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Intergenerational Transmission of Dyslexia: How do Different Identification Methods of Parental Difficulties Influence the Conclusions Regarding Children's Risk for Dyslexia?

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ABSTRACT

By investigating children whose parents have dyslexia, family risk (FR) studies are expanding our understanding of the intergenerational transmission of dyslexia. These studies, however, vary in their identification of FR, and how the use of different identification methods influences research findings and conclusions is yet to be systematically investigated. This study aims to evaluate the association between two FR identification methods—parental self-reports and direct skill assessments—and their unique contributions in the prediction of children's reading. The study employed two datasets: a prospective FR sample (half of the parents in the sample had dyslexia and the remaining half did not) and an unselected sample. Parental self-reports and direct skill assessments correlated strongly (.60) in the prospective FR sample and moderately (.42) in the unselected sample. Moreover, both FR identification methods were almost equally predictive of children's reading (explaining 5%-9% of the variance at different time points) in the prospective FR sample only. In the prediction of the children's skills, the two methods complemented each other only for some of the measures. At the same time, in the unselected sample, parental skills were not predictive of children's reading, whereas self-reports were. The two FR identification methods seem to have equally high predictive power when the variability in parental data is high. However, they lose their predictive power when either the lower or higher end of the parental reading distribution is underrepresented.

Dyslexia is a neurodevelopmental disorder that affects the acquisition of reading skills and usually involves difficulties with reading fluency, accuracy, and spelling (American Psychiatric Association, 2011). Like other neurodevelopmental disorders, dyslexia is subject to intergenerational transmission. A recent meta-analysis of family risk (FR) studies (Snowling & Melby-Lervåg, 2016) estimated that if a child has a parent with dyslexia, their probability of having dyslexia is on average 45%. This makes parental reading difficulties an important risk marker for the early identification of children who are prone to later dyslexia and who are likely to benefit from early support.

Although estimations of the probability of dyslexia vary across studies, FR is a significant predictor of reading skills: children with FR are 4–10 times more likely to have reading difficulties than their peers without such family history (e.g., in Finnish, Torppa et al., 2011; in Norwegian, Esmaeeli et al., 2019; in Dutch, van Bergen et al., 2014; in English, Hulme

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et al., 2015; in Chinese, McBride-Chang et al., 2011). The predictive magnitude of FR varies across studies likely owing to their use of different methodologies to identify parental reading difficulties. The two main identification methods are parental self-reports of reading difficulties and direct skill assessments. Importantly, previous studies indicate that the accuracy of adult dyslexia identification can be significantly affected by the employed methodology (e.g., Deacon et al., 2012; Tamboer et al., 2014). However, how exactly these identification methods influence research findings and conclusions remains to be systematically investigated.

The next logical step to extend existing research is to investigate how different identification methods influence the prediction of children's reading skills. The extent to which parental self-reports and direct skill assessments explain common variance in children's reading skills remains unclear. There are three ways that parental self-reports and direct assessments may be considered: (1) the two methods can be used interchangeably because they provide risk estimations that fully correspond to each other and neither method is superior to the other; (2) one of the methods has a clear predictive advantage, so the other one can be completely abandoned; and (3) the two methods complement each other (e.g., in cases where parents have dyslexia that resolved over time), calling for both methods to be used together for better prediction accuracy. Establishing what FR identification method provides the best prediction accuracy is of empirical and theoretical interest for our current understanding of reading development and for future research. It is also of practical importance—compared with parental skill assessments, a short parental questionnaire can be more easily and widely used to screen for at-risk children. However, is this method sufficiently accurate when used alone? In this study, we set out to address this question. Overall, this study investigated the association between self-reported and directly assessed parental dyslexia, evaluated the unique contribution of each parental dyslexia identification method to predict children's skills, and evaluated the necessity of employing parental assessments for risk estimation after self-reports were already used.

FR Identification with Self-Reports

Self-reports are often regarded as a reliable measure to detect FR (Esmaeeli et al., 2018; Leavett et al., 2014; Snowling et al., 2012). Self-reports have repeatedly been noted as a time-saving and cost-effective tool, especially in large-scale studies for which demand is growing (Esmaeeli et al., 2018; McGonnell et al., 2007; Snowling et al., 2012). Currently, multiple self-report measures that employ various sets of questions are in use. Nevertheless, research investigating how these different measures and their specific items contribute to the accurate identification of children with FR is limited. Moreover, the accuracy of these measures cannot be compared across publications owing to various research design differences.

The main problem with all self-reports stems from researchers' inability to estimate how close the participants' perceptions of themselves are to an objective reality, as social desirability bias is likely to occur and participants' understandings of what constitutes reading difficulties likely vary. Snowling et al. (2012) found that factors such as age, gender, and socioeconomic status significantly influenced parents' likelihood of self-reporting reading difficulties. Deacon et al. (2012) reasonably argued that people can only fill in self-reports based on their individual perceptions of their skills. However, these perceptions can be easily distorted if, for example, a person compares themselves with a gifted sibling or was taught to read by someone who provided ill-suited feedback (either overly positive or negative).

The simplest self-reports rely on a direct self-identification of difficulties. For example, two recent large-scale FR studies (Esmaeeli et al., 2018, 2019; Khanolainen et al., 2020) used a self-report measure that consisted of only one question about having reading and/or writing difficulties. Such measures essentially capture a person's self-concept of ability that is based on a person's perception of oneself formed through experience with and interpretation of one's environment (Shavelson et al., 1976). Although such a simple yes-or-no self-report enabled the collection of large samples, its predictive power was low—FR only explained about 1% (Khanolainen et al., 2020) and 3% (Esmaeeli et al., 2018, 2019) of the variance in children's reading skills. Reducing the reliance on subjective self-perceptions in self-reports, however, is theoretically possible through tapping into different domains of participants' abilities by employing a combination of different types of questions.

A more comprehensive self-report measure was developed and tested by Snowling et al. (2012). Their 15-item questionnaire (the adult reading questionnaire) included not only self-concept questions (e.g., "Do you think you are a good reader?"), but also questions describing specific situations (e.g., "Do you have problems with organization or time management?" and "Do you find it difficult to find the right word to say?") and a direct question about diagnosis (e.g., "Have you ever had a diagnosis of dyslexia?"). Snowling et al. (2012) tested the validity of their measure by asking participants to complete both direct reading assessments and the adult reading questionnaire. Although the self-report measure was found to be valid in the sense that it correlated well with the tested skills, the researchers identified specific groups that were more likely to report difficulties. For example, fathers, older parents, and parents with higher levels of education were more likely to

self-report dyslexia. Establishing what explains these findings is difficult, but the researchers speculated that men and people with higher education might feel more comfortable with admitting their reading difficulties. Leavett et al. (2014) used the same dataset as Snowling et al. (2012) and found that adults with a higher socioeconomic status and mild difficulties were more likely to self-report dyslexia than adults with a lower socioeconomic status and more pronounced difficulties. They thus argued that people's self-perception of skills depends on their immediate circle of peers—people compare themselves to those with whom they socialize, and adults with a higher socioeconomic status are often surrounded with people having higher qualifications and more intellectually demanding jobs. However, the extent to which the adult reading questionnaire predicts children's reading difficulties is not known, as neither Snowling et al. (2012) nor Leavett et al. (2014) included children's skills in their analysis.

