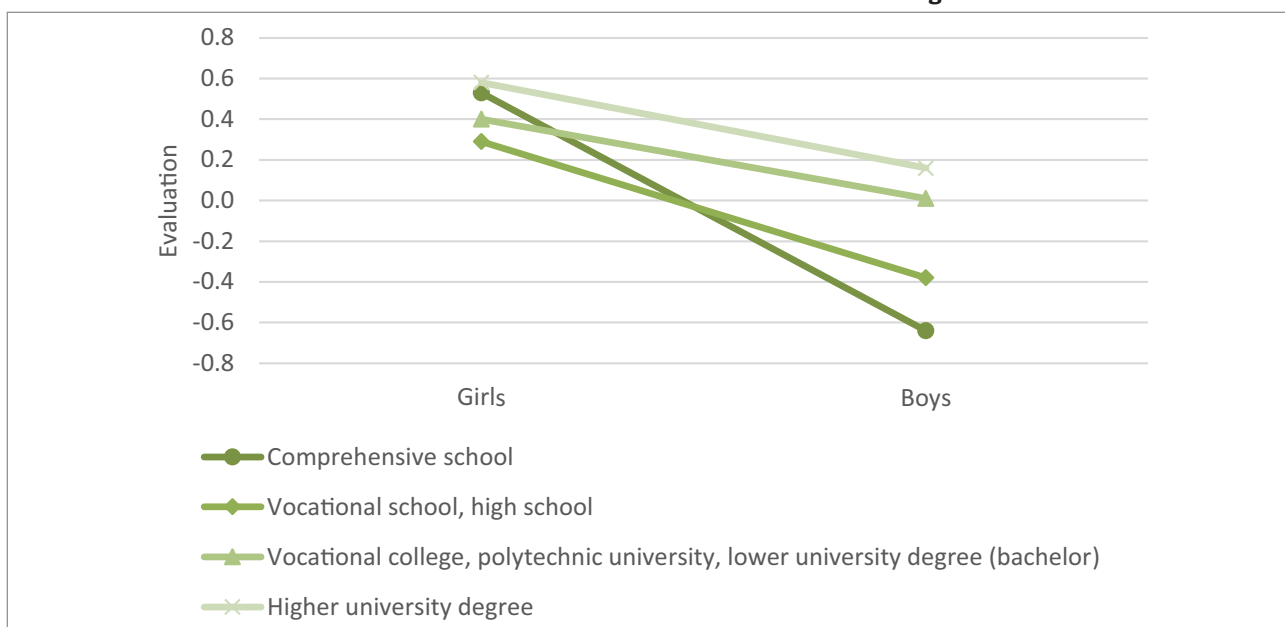
findings regarding the association between parental education and PISA performance offered corroborative evidence for better performance of children with highly educated parents. Some intriguing and novel interaction effects between child's gender and parental education were also revealed, particularly concerning the differential effect of father's education on the PISA reading performance of boys compared

FIGURE 10
Child's Gender × Father's Education Interaction Effect on Interpretation in PISA Reading



Note. Scores are standardized.

FIGURE 11
Child's Gender × Father's Education Interaction Effect on Evaluation in PISA Reading



Note. Scores are standardized.

to girls. Boys with the least educated fathers had the lowest PISA reading subscores, whereas father's education had no effect on any of the PISA reading subscores among girls. A trend ($p=.06-.08$) for a similar pattern—that is, the tendency for the greater effect of father's education on boys' reading comprehension skills—emerged also for the grade-level reading comprehension assessments in Grades 4–7 and

may imply that difficulties in reading comprehension among boys with less educated fathers may appear particularly in early grades. These findings support those of the Turkish study by İnce and Gözütok (2018), wherein fathers' higher education levels were found to benefit adolescents' performance in the PISA reading tasks; however, the analyses did not focus on gender differences.