Another popular self-report measure to identify adult reading difficulties is the adult reading history questionnaire (ARHQ) developed by Lefly and Pennington (2000). Their 23 items tap into an adult's childhood abilities (e.g., "How much difficulty did you have learning to read in elementary school?"), current reading skills (e.g., "How would you compare your current reading speed to that of others of the same age and educational qualifications?"), and memory (e.g., "Do you have difficulty remembering addresses, phone numbers, or dates?"). Deacon et al. (2012) used ARHQ to test if the measure was sufficient to accurately identify high-functioning adults with dyslexia by comparing the reading skills and phonological awareness of three groups of university students: those with an official diagnosis of dyslexia received in childhood, those who never had a diagnosis but self-reported reading difficulties, and the controls. Because all participants were studying at the university level, authors considered those with either a childhood diagnosis or self-reported difficulties to be high-functioning individuals with dyslexia. The two groups with difficulties (diagnosed in childhood and self-reported) performed remarkably similarly across a variety of measures (word and non-word reading fluency and accuracy, reading comprehension, and phonological awareness). Based on these results, Deacon et al. (2012) argued that ARHQ is sufficiently accurate in identifying high-functioning adults with dyslexia whose difficulties were already mostly resolved. However, in FR research, ARHQ is primarily used in combination with direct assessments (Pennington & Lefly, 2001); therefore, the predictive power of the questionnaire regarding children's reading when used on its own remains unclear. Resolved or partly resolved difficulties in parents might still be an important risk factor for child development. The use of self-reports could be the only way to detect this group of parents, and ARHQ appears to be sensitive in this respect.

Specific items might be more predictive in some contexts than others, so the search for the most reliable and practical identification measures continues in different countries. For example, to detect dyslexia among Spanish adults, Giménez et al. (2017) recently developed a 30-item questionnaire with 30 specific situations (e.g., "You sometimes lose the thread of the conversation" and "You have to read slowly to avoid confusion"). Results showed that parental self-reports were almost as accurate predictors of the child reading achievement in Grade 1 as commonly used children's early cognitive skills—rapid automatized naming (RAN) letters, word accuracy, and phonological processing. The researchers performed receiver operating characteristic (ROC) analysis to assess the predictors' discriminative potential and reported the following results: area under curve (AUC) of self-report = .69, AUC of RAN = .73, AUC of phonological processing = .76, and AUC of word accuracy = .81. Although the findings for self-reports do not suggest strong discriminating power (as AUC was below .70), the researchers argued that because parental skill assessments are out of school scope, self-reports are a good alternative measure to identify preschool children in need of preventative support.

Another comprehensive self-report inventory was recently developed in Dutch by Tamboer and Vorst (2015) and included 56 items. First, participants with dyslexia were identified using 10 tests covering all known symptoms of dyslexia (Dutch dictation, English dictation, pseudowords, sound deletion, spoonerisms, spelling, rhyming words, words with missing letters, words with changed letter order, and working memory). Second, the researchers tested which of the self-report items were most predictive of directly assessed dyslexia. They found that less than 20 items were sufficient to accurately differentiate between adults with and without dyslexia, with estimations of correct positive and negative identifications being 89% and 99%, respectively. Despite its promising results, to date, this identification method has not been used in any FR research to predict children's skills. Overall, only few studies use FR to predict children's skills, and they all use different FR identification methods. Thus, before deciding if large-scale studies should shift away from cumbersome assessment batteries and exclusively rely on the use of concise self-report measures, evaluating how FR identification methods influence the prediction of children's skills is important.

FR Identification with Direct Skill Assessments

FR studies using parental reading assessments have reported varying predictive values of FR on children's skills. For example, Torppa et al. (2011) and van Bergen

et al. (2014) estimated that FR identified with direct assessments could explain 8%–16% and 11% of the variance in children's reading fluency (children aged 9 in both samples), respectively. In a later cross-sectional study, van Bergen et al. (2016) reported that 17% of the variance in children's (age range: 7–17 years, M = 10.92 years, SD = 2.21) reading fluency was predicted by parental reading fluency.

The main drawback of adult skill assessments was highlighted by Deacon et al. (2012) and Tamboer et al. (2014)—compared with childhood, difficulties in adulthood usually become less pronounced (especially in people with resolved dyslexia) as skills change through educational and occupational experiences. In a Finnish sample of 48 adults with diagnosed childhood reading difficulties and 37 controls, Eloranta et al. (2019) found that more than half (60.4%) of those with childhood reading difficulties did not meet the criteria for adult reading difficulties. This finding calls for further research to investigate whether using parental self-reports and direct skills assessments together increases FR's predictive power.

Present Study

FR studies considerably vary in their research design (in measures and their cutoffs, in participants' age and language, in their decision to include or exclude those with comorbid difficulties, etc.), and the identification tool that predicts children's skills with the highest accuracy has not yet been identified. Thus, research is required that employs both methods—parental self-reports and direct skills assessments—in conjunction, allowing for their effective comparison. This study aimed to analyze how different FR identification methods influence the results of FR studies in the Finnish context. The study sought to answer the following research questions:

1. What is the relationship between self-reported reading difficulties and reading difficulties identified with direct skill assessments among parents?
2. What is the association between parental difficulties (identified with self-reports or direct assessments) and children's skills?
3. Do additional direct skill assessments improve the prediction of children's skills obtained with only parental self-reports?
4. Do the predictive values of self-reports and direct assessments hold when children's own skills from earlier time points are included into the model (as autoregressors)?

To answer these research questions, the present study employed two different samples collected in Finland. The first was the Jyväskylä longitudinal study of dyslexia (JLD) that used a prospective FR design (half of the children in the sample were at FR for dyslexia identified through parental dyslexia and half were controls); this sample had statistical power because it included many parents with dyslexia and had a long follow-up (from birth to age 23), but it made generalization to a general population sample problematic. The second was the interaction, learning, and development (VUOKKO) study that had a recently collected population-based sample; however, the follow-up was short because the children have recently completed Grade 1. The JLD sample had more parents and children with dyslexia and thus more variability. Therefore, we expected stronger associations between parental variables and children's skills in this prospective FR sample than in the VUOKKO sample. However, the population-based sample VUOKKO allowed to validate the associations found in the JLD sample and decide whether they could be generalized to a general population. Both samples had their own advantages and limitations, and using them in combination helped assess the value of different FR identification methods in the prediction of children's reading skills from pre-school to adulthood. Previous studies have provided only a fragmented picture so far because they used samples with specific populations (university students and at-risk groups of people) and/or had a different research focus owing to which their analysis did not include either children's skills or both parental variables (self-reports or direct skill assessment scores). Answering our research questions using both samples enabled us to systematically evaluate how the application of different FR identification methods in different samples can influence our understanding of dyslexia and its intergenerational transmission.

Method

Sample 1

JLD aimed to identify the early precursors of dyslexia by recruiting 200 families expecting a child between 1993 and 1995 and following them since the children were newborns (Leinonen et al., 2001; Lohvansuu et al., 2021). In the present study, we included JLD data from parents (collected before the children were born) and data from their children (collected at six time points: age 7/Grade 1, age 8/Grade 2, age 9/Grade 3, age 14/Grade 8, and age 23). Half of the children were at FR for dyslexia ($N = 102$), and half were age-matched controls ($N = 89$). To be included in the FR group, children needed to have at least one parent with dyslexia. Parental dyslexia was identified using direct skill assessments, clinical interviews, and questionnaires. In addition to concurrent difficulties, the parent with dyslexia was expected to report childhood reading difficulties and having at least one other relative with dyslexia. To be included in the control group, children's parents were

required to achieve a z-score higher than −1 in all literacy-related assessments and to report no reading difficulties in their family. Moreover, the two groups were matched on the basis of intelligence quotient scores (all of them had scores higher than 80) and educational levels (they were close to the average level in Finland; see Table 2 for more details). All families recruited in the study were monolingual and spoke Finnish as their first language.

Parental Measures

In the JLD sample, the parents were included based on an initial screening questionnaire. Next, the parents' skills were tested. Then, based on the testing results, they were divided into control and FR groups. In all control families, both parents were tested to ensure that their child did not have FR for dyslexia. The average reading scores of the parents in the control group were used in this study. However, in the at-risk families, only the parents who self-reported dyslexia in the initial screening questionnaire were tested to ensure that they indeed had dyslexia and that the child had FR for dyslexia. Thus, most at-risk families only had a test score available from one parent with dyslexia, and this individual score was used in all calculations (in 10 at-risk families, however, both parents were tested, and in 3 families, both parents had dyslexia; average reading scores of both parents were obtained in those cases).

Direct Reading Assessments

The cognitive assessment for the parents with self-reported dyslexia included a broader assessment battery than the one used with the controls. Of the assessments, two reading tasks that were available for both groups, controls and parents with dyslexia, are included in this study: (1) text reading accuracy and fluency (Tunturilappi: Leinonen et al., 2001) and (2) pseudoword reading accuracy and fluency (Leinonen et al., 2001).

In the text reading task, parents were asked to read aloud a passage about Lapland as fast and as accurately as they could. The reading time of the passage in seconds was the score for text reading fluency, and the total number of correctly read words was the score for text reading accuracy. In the pseudoword reading task, parents were asked to read aloud 30 pseudowords presented one by one (their length varied from two to four syllables). The mean reaction time was the score for reading fluency, and the number of correctly read pseudowords was the score for reading accuracy. The total score of parental skills was computed as an average of the two fluency and two accuracy z-scores. Cronbach's alphas for the overall composites were .92 for both mothers and fathers.

Self-reports of Reading Difficulties

Parents were asked to complete a self-report measure that included items that were identical or almost identical to the items from the ARHQ (Lefly & Pennington, 2000). The 12 items used in this study corresponded to the ARHQ items 2, 5, 6, 9, 11, 13, 16, 17, 19, 20, 22, and 23. An average of both parental self-reports was obtained in the case of all control families and when data on the at-risk families with two parental assessments were available (10 cases). In the case of most at-risk families, however, an individual score of the parent who participated in the reading assessment was used. Cronbach's alphas for the composites of all self-report items were .81 for mothers and .77 for fathers.

Child Measures

Separate total scores for reading fluency and accuracy were computed for different time points (Grades 2, 3, and 8 as well as age 23) as the composites of the fluency and accuracy scores achieved on the assessments listed below (word list reading, text reading, and pseudoword text reading). Cronbach's alphas for the fluency composites were .90 in Grade 2, .87 in Grades 3 and 8, and .86 at age 23. Cronbach's alphas for the accuracy composites were .65 in Grade 2, .67 in Grade 3, .60 in Grade 8, and .66 at age 23. Grade 1 assessment included only one measure.

Word Reading

A subtest of the nationally standardized reading test battery (ALLU; Lindeman, 1998) was used to assess word-level reading in Grade 1. This test offered 80 items containing a picture with four phonologically similar words next to it. Children were asked to look at pictures and choose a matching word for them within a 2-min time limit. The fluency score used in the analyses was obtained by calculating the sum of correct answers (the maximum value was 80). The accuracy score was calculated as 100 * the sum of correct answers/(the sum of correct answers + the sum of incorrect answers).

Word List Reading

Word list reading was assessed with the nationally standardized reading test Lukilasse (Häyrinen et al., 1999) in Grades 2, 3, and 8 and at age 23. The reading list comprised 90 items in Grade 2 and 105 items in Grades 3–8 and at age 23. Children were asked to read aloud as many words as possible within 2 min in Grade 2 and within 1 min in Grades 3 and 8. The fluency score was calculated as the sum of all correctly read words, whereas the accuracy score corresponded to the percentage of correctly read words out of all attempted items.

Text Reading

Three age-appropriate texts of varying lengths (124–204 words) were used to assess text reading in Grades 2, 3, and 8 and at age 23. The reading time was considered as the fluency score, and the percentage of correctly read words corresponded to the accuracy score.

Pseudoword Text Reading

Children were asked to read aloud a short text comprising 19 pseudowords in Grade 2 and 38 pseudowords in Grades 3 and 8 and at age 23. The sentence structure and made-up words resembled the Finnish language. The reading time was considered as the fluency score. The percentage of correctly read words was considered as the accuracy score.

Sample 2

The VUOKKO study (Lerkkanen & Salminen, 2015–2019; Salminen, Lerkkanen, et al., 2021–2023) is a follow-up study that follows the development of children's emerging literacy and numeracy skills across toddlerhood (age 2–3 years), preschool (age 5–6 years), and primary school (age 7/Grade 1). The VUOKKO study aims to better understand how the characteristics of children's different learning environments (early childcare and learning, primary education, and children's home environment) are associated with children's learning and development across childhood. For the study, children born in 2013 (N = 265; 138 males, 127 females), with their parents and early childhood educators, were recruited from one mid-sized city in Central Finland in 2015 when the children were 2 years old. Majority of the families recruited in the study were monolingual and spoke Finnish as their first language (five families spoke a language other than Finnish). In the present study, we used data collected at one time point: at age 7–8/Grade 1 (N = 318; 152 girls and 166 boys).