Our finding that father's low educational level predicted his son's but not daughter's low reading achievement is intriguing and hard to interpret. Prior literature suggests that highly educated parents are likely to provide their children with rich learning environments, involving literacy activities of high quality (e.g., Chiu & McBride-Chang, 2006; Khanolainen et al., 2020; Salminen et al., 2021; Sirin, 2005), which have been shown to have long-term effects on children's reading achievements (e.g., Bus et al., 1995; Mol & Bus, 2011; Scarborough & Dobrich, 1994; Sénéchal & LeFevre, 2002; Torppa et al., 2022). It may be that varied and enriching father-child literacy activities may benefit children in general and at-risk boys in particular. Khanolainen et al. (2020), for example, showed that kindergarteners' shared reading with their fathers predicted the children's higher reading comprehension levels in Grades 1 and 2. Further, Foster et al. (2016) found that in families where the mother's education level was lower than a bachelor's degree, the father's home learning environment practices predicted preschoolers' early literacy skills, including decoding and letter knowledge.

However, in the interpretation of the association between parental education and children's reading performance it should be noted that there are different aspects associated with one's education. One aspect, for example, is reading difficulties which tend to be associated with lower educational levels (Eloranta et al., 2019; McLaughlin et al., 2014) and run in families (Lohvansuu et al., 2021; Snowling & Melby-Lervåg, 2016). Possibly, the association between parental education and a child's reading skills may be stronger between fathers and their sons. Previous studies have suggested that boys are more often identified as reading impaired than girls (e.g., Quinn & Wagner, 2015). An earlier report on the increased odds for boys with less educated parents being dyslexic (Mascheretti et al., 2015) supports the possible overrepresentation of boys with reading difficulties. The available data do not include measures allowing the identification of reading impairments among parents and therefore, further studies are needed to examine this possibility. Overall, the interaction effects identified suggest that fathers' low education levels do not constitute a strong risk factor for girls as they do for boys.

The present study has certain limitations. First, several kindergarten and Grade 1 fall measures were psychometrically at or close to a ceiling, which is quite typical for the phonological and letter knowledge measures considered for this age range in the Finnish language context due to the almost perfect grapheme-phoneme correspondence. Once learned, any items tapping phonological skills or reading tend to be at ceiling. In the context of a transparent orthography, this happens very early on in the school path. Further studies in the transparent language contexts with younger children are needed to verify the gender differences in early prereading skills. Second, it should be

noted that in a long follow-up study, test items must be changed over time and hence the scores were not fully comparable across time. Although the type and the requirements for the tasks remained the same, the more difficult items were added to the scales along with reduced time to finish tasks which led to some variation in the developmental paths. In the reading comprehension assessment in Grades 1–6, the texts came from the same nationally standardized battery but were different in each grade (grade-level standardized texts). In Grades 7 and 9, a different battery was used because the primary school battery did not include grade-appropriate tasks for adolescents. Therefore, the reading comprehension raw scores are not comparable across age. Third, although the overall sample was large, fewer fathers responded to questionnaires than mothers, which is quite typical but also lowered the statistical power of the analyses. Fourth, the number of parents with the lowest educational level was clearly smaller than that of the other educational levels. However, it is typical for people in Finland to continue to further education after comprehensive school. Fifth, although the same sample was followed over many years, there was variability in participation across timepoints for various reasons, such as the children and their families moving to another municipality or, in rare instances, withdrawing from the study. Finally, only a small subsample of participants was assessed at 18 years of age.

Conclusions

This longitudinal study showed that Finnish girls have an edge over boys in reading throughout the compulsory education. The outcome was expected and despite some previous discrepant results (McGeown et al., 2012; McIntosh et al., 2013), the gender gap seems to be quite consistent and highly reliable in our context. However, its sheer size is far from impressive, a fact which often is clouded by the wide publicity the phenomenon receives in the media. Our data do not indicate that school would be the culprit for boys' poorer reading profile by favoring girls in some murky ways. First, any grading bias (see e.g., Lievore & Triventi, 2023) is ruled out because all tests were carried out by outside professionals. Second, Torppa et al. (2023) have recently shown with the partially same sample that boys are superior to girls in arithmetic throughout the compulsory education. Rather, our results suggest an early-existing, gradually growing trend in the development of reading skills.

Furthermore, our findings suggest that gender differences emerge already prior to school entry as girls' performance was better in most prereading skills already in kindergarten. If replicable, this finding calls for early childhood education and care interventions. Although our previous findings (Manu et al., 2021) suggested that over long-term, the gender gap in reading is not fully

explained by the early gender differences in the prereading skills, they are strong predictors of reading development and seem to offer a partial explanation also for the gender gap. Therefore, early intervention efforts are meaningful. As individual differences in the prereading skills are important predictors of reading development for both girls and boys, in our opinion, a program involving the whole cohort in language and literacy activities, which are sensitive to individual needs and support intrinsic motivation of all (see e.g., Lundberg et al., 1988), would be better than targeted interventions for boys or children from specific socio-economic backgrounds. However, having said that, the mechanisms explaining the finding of the co-occurrence of father's low educational level and his son's but not daughter's low reading performance requires further investigation. Early education and care as well as schools have a momentum in compensating for children's possible lack of home literacy support or other risk factors but in the development of the support, a better understanding of the reasons for individual differences are of importance. Reading is an essential civic skill, and we need to find efficient and equitable ways to offer high quality support for all children.

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Conflict of Interest

None.

Ethics Statement

The First Steps Study and the School Path Study have been reviewed by the University of Jyväskylä Ethical Committee in 2006 and in 2018. The signed forms giving the permission to publish the information are provided by the study participants and/or their parents. The manuscript does not include any reproduced material from other sources.

The data are not openly available as they were collected during a long time period and the review by the University of Jyväskylä Ethical Committee as well as participants' consents are binding.

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APPENDIX A

Descriptive Statistics of the Measures

	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Min</i>	<i>Max</i>
Kindergarten fall							
Initial phoneme identification	1867	7.46	2.45	−.81	−.21	0	10
Letter knowledge	1867	16.95	9.01	−.25	−1.27	0	29
Word reading accuracy	1867	1.00	1.99	1.81	1.60	0	6
Kindergarten spring							
Initial phoneme identification	1836	8.93	1.72	−1.99	4.12	0	10
Letter knowledge	1836	23.21	6.61	−1.34	1.02	0	29
Word reading accuracy	1823	4.03	4.29	.45	−1.61	0	10
Rapid naming	1835	70.29	17.78	1.72	6.69	34	210
Vocabulary	1839	19.82	3.38	−.38	.32	7	29
Listening comprehension	1832	7.71	2.34	−.31	−.13	0	12
Grade 1 fall							
Initial phoneme identification	2022	9.38	1.31	−2.88	9.85	0	10
Phoneme blending	2022	7.75	1.66	−1.53	2.03	0	10
Word reading accuracy	2022	6.83	8.04	.24	2.24	−31	51
Letter writing	2021	23.55	5.68	−1.42	1.60	0	29
Reading fluency							
Word reading fluency test							
Grade 1	2051	18.28	8.97	.66	.20	0	58
Grade 2	2005	24.20	7.63	.40	.06	3	58
Grade 3	1995	35.30	8.97	−.20	.37	1	63
Grade 4	1954	36.06	9.25	−.02	.15	0	66
Grade 6	1820	47.23	10.94	.00	.00	10	80
Grade 7	1765	37.70	8.38	−.18	.35	2	65
Grade 9	1707	41.47	9.07	−.02	.27	11	72
Word-chain test							
Grade 1	2047	6.91	5.08	1.04	1.72	0	32
Grade 2	2001	11.33	6.10	.67	.59	0	38
Grade 3	1992	16.02	7.20	.42	.00	0	40
Grade 4	1951	17.03	7.12	.28	−.22	0	40
Grade 6	1820	21.63	7.44	.09	−.36	1	40
Grade 7	1765	25.75	7.60	.07	−.50	0	40
Grade 9	1704	46.06	11.55	−.17	−.10	8	76

(continued)

APPENDIX A

Descriptive Statistics of the Measures (continued)