Parental Measures

Direct Reading Assessments

When the children in the sample were in Grade 1, their parents were invited to participate in the assessment of their own reading skills. Of the assessments, two reading tasks are included in this study: (1) text reading accuracy and fluency (Tunturilappi: Leinonen et al., 2001) and (2) pseudoword list reading accuracy and fluency (Nevala et al., 2006).

In the text reading task, parents were asked to read aloud as fast and as accurately as they could the same passage about Lapland used in Sample 1 (JLD). The reading time of the passages in seconds was considered as the score for reading fluency, and the total number of correctly read words was considered as the score for text reading accuracy. In the pseudoword list reading task, parents were asked to read aloud the list of pseudowords as quickly and as accurately as they could. The fluency score was represented by the total reading time, and the accuracy score was the number of correctly read pseudowords. The total parental skill score was computed as the average of the two fluency and two accuracy z-scores. Cronbach's alphas for the parental skill scores (combining text and pseudoword list accuracy and fluency) were .68 and .76 for mothers and fathers, respectively. In cases when the scores of both parents were available, their average was calculated (both parents of 37 children were assessed). However, in the case of most children, only one parent consented to their direct assessment (59 fathers and 88 mothers). Thus, their individual scores were used in all calculations.

Self-reports of Reading Skills and Difficulties

All parents of children in Grade 1 were asked to self-assess their reading skills by completing the full set of items of the ARHQ (Lefly & Pennington, 2000). We then selected the 12 items that were also available in JLD. Cronbach's alphas for the composites of the selected items were .76 and .73 for mothers and fathers, respectively. All available self-reports were used in initial analyses. However, because the parental skill assessment data had considerable missingness, analysis was performed a second time including only those self-reports whose direct assessments were also available (the sum score of both parental self-reports was obtained for families whose both direct assessments were available, and an individual self-report score was used in cases when only one parent participated in the assessments).

Child Measures

Separate total scores were computed for reading fluency and accuracy in Grade 1 by combining the word reading and sentence reading tasks. Cronbach's alphas for the fluency and accuracy composites were .87 and .56, respectively.

Word Reading

A subtest of the nationally standardized reading test battery (ALLU/TL2A; Lindeman, 1998) was used to assess word-level reading fluency and accuracy in Grade 1. In this test, a maximum of 80 items can be attempted within a 2-min time limit. Each item contained a picture with four words next to it. Children were asked to read the four phonologically similar words and draw a line connecting the picture to the word that matched it. The fluency score used in the analyses was obtained by calculating the sum of correct answers (the maximum value was 80). The accuracy score was calculated as 100 * the sum of correct answers/(the sum of correct answers + the sum of incorrect answers).

Sentences Reading

The test of silent reading efficiency and comprehension (TOSREC; Wagner et al., 2009) was used as a measure of sentence-level reading fluency and accuracy in Grade 1. TOSREC is a group-administered reading test wherein children read and evaluate the truthfulness of sentences based on real-world knowledge. The sentences gradually became more difficult. Children were given 3 min to read

and verify the truthfulness of as many sentences as possible. The fluency score was calculated by summarizing the number of correct answers (the maximum value was 60). The accuracy score was calculated in the same way as for the word reading task.

Statistical Analysis

Table 1 lists the descriptive statistics for all variables used in both samples in this study. Because the distributions of many variables were skewed, we used the maximum likelihood estimator with robust standard errors (MLR) for model estimation in Mplus. Reliance on robust standard errors provides more accurate results when data are non-normal (Maydeu-Olivares, 2017; Savalei, 2010). Before performing the analysis, we checked the two datasets for outliers. Few outliers were detected using z-scores with cutoff values of 3 and −3. We then performed our analysis twice—first with clean datasets in which outliers were moved to the tails and second with original datasets in which outliers were kept intact. The results did not significantly differ. In view of this, the findings reported below were obtained with the original datasets.

As the next step of data preparation, we examined the patterns of missing data. In the JLD sample, the parental self-reports had no missing data and parental skill assessments had only two missing values. Little's test of missing completely at random (MCAR) showed that children's data were missing at random ($\chi^2(18) = 23.853$, $p = .160$) with one exception—skills in Grade 1. This variable, however, contained very few missing values (two values, which is around 1%). In view of this, we proceeded with our analysis without any further action related to missingness.

In contrast, in the VUOKKO sample, 336 parents submitted their self-reports, but only 147 parents' skills were directly assessed. Overall, out of the 318 children assessed in Grade 1, 101 had at least one parent with a direct assessment. Extensive missingness in parental skills prompted us to examine its pattern. We performed Little's MCAR test; results showed that parental skills were not missing at random ($\chi^2(10) = 19.32$, $p = .036$). Further inspection revealed that parents whose children had lower reading scores were less likely to participate in a direct assessment.

Apart from this systematic missingness in parental skill data, we established that the VUOKKO sample had other distinctive features that need to be noted. Although parental reading test and self-report scores were approximately normally distributed, highly educated parents with solid reading skills were overrepresented. Table 2 shows that in the VUOKKO sample, parents were not only more educated than those in the JLD sample, but also more educated than the control parents in the JLD sample. In addition, we specifically examined the results of the text reading task because it was used to assess parents in both samples (Tunturilappi: Leinonen et al., 2001). This analysis revealed that the parents in the VUOKKO sample read faster than the control parents in the JLD sample (the means in the entire VUOKKO sample were 124.54 and 134.86 s for mothers and fathers, respectively, whereas the means in the JLD control group were 137.96 and 147.57 s for mothers and fathers, respectively). The implications of these sample characteristics are discussed later in the article (in the Discussion section).

Our analysis strategy comprised three main steps and was followed for each dataset using SPSS 24 and Mplus Version 7.4 (Muthén & Muthén, 2012). First, we separately used each FR identification method's scores (parental skill assessments and self-reports) to predict children's skills at each time point through a series of simple linear regressions. Second, we conducted hierarchical linear regression analysis to assess whether the inclusion of direct assessment improves children's skill prediction conducted with only parental self-reports. We also added the interaction between parental self-reports and skill assessments as the last block in our hierarchical regressions to determine whether having all the different aspects of FR (a person's broadly but subjectively self-reported history of various experiences related to reading as well as adult difficulties objectively but briefly measured via direct assessments) constitutes a particularly high risk for children's reading development. Third, to further investigate the predictive relations between parental and children's variables, longitudinal path models with observed variables were constructed. Separate path models (that included both self-reported and assessed parental skills as predictors of children's skills at all time points) were fitted to the longitudinal dataset (JLD): one for children's reading fluency and the other for children's reading accuracy. The goodness of fit of these models was assessed using four indicators: chi-square test, comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). To be considered as a model with a good fit, the four indices below needed to be as follows: non-significant chi-square, CFI greater than 0.95, RMSEA less than 0.06, and SRMR less than 0.08 (Hu & Bentler, 1999).