	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Min</i>	<i>Max</i>
Sentence reading test							
Grade 1	2049	17.91	8.19	.35	.02	0	46
Grade 2	1996	29.83	8.53	−.10	.28	0	60
Grade 3	1989	38.12	8.76	−.07	.22	6	60
Grade 4	1954	45.43	9.33	−.52	.46	2	60
Grade 6	1822	30.61	7.38	.15	.28	4	62
Grade 7	1764	33.14	7.41	.00	.25	0	57
Grade 9	1705	37.53	8.48	−.05	.38	0	70
Age 18	117	36.66	8.43	−.17	.19	7	54
Reading comprehension							
Grade 1	2035	5.50	3.18	.00	−.96	0	12
Grade 2	1974	8.52	2.71	−.73	−.20	0	12
Grade 3	1988	9.09	2.17	−1.17	1.72	0	12
Grade 4	1950	8.10	2.52	−.47	−.34	0	12
Grade 6	1821	7.15	2.55	−.20	−.59	0	12
Grade 7	1758	6.59	2.54	.05	−.64	0	12
Grade 9	1702	7.02	2.43	−.15	−.57	0	12
PISA reading							
Total score	1512	20.26	6.20	−.57	−.04	0	32.73
Multiple-choice questions	1512	7.19	2.17	−.38	−.68	0	11.3
Open-ended questions	1512	11.36	4.35	−.50	−.36	0	20.00
Information retrieval	1512	4.92	1.45	−.67	.53	0	8.33
Interpretation	1512	8.28	2.94	−.31	−.71	0	14.00
Evaluation	1512	5.35	2.47	−.31	−.71	0	10.00
Parental education							
Mothers	1563	2.81	.94	−.22	−.96	1	4
Fathers	1117	2.76	.92	−.12	−.94	1	4

APPENDIX B

Gender Comparisons of Reading Fluency Subtests Across Grades 1–9

	Girls			Boys			<i>t</i> ^a	Levene	<i>d</i> ^a
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>			
Word reading fluency test									
Grade 1	977	18.79	8.85	1065	17.74	9.03	2.66**	0.22	.12
Grade 2	950	24.35	7.38	1046	23.99	7.81	1.05	0.81	.05
Grade 3	944	35.85	9.08	1042	34.77	8.83	2.68**	1.22	.12
Grade 4	922	36.77	9.48	1023	35.36	8.97	3.37***	1.84	.15
Grade 6	855	48.68	10.72	956	45.93	10.91	5.40***	0.26	.25
Grade 7	836	39.29	8.09	920	36.25	8.37	7.71***	2.09	.37
Grade 9	798	43.62	8.65	898	39.51	8.97	9.57***	0.08	.47
Word-chain test									
Grade 1	975	7.62	5.19	1063	6.22	4.86	6.26***	3.13	.28
Grade 2	949	12.30	6.44	1043	10.40	5.62	7.02***	15.51***	.31
Grade 3	941	17.74	7.39	1042	14.38	6.60	10.62***	9.60**	.48
Grade 4	919	18.47	7.12	1023	15.69	6.84	8.78***	3.40	.40
Grade 6	855	23.86	7.07	956	19.58	7.18	12.74***	0.11	.60
Grade 7	836	27.54	7.39	920	24.09	7.40	9.75***	0.93	.47
Grade 9	798	49.70	10.34	895	42.77	11.63	13.00***	11.20***	.63
Sentence reading test									
Grade 1	975	19.03	8.04	1065	16.82	8.15	6.16***	0.20	.27
Grade 2	944	31.22	8.18	1043	28.50	8.61	7.19***	3.68	.32
Grade 3	941	39.64	8.50	1039	36.69	8.77	7.59***	0.09	.34
Grade 4	922	47.11	8.96	1023	43.86	9.39	7.81***	1.36	.35
Grade 6	856	32.02	7.01	957	29.31	7.43	7.97***	1.59	.37
Grade 7	836	34.42	7.28	919	31.96	7.31	7.05***	0.69	.34
Grade 9	801	39.37	7.81	893	35.84	8.67	8.83***	4.79*	.43

^aEffect sizes were estimated with Cohen's *d* computed using pooled standard deviation.

p* ≤ .05, *p* ≤ .01, ****p* ≤ .001.

APPENDIX C

GIRLS' and Boys' Reading Skills by Mother's Education Level

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Girls												
Kindergarten fall												
Initial phoneme identification	68	-0.25	1.12	221	0.00	1.00	249	0.16	0.87	186	0.50	0.77
Letter knowledge	68	0.00	0.94	221	-0.05	0.94	249	0.18	0.97	186	0.56	0.79
Word reading accuracy	68	0.07	1.10	221	-0.09	0.92	249	0.11	1.05	186	0.62	1.28
Kindergarten spring												
Initial phoneme identification	67	0.14	0.91	221	0.06	0.87	249	0.22	0.74	189	0.41	0.51
Letter knowledge	67	0.08	0.91	221	0.05	0.84	249	0.18	0.84	188	0.44	0.65
Rapid naming	67	0.00	1.06	221	0.06	1.07	249	-0.12	0.93	189	-0.33	0.89
Vocabulary	67	-0.14	0.95	221	-0.16	0.99	250	0.13	0.86	189	0.27	0.89
Listening comprehension	67	0.21	0.91	220	-0.14	1.06	250	0.10	0.96	188	0.26	1.02
Word reading accuracy	67	0.15	1.00	220	-0.05	0.96	248	0.21	1.00	189	0.59	0.98
Grade 1 fall												
Initial phoneme identification	59	0.32	0.42	209	0.07	0.86	242	0.19	0.78	177	0.32	0.45
Phoneme blending	59	0.26	0.68	209	0.04	0.96	242	0.20	0.89	177	0.41	0.71
Word reading accuracy	59	0.09	0.75	209	-0.02	0.94	242	0.22	0.99	177	0.53	0.93
Letter writing	59	0.14	0.74	209	0.08	0.87	242	0.29	0.74	177	0.44	0.64
Reading fluency												
Grade 1	59	-0.03	0.92	212	0.02	0.77	240	0.23	0.82	178	0.41	0.85
Grade 2	59	-0.12	0.82	204	0.01	0.83	232	0.22	0.78	170	0.45	0.80
Grade 3	57	-0.01	0.89	203	0.07	0.82	231	0.25	0.83	169	0.44	0.81
Grade 4	54	-0.02	0.80	198	0.06	0.84	226	0.24	0.79	165	0.49	0.77
Grade 6	34	-0.05	0.77	150	0.20	0.87	174	0.30	0.68	139	0.52	0.76
Grade 7	36	0.04	0.87	138	0.20	0.89	170	0.27	0.79	130	0.49	0.79
Grade 9	34	0.02	0.70	134	0.22	0.83	160	0.42	0.72	124	0.62	0.73
Reading comprehension												
Grade 1	59	-0.25	1.07	211	-0.07	0.95	241	0.18	0.89	178	0.50	0.94
Grade 2	59	0.04	1.03	203	-0.02	0.94	231	0.20	0.89	167	0.55	0.71
Grade 3	57	0.07	0.82	203	0.00	0.87	230	0.25	0.79	169	0.53	0.66
Grade 4	54	-0.10	0.98	198	0.05	0.94	226	0.24	0.86	165	0.56	0.76

(continued)

APPENDIX C

Girls' and Boys' Reading Skills by Mother's Education Level (continued)

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Grade 6	34	-0.08	1.03	150	-0.03	0.95	174	0.14	0.95	138	0.58	0.83
Grade 7	36	-0.27	0.92	139	0.04	0.98	170	0.18	0.97	130	0.63	0.91
Grade 9	36	0.05	0.91	135	0.03	1.06	161	0.33	0.88	124	0.60	0.81
PISA reading												
Total score	31	-0.03	0.76	118	0.16	0.84	145	0.29	0.85	116	0.63	0.74
Multiple-choice questions	31	-0.11	1.03	118	0.15	0.90	145	0.22	0.93	116	0.36	0.97
Open-ended questions	31	0.01	0.77	118	0.14	0.87	145	0.27	0.86	116	0.66	0.70
Information retrieval	31	-0.05	0.94	118	0.20	0.83	145	0.32	0.87	116	0.42	0.65
Interpretation	31	-0.06	0.89	118	0.08	0.91	145	0.23	0.90	116	0.42	0.96
Evaluation	31	00.03	0.81	118	0.17	0.93	145	0.22	0.91	116	0.73	0.70
Boys												
Kindergarten fall												
Initial phoneme identification	58	-0.23	1.02	253	-0.24	1.02	261	-0.06	0.95	251	0.21	0.94
Letter knowledge	58	-0.26	1.06	253	-0.33	1.02	261	-0.11	1.01	251	0.30	0.91
Word reading accuracy	58	-0.21	0.83	253	-0.23	0.77	261	-0.11	0.89	251	0.12	1.11
Kindergarten spring												
Initial phoneme identification	58	-0.27	1.14	252	-0.40	1.25	256	-0.05	1.03	250	0.15	0.83
Letter knowledge	58	-0.33	1.24	252	-0.36	1.24	256	-0.08	0.98	251	0.18	0.90
Rapid naming	58	0.40	1.09	252	0.04	0.97	257	0.07	0.93	250	-0.14	0.91
Vocabulary	58	-0.17	1.13	252	-0.12	1.04	257	0.08	0.86	251	0.37	0.98
Listening comprehension	58	-0.19	0.88	252	-0.20	1.00	255	-0.07	1.04	250	0.20	1.00
Word reading accuracy	57	-0.15	0.98	248	-0.32	0.91	254	-0.20	0.96	249	0.17	1.02
Grade 1 fall												
Initial phoneme identification	51	-0.08	1.01	227	-0.31	1.31	245	0.01	0.92	240	0.09	0.88
Phoneme blending	51	-0.13	1.06	227	-0.24	1.07	245	-0.18	1.03	240	0.08	0.93
Word reading accuracy	51	-0.19	1.01	227	-0.29	0.97	245	-0.21	0.99	240	0.17	1.00
Letter writing	51	-0.27	1.15	227	-0.33	1.21	244	-0.13	0.98	240	0.09	0.99
Reading fluency												
Grade 1	50	-0.24	0.73	226	-0.15	0.85	248	-0.13	0.79	237	0.09	0.91
Grade 2	50	-0.32	0.82	218	-0.10	0.87	240	-0.20	0.77	233	0.11	0.88