Results

Pearson correlation coefficients are reported across all measures in Table 3 for JLD and Table 4 for VUOKKO. Most variables were significantly related with one another. As can be seen from these tables, parental self-reported difficulties and parental reading skills assessed with direct assessments were significantly correlated (.60 in JLD and .42 in VUOKKO). These associations provide an answer to our first research question.

To answer the second research question (about the association between parental difficulties and children's

TABLE 1
Descriptive Statistics for All Variables Across Time

	N	Minimum	Maximum	Mean	SD	Skewness (std. error)	Kurtosis (std. error)
JLD (the whole sample)							
Reading fluency							
Grade 1	182	8.00	80.00	43.53	19.68	.33 (.18)	−.86 (.36)
Grade 2	169	1.23	10.22	5.16	2.06	.26 (.19)	−.68 (.37)
Grade 3	191	1.55	11.30	5.84	1.86	.38 (.18)	−.13 (.35)
Grade 8	173	2.96	13.85	8.71	2.03	−.11 (.18)	−.09 (.37)
Age 23	129	4.10	17.48	10.21	2.23	.21 (.21)	−.36 (.42)
Reading accuracy							
Grade 1	182	28.13	100.00	95.49	9.41	−4.51 (.18)	23.18 (.36)
Grade 2	169	56.53	100.00	88.29	9.05	−1.23 (.19)	1.09 (.37)
Grade 3	191	63.56	100.00	91.41	7.23	−1.50 (.18)	2.09 (.35)
Grade 8	173	72.46	99.68	94.93	4.94	−2.46 (.18)	6.85 (.37)
Age 23	129	73.91	100.00	97.17	3.53	−3.58 (.21)	17.39 (.42)
Parental formally assessed reading skill							
	189	−1.02	5.21	.00	1.00	2.05 (.18)	5.39 (.35)
Parental self-reported reading skill							
	191	.21	2.27	.97	.43	.64 (.18)	−.14 (.35)
JLD (FR group only)							
Reading fluency							
Grade 1	97	8.00	80.00	38.20	18.22	.60 (.24)	−.40 (.48)
Grade 2	94	1.23	9.33	4.52	1.81	.40 (.25)	−.34 (.49)
Grade 3	102	1.75	11.30	5.42	1.77	.76 (.24)	1.02 (.47)
Grade 8	95	2.96	13.85	8.19	2.10	.16 (.25)	−.26 (.49)
Age 23	69	5.59	16.18	9.70	2.29	.52 (.29)	−.11 (.57)
Reading accuracy							
Grade 1	97	45.28	100.00	94.43	10.17	−3.30 (.24)	11.07 (.48)
Grade 2	94	56.53	99.46	85.86	10.34	−.84 (.25)	−.07 (.49)
Grade 3	102	63.56	100.00	89.48	7.99	−1.01 (.24)	.58 (.47)
Grade 8	95	74.33	92.52	93.85	5.62	−1.87 (.25)	3.28 (.49)
Age 23	69	82.12	100.00	96.75	3.49	−2.27 (.29)	5.95 (.57)
Parental formally assessed reading skill							
	100	−.75	5.21	.59	1.06	1.68 (.24)	3.79 (.48)
Parental self-reported reading skill							
	102	.42	2.27	1.28	.35	.48 (.24)	−.42 (.47)
JLD (controls only)							
Reading fluency							
Grade 1	84	8.00	80.00	49.49	19.69	.06 (.26)	−.99 (.52)
Grade 2	75	1.60	10.22	5.56	2.07	−.05 (.28)	−.81 (.55)

(continued)

TABLE 1
Descriptive Statistics for All Variables Across Time (*continued*)

	N	Minimum	Maximum	Mean	SD	Skewness (std. error)	Kurtosis (std. error)
Grade 3	89	1.55	10.69	6.33	1.86	.01 (.25)	−.51 (.51)
Grade 8	78	3.33	13.85	9.34	1.74	−.25 (.27)	.97 (.54)
Age 23	60	4.10	17.48	10.79	2.03	−.01 (.31)	2.43 (.61)
Reading accuracy							
Grade 1	84	28.13	100.00	96.69	8.40	−6.99 (.26)	55.24 (.52)
Grade 2	75	71.13	100.00	91.34	5.89	−1.30 (.28)	1.86 (.55)
Grade 3	89	65.83	100.00	93.63	5.50	−2.36 (.25)	7.99 (.51)
Grade 8	78	72.46	99.68	96.25	3.57	−4.16 (.27)	25.37 (.54)
Age 23	60	73.91	100.00	97.64	3.56	−5.30 (.31)	34.30 (.61)
Parental formally assessed reading skill							
	89	−1.02	.12	−.66	.18	.81 (.25)	2.67 (.51)
Parental self-reported reading skill							
	89	.21	1.81	.62	.18	.43 (.25)	−.08 (.51)
VUOKKO (the whole sample)							
Reading fluency							
Grade 1	318	−2.14	4.36	.00	.94	.78 (.14)	1.39 (.27)
Reading accuracy							
Grade 1	318	−8.20	.48	.00	.83	−4.97 (.14)	37.14 (.27)
Parental formally assessed reading skill							
	100	−1.35	2.19	−.03	.64	.91 (.24)	1.35 (.48)
Parental self-reported reading skills							
	316	1.17	4.17	2.11	.54	.74 (.14)	.60 (.27)

skills at each time point), a series of simple linear regressions were calculated. The results are presented in Table 5 for the JLD sample and in Table 6 for the VUOKKO sample. Regressions were calculated first with parental self-reports as a single predictor and then with parental test scores as a single predictor of children's skills. Regarding the JLD sample, the regressions were run for the full sample and then separately for the FR and control groups.

In the JLD sample, self-reported parental reading and directly assessed parental reading were both significant predictors of children's reading fluency and accuracy at most ages. The only exceptions were children's accuracy in Grade 1 and at age 23—neither parental measure was significantly predictive at these two time points. The regression coefficients for the self-reports and assessments were similar; they predicted between 5% and 8% of variance in children's fluency and between <1% and 15% in children's reading accuracy. However, parental self-reports and skill assessments were rarely significant predictors when the FR and control groups were separated. Among the controls, parental skills predicted children's reading fluency in Grade 2. Among the FR group, parental skills predicted children's reading accuracy in Grade 3.