(continued)

APPENDIX C

Girls' and Boys' Reading Skills by Mother's Education Level (continued)

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Grade 3	48	-0.24	0.68	215	-0.13	0.83	235	-0.18	0.78	234	0.04	0.82
Grade 4	47	-0.29	0.70	212	-0.15	0.86	229	-0.21	0.78	232	0.15	0.86
Grade 6	33	-0.22	0.63	148	-0.16	0.83	185	-0.19	0.78	205	0.05	0.86
Grade 7	32	-0.36	0.72	137	-0.23	0.84	180	-0.19	0.81	194	0.07	0.88
Grade 9	30	-0.54	0.64	132	-0.36	0.83	176	-0.17	0.83	191	0.03	0.84
Reading comprehension												
Grade 1	49	-0.29	0.97	225	-0.24	1.00	246	-0.01	1.03	236	0.19	1.04
Grade 2	49	-0.29	1.22	217	-0.23	1.04	239	-0.14	1.01	234	0.19	0.92
Grade 3	49	-0.45	1.10	215	-0.33	1.16	235	-0.07	1.04	234	0.10	1.04
Grade 4	47	-0.24	0.99	212	-0.36	1.07	229	-0.13	0.96	231	0.34	0.89
Grade 6	33	-0.41	0.92	148	-0.23	1.01	185	-0.08	1.04	205	0.31	0.99
Grade 7	32	-0.48	0.94	134	-0.19	1.02	180	-0.02	1.00	193	0.14	1.01
Grade 9	31	-0.52	1.02	133	-0.42	0.93	177	-0.03	0.93	190	0.18	1.01
PISA reading												
Total score	29	-0.48	1.17	120	-0.38	1.05	148	-0.12	0.96	172	0.22	0.92
Multiple-choice questions	29	-0.39	1.07	120	-0.16	0.98	148	-0.06	0.96	172	0.19	1.00
Open-ended questions	29	-0.43	1.11	120	-0.43	1.05	148	-0.15	0.97	172	0.21	0.92
Information retrieval	29	-0.31	1.19	120	-0.24	1.09	148	-0.08	1.01	172	0.18	0.99
Interpretation	29	-0.34	1.10	120	-0.21	1.00	148	-0.13	0.98	172	0.23	0.98
Evaluation	29	-0.52	1.04	120	-0.50	1.01	148	-0.11	0.94	172	0.15	0.94

Note. Scores are standardized.

APPENDIX D

Girls' and Boys' Reading Skills by Father's Education Level

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Girls												
Kindergarten fall												
Initial phoneme identification	51	-0.14	1.06	169	0.13	0.91	164	0.17	0.93	120	0.50	0.73
Letter knowledge	51	0.01	1.06	169	0.06	0.98	164	0.20	0.91	120	0.67	0.70
Word reading accuracy	51	0.03	1.03	169	0.10	1.06	164	0.02	1.01	120	0.78	1.34
Kindergarten spring												
Initial phoneme identification	50	0.03	0.80	169	0.24	0.71	165	0.25	0.65	122	0.42	0.47
Letter knowledge	50	0.02	0.95	169	0.11	0.86	165	0.23	0.71	122	0.53	0.49
Rapid naming	50	0.13	0.96	169	-0.08	1.07	165	-0.16	0.83	122	-0.28	1.04
Vocabulary	50	0.01	0.84	170	0.04	0.93	165	0.19	0.89	122	0.39	0.82
Listening comprehension	50	-0.08	0.89	170	-0.10	1.01	163	0.28	0.98	122	0.31	0.95
Word reading accuracy	50	-0.06	0.96	169	0.13	0.99	164	0.19	0.98	122	0.68	0.93
Grade 1 fall												
Initial phoneme identification	48	-0.05	1.13	163	0.16	0.85	156	0.28	0.49	118	0.32	0.41
Phoneme blending	48	-0.16	1.16	163	0.23	0.81	156	0.20	0.81	118	0.47	0.59
Word reading accuracy	48	-0.03	0.68	163	0.15	0.98	156	0.25	0.88	118	0.62	1.02
Letter writing	48	0.13	0.83	163	0.27	0.74	156	0.31	0.68	118	0.54	0.51
Reading fluency												
Grade 1	48	-0.13	0.74	165	0.17	0.84	159	0.21	0.81	115	0.43	0.91
Grade 2	47	-0.01	0.73	160	0.13	0.81	155	0.24	0.75	112	0.48	0.84
Grade 3	46	0.05	0.76	158	0.22	0.84	152	0.22	0.77	113	0.50	0.81
Grade 4	45	0.12	0.80	158	0.18	0.82	149	0.22	0.79	112	0.52	0.79
Grade 6	34	0.13	0.83	133	0.24	0.82	116	0.38	0.77	91	0.52	0.71
Grade 7	29	0.25	0.80	126	0.28	0.80	113	0.29	0.84	84	0.52	0.81
Grade 9	28	0.22	0.73	118	0.40	0.77	106	0.40	0.78	82	0.63	0.75
Reading comprehension												
Grade 1	48	-0.22	0.98	165	0.06	0.93	159	0.24	0.89	115	0.57	0.95
Grade 2	47	0.03	1.03	160	0.11	0.93	152	0.31	0.84	111	0.56	0.77
Grade 3	46	0.11	0.94	158	0.10	0.85	152	0.31	0.79	113	0.47	0.73
Grade 4	45	0.12	0.93	158	0.19	0.92	149	0.35	0.81	112	0.51	0.87

(continued)

APPENDIX D

Girls' and Boys' Reading Skills by Father's Education Level (continued)