In the VUOKKO sample, reading fluency in Grade 1 was significantly predicted by parental self-reports but not by their directly assessed skills. Moreover, as can be seen from Table 6, self-reports were significantly predictive of children's fluency in Grade 1 only when all available self-reports were included. However, self-reports stopped being significantly predictive when the model included only the self-reports from parents who also participated in a direct skill assessment. In addition, neither parental measure predicted children's accuracy in Grade 1, thus replicating the findings of the JLD sample.

Because findings based on p-values alone can be misleading, Tables 5 and 6 present the confidence intervals and coefficients of determination. Moreover, most of the significant values would remain significant ($p < .05$) even if the p-values were adjusted for multiple testing using the Bonferroni correction method (multiplying the raw

TABLE 2
Parental Education Levels in JLD and VUOKKO

Parental education levels	JLD			VUOKKO
	Whole sample	FR group only	Controls only	Whole sample
	N (percent in the sample)			*N* (percent in the sample)
Mothers				
No vocational education or short-term courses only	11 (5.5%)	8 (7.8%)	3 (3.4%)	1 (0.4%)
Vocational school degree	48 (24.0%)	31 (30.4%)	16 (18.0%)	53 (20.1%)
Vocational college degree	53 (26.5%)	22 (21.6%)	30 (33.7%)	10 (3.8%)
University degree (including higher degrees)	88 (44.5%)	41 (40.2%)	40 (44.9%)	200 (75.8%)
Fathers				
No vocational education or short-term courses	14 (7.1%)	6 (5.9%)	8 (9.0%)	4 (3.5%)
Vocational school degree	98 (49.5%)	56 (55.4%)	37 (41.6%)	22 (19.5%)
Vocational college degree	37 (18.7%)	18 (17.8%)	17 (19.1%)	7 (6.2%)
University degree (including higher degrees)	49 (24.7%)	21 (20.8%)	27 (30.3%)	80 (70.8%)

p-values by the number of tests). The use of both this method and multiple effect indicators reveals consistent results, thus increasing our confidence in our findings. The overall pattern is clear: in the JLD sample, the two parental measures were equally significant predictors of both children's fluency and accuracy (with two exceptions—accuracy in Grade 1 and at age 23; these values were predicted by neither method), whereas in the VUOKKO sample, only parental self-reports were predictive of children's fluency in Grade 1 (again, accuracy in Grade 1 was not predicted).

To assess whether the inclusion of both FR identification methods improved the prediction of children's skill (the third research question), or whether the interaction

TABLE 3
Pearson Correlation Coefficients Between all Variables in the JLD Sample

	1	2	3	4	5	6	7	8	9	10	11	12
1. Reading fluency in Grade 1	1											
2. Reading fluency in Grade 2	.77***	1										
3. Reading fluency in Grade 3	.64***	.89***	1									
4. Reading fluency in Grade 8	.51***	.73***	.79***	1								
5. Reading fluency at Age 23	.46***	.71***	.76***	.80***	1							
6. Reading accuracy in Grade 1	.41***	.38***	.32***	.29***	.26**	1						
7. Reading accuracy in Grade 2	.55***	.51***	.51***	.49***	.49***	.39***	1					
8. Reading accuracy in Grade 3	.51***	.59***	.51***	.55***	.58***	.37***	.68***	1				
9. Reading accuracy in Grade 8	.33***	.42***	.43***	.43***	.51***	.30***	.55***	.67***	1			
10. Reading accuracy at Age 23	.32***	.39***	.41***	.45***	.44***	.28***	.52***	.67***	.75***	1		
11. Parental skills assessment	26***	.29***	.23**	.27***	.29**	.05	.31***	.39***	.19*	.23**	1	
12. Parental self-report	.26***	.29***	.24**	.28***	.22*	.12	.25**	.26***	.20**	.16	.60***	1

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

TABLE 4
Pearson Correlation Coefficients Between all Variables in the VUOKKO Sample

	1	2	3	4
1. Reading fluency in Grade 1	1			
2. Reading accuracy in Grade 1	.30***	1		
3. Parental skills assessment	.02	.06	1	
4. Parental self-report	.27***	.09	.42***	1

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

between self-reports and skill assessments predicted children's skills, a series of hierarchical linear regressions was performed (one for each time point). This analysis was performed only with the JLD sample after it was established that in the VUOKKO sample, children's skills were predicted only by parental self-reports (Table 7). Parental self-reports in JLD were added as a predictor for the first block analysis, direct assessments for the second block analysis, and the interaction of self-reports and assessments for the third block analysis (prior to this step in the analysis, independent variables were centered to reduce structural multicollinearity). The results revealed that incorporating direct skill assessments did not significantly improve the prediction of children's fluency over and above the self-report measure. One exception was the reading fluency at age 23, where the prediction was improved by implementing both FR identification methods. Moreover, the prediction of children's accuracy in Grades 2 and 3 and at age 23 was significantly improved by implementing parental skill assessments. None of the interactions was significantly predictive, suggesting that the effects either were tapping the same variance or were additive (for reading fluency at age 23 and reading accuracy in Grades 2 and 3 and at age 23).

To further assess the association between parental difficulties and children's reading skills and to answer the fourth research question (about the addition of

TABLE 5
Standardized Model Estimates in Simple Linear Regressions Conducted Separately for Each Time Point, for Each Predictor and for the Controls and FR Group (JLD Sample)