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Grade 6	34	0.09	0.99	133	0.11	0.96	116	0.24	0.84	90	0.54	0.92
Grade 7	29	0.19	1.02	127	0.13	0.97	113	0.22	0.83	84	0.66	0.98
Grade 9	28	0.07	1.13	120	0.15	0.95	106	0.35	0.84	83	0.63	0.87
PISA reading												
Total score	24	0.49	0.84	116	0.28	0.84	93	0.42	0.82	77	0.44	0.88
Multiple-choice questions	24	0.11	1.03	116	0.26	0.92	93	0.30	0.94	77	0.15	1.05
Open-ended questions	24	0.62	0.70	116	0.25	0.86	93	0.42	0.81	77	0.49	0.81
Information retrieval	24	0.67	0.83	116	0.25	0.85	93	0.33	0.85	77	0.28	0.78
Interpretation	24	0.22	1.00	116	0.19	0.90	93	0.34	0.90	77	0.21	1.05
Evaluation	24	0.53	0.69	116	0.29	0.92	93	0.40	0.86	77	0.58	0.78
Boys												
Kindergarten fall												
Initial phoneme identification	39	-0.23	1.00	200	-0.07	0.96	207	-0.03	0.98	157	0.26	0.91
Letter knowledge	39	-0.10	1.06	200	-0.14	1.01	207	0.08	0.98	157	0.25	0.98
Word reading accuracy	39	-0.14	0.93	200	-0.19	0.80	207	-0.04	1.02	157	0.18	1.10
Kindergarten spring												
Initial phoneme identification	38	-0.37	1.25	199	-0.19	1.09	207	0.06	0.94	156	0.18	0.76
Letter knowledge	38	-0.39	1.36	199	-0.15	1.09	207	0.06	1.00	157	0.18	0.84
Rapid naming	38	0.35	1.12	200	0.14	1.06	207	-0.01	0.91	156	-0.14	0.92
Vocabulary	38	-0.23	1.28	200	-0.01	1.07	207	0.11	0.91	157	0.39	1.01
Listening comprehension	38	-0.02	0.92	199	-0.18	1.00	206	0.08	1.03	156	0.11	0.97
Word reading accuracy	38	-0.33	0.96	196	-0.18	0.97	205	-0.02	1.00	156	0.21	1.02
Grade 1 fall												
Initial phoneme identification	37	-0.27	1.13	183	-0.10	1.04	197	0.08	0.90	152	0.14	0.68
Phoneme blending	37	-0.32	1.17	183	-0.15	1.05	197	-0.02	0.96	152	0.10	0.92
Word reading accuracy	37	-0.10	1.22	183	-0.18	1.09	197	-0.01	0.98	152	0.10	0.93
Letter writing	37	-0.12	1.07	183	-0.20	1.13	197	0.06	0.96	152	0.08	0.88
Reading fluency												
Grade 1	35	-0.25	0.84	184	-0.11	0.80	197	0.05	0.83	150	0.07	0.92
Grade 2	35	-0.33	0.88	178	-0.19	0.84	194	0.08	0.82	148	0.08	0.88

(continued)

APPENDIX D

Girls' and Boys' Reading Skills by Father's Education Level (continued)

	Comprehensive school			Vocational school, High school			Vocational college, polytechnic, lower university degree (bachelor)			Higher university degree		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Grade 3	34	-0.37	0.74	177	-0.14	0.80	189	-0.02	0.76	149	0.02	0.88
Grade 4	33	-0.42	0.82	174	-0.23	0.81	186	0.07	0.78	148	0.10	0.90
Grade 6	28	-0.43	0.82	134	-0.17	0.74	143	0.01	0.82	135	0.06	0.87
Grade 7	24	-0.55	0.78	128	-0.23	0.89	136	0.02	0.84	129	0.07	0.82
Grade 9	24	-0.64	0.81	120	-0.23	0.85	135	-0.06	0.79	129	0.06	0.84
Reading comprehension												
Grade 1	34	-0.18	1.09	184	-0.18	0.99	196	0.18	1.03	150	0.19	1.03
Grade 2	35	-0.39	1.07	177	-0.20	1.05	192	0.07	1.02	148	0.18	0.91
Grade 3	34	-0.43	1.19	178	-0.28	1.18	189	-0.06	0.99	149	0.30	0.91
Grade 4	33	-0.52	1.08	174	-0.30	1.02	186	0.09	0.96	147	0.33	0.86
Grade 6	28	-0.59	0.89	134	-0.32	1.07	143	0.17	0.95	135	0.31	0.99
Grade 7	22	-0.55	0.87	127	-0.21	0.96	136	0.12	1.02	129	0.20	1.00
Grade 9	24	-0.47	1.05	120	-0.24	0.90	135	0.12	0.96	129	0.16	1.03
PISA reading												
Total score	21	-0.68	1.13	105	-0.36	1.03	121	0.02	0.97	109	0.23	0.85
Multiple-choice questions	21	-0.52	1.15	105	-0.20	1.00	121	0.03	1.00	109	0.22	0.94
Open-ended questions	21	-0.64	0.97	105	-0.39	1.04	121	0.02	0.97	109	0.20	0.90
Information retrieval	21	-0.63	1.11	105	-0.28	1.01	121	0.05	1.03	109	0.17	0.94
Interpretation	21	-0.48	1.10	105	-0.27	0.99	121	0.02	1.03	109	0.25	0.95
Evaluation	21	-0.64	0.99	105	-0.38	1.02	121	0.01	0.91	109	0.16	0.94

Note. Scores are standardized.