	Predictor—Parental self-reports						Predictor—Parental skills					
Outcome	Whole sample estimate (s.e.) 95% CI	R^2	FR group estimate (s.e.) 95% CI	R^2	Control group estimate (s.e.) 95% CI	R^2	Whole sample estimate (s.e.) 95% CI	R^2	FR group estimate (s.e.) 95% CI	R^2	Control group Estimate (s.e.) 95% CI	R^2
Reading fluency												
Grade 1	.26*** (.07) [.12, .40]	.07	.07 (.11) [−.15, .30]	.01	.10 (.11) [−.12, .32]	.01	.26*** (.06) [.15, .38]	.07	.13 (.08) [−.02, .28]	.02	.19 (.11) [−.03, .40]	.03
Grade 2	.29*** (.07) [.16, .43]	.09	.04 (.10) [−.16, .25]	.00	.09 (.12) [−.15, .34]	.01	.29*** (.06) [.19, .38]	.08	.08 (.09) [−.06, .22]	.01	.28* (.11) [.10, .47]	.08
Grade 3	.24*** (.06) [.12, .37]	.06	.11 (.09) [−.07, .29]	.01	.09 (.12) [−.14, .32]	.01	.23*** (.06) [.12, .34]	.05	.12 (.08) [−.03, .28]	.01	.11 (.10) [−.08, .31]	.01
Grade 8	.28*** (.07) [.14, .41]	.08	.10 (.10) [−.09, .29]	.01	.12 (.12) [−.12, .36]	.01	.27*** (.06) [.15, .39]	.07	.13 (.08) [−.03, .30]	.02	.13 (.12) [−.10, .37]	.02
Age 23	.22** (.08) [.07, .37]	.05	.06 (.10) [−.15, .26]	.00	.05 (.15) [−.25, .36]	.00	.29*** (.08) [.13, .43]	.08	.22* (.09) [.03, .40]	.05	.18 (.11) [−.03, .39]	.03
Reading accuracy												
Grade 1	.12 (.09) [−.05, .30]	.01	.05 (.12) [−.18, .28]	.00	.05 (.11) [−.17, .27]	.00	.05 (.06) [−.07, .17]	.00	.06 (.09) [−.23, .11]	.00	.12 (.08) [−.04, .28]	.01
Grade 2	.25** (.08) [.10, .40]	.06	.03 (.11) [−.19, .25]	.00	.09 (.13) [−.17, .35]	.01	.31*** (.08) [.15, .46]	.09	.18 (.11) [−.03, .39]	.03	.02 (.11) [−.20, .23]	.00
Grade 3	.26*** (.07) [.12, .40]	.07	.06 (.10) [−.14, .26]	.00	.10 (.13) [−.17, .36]	.01	.39*** (.07) [.24, .53]	.15	.34** (.10) [.15, .54]	.12	.01 (.09) [−.17, .19]	.00
Grade 8	.20** (.07) [.07, .32]	.04	.02 (.11) [−.23, .19]	.00	.17 (.16) [−.14, .48]	.03	.19* (.09) [.00, .38]	.04	.06 (.13) [−.19, .31]	.00	.02 (.07) [−.16, .13]	.00
Age 23	.16 (.09) [−.02, .34]	.03	.10 (.14) [−.17, .36]	.01	.14 (.20) [−.24, .52]	.02	.23 (.15) [−.07, .54]	.05	.33 (.20) [−.07, .73]	.11	.05 (.05) [−.15, .06]	.00

Note. *$p < .05$, **$p < .01$, ***$p < .001$. All models were saturated.

TABLE 6
Standardized Model Estimates in Simple Linear Regressions Conducted Separately for Each Time Point and for Each Predictor (VUOKKO Sample)

	Predictor—Parental self-reports			Predictor—Parental skills		
Child outcomes	Estimate (s.e.)	95% CI	R^2	Estimate (s.e.)	95% CI	R^2
Regressions with all self-reports included (N = 336)						
Reading fluency, Grade 1	.27*** (0.05)	[.17, .37]	.07	.02 (0.09)	[−.16, .21]	.00
Reading accuracy, Grade 1	.09 (0.05)	[−.01, .19]	.01	.09 (0.09)	[−.07, .24]	.01
Regressions with self-reports from parents who also participated in assessments (N = 103)						
Reading fluency, Grade 1	.12 (0.10)	[−.08, .31]	.01	.02 (0.09)	[−.16, .21]	.00
Reading accuracy, Grade 1	.11 (0.08)	[−.27, .04]	.01	.09 (0.09)	[−.07, .24]	.01

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. The models were saturated.

autoregressors), two longitudinal path models were constructed with the JLD total sample (one for fluency and the other for accuracy, as presented in Figures 1 and 2, respectively). The accuracy model fitted the data well: $\chi 2(6) = 11.50$, $p = .07$, RMSEA = .06, CFI = .98, and SRMR = .06. However, because the same type of model for fluency did not fit the data well, we inspected the modification indices provided by Mplus. A theoretically relevant path with modification index above 10.00 was added to the fluency model to improve its fit: children's reading fluency at age 23 was regressed on reading fluency in Grade 3 (standardized estimates of this path are presented in Figure 1). After the new path was added, the fluency model fitted the data well: $\chi^2(5) = 5.92$, $p = .31$, RMSEA = .03, CFI = .99, and SRMR = .01.In comparison to the previous models (simple linear regressions), these two longitudinal models included children's skills as autoregressors; therefore, both parental skill assessment scores and self-reports stopped being predictive of children's reading fluency. For the accuracy model, however, parental skill assessment scores were still significantly predictive of children's reading accuracy in Grade 2. Overall, children's fluency scores demonstrated higher stability over time than their accuracy scores.

Discussion

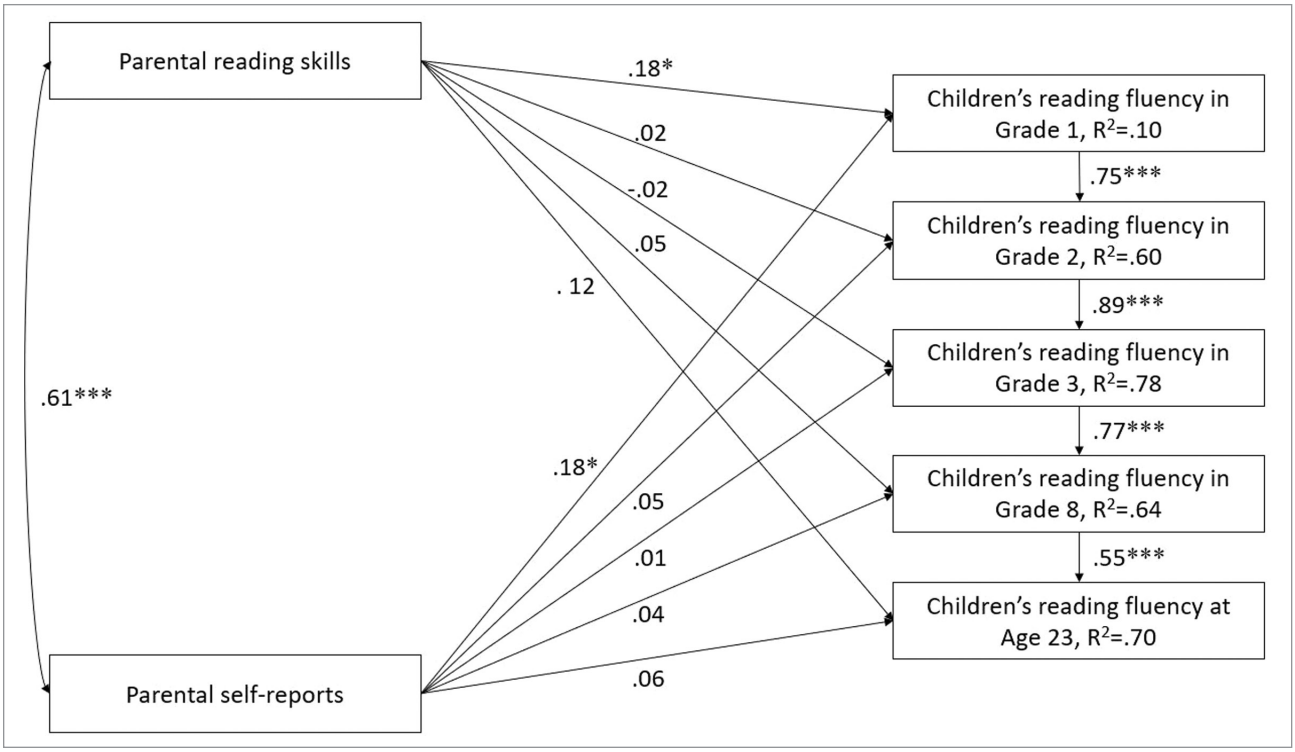
FR for dyslexia can be defined as children's predisposition for developmental dyslexia stemming from one or both of their parents having dyslexia. In this study, we investigated how different FR identification methods influence the associations between FR and children's reading skills. Our study employed two different samples collected in Finland.

TABLE 7
Hierarchical Regressions for Fluency and Accuracy Outcomes in JLD (the Whole Sample), Each with Three Steps: 1) Self-reports, 2) Formal Assessments, 3) Interaction Between Self-reports and Formal Assessments

	Parental self-report (step 1)		Parental formal tests (step 2)		Interaction (step 3)	
Child outcomes	ΔR^2	F change	ΔR^2	F change	ΔR^2	F change
1. Gr 1 fluency	.07	13.41***	.02	3.52	.00	.58
2. Gr 2 fluency	.09	15.58***	.02	3.72	.01	1.23
3. Gr 3 fluency	.06	12.36**	.01	1.97	.00	.02
4. Gr 8 fluency	.08	13.81***	.02	3.14	.01	1.05
5. Age 23 fluency	.04	5.61*	.04	5.33*	.00	.26
6. Grade 1 accuracy	.02	2.90	.00	.17	.01	1.45
7. Grade 2 accuracy	.05	9.58**	.04	8.06**	.00	.43
8. Grade 3 accuracy	.06	11.85**	.09	19.83***	.00	.29
9. Grade 8 accuracy	.03	5.75*	.01	1.89	.01	1.34
10. Age 23 accuracy	.01	1.96	.04	5.24*	.01	1.19

Note. Changes in F: *$p < .05$, **$p < .01$, ***$p < .001$.

FIGURE 1
Regression Paths and Residual Correlations in the Full Fluency Model (JLD)



Note. *p < .05, **p < .01, ***p < .001. Additionally, to improve the model fit fluency scores at age 23 were regressed on fluency in Grade 3 (.31***).

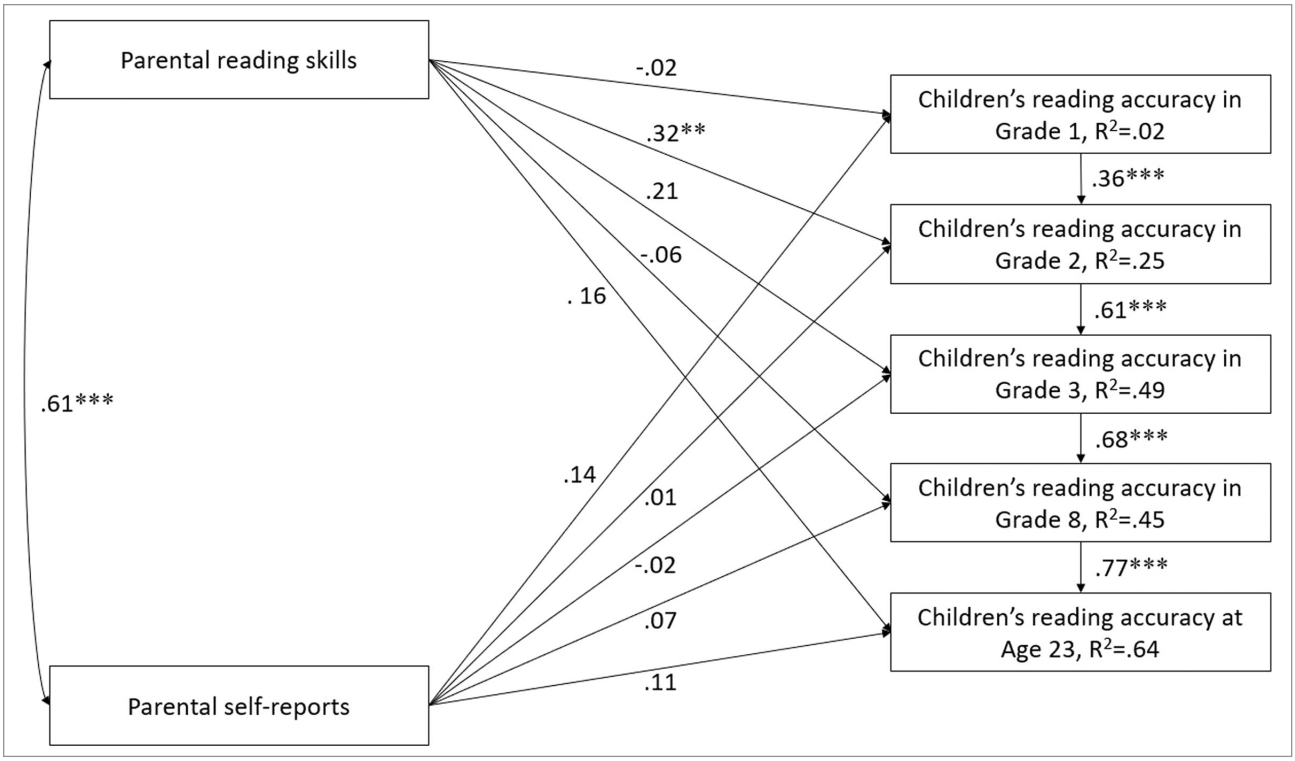
The first dataset, JLD, was a prospective FR sample that included families with and without parental dyslexia. This sample had two main advantages: a wide representation of lower reading skills (owing to approximately half of the families having one parent with dyslexia) and long-term follow-up until age 23. Because the sample included many parents with dyslexia, it had a large variation from the lower end of skill distribution, which is often lacking in general population samples. However, because the sample was pre-selected, replicating the findings in other samples is important. To this end, we used the second sample, VUOKKO, where parents were unselected for their skills and the children were in Grade 1. The inclusion of the two samples contributed to a better understanding of the associations between skill assessments and self-reports as well as of the usability of different FR identification methods to predict children's reading skills.

Parental reading measured with self-reports and direct assessments correlated strongly in JLD (.60) and moderately in VUOKKO (.42). Both these associations were weaker, however, than the correlation previously found in a Dutch prospective FR study (.84–.85) by van Bergen et al. (2014). Moreover, our associations were close to what was previously reported by Snowling et al. (2012), who found that the composite score combing five self-report questions (focusing particularly on reading) moderately correlated with directly assessed non-word reading (.66), spelling (.60), and word reading (.51). The finding that these associations are far from 1 is only to be expected. Although the two methods are designed to measure the same concept (reading skills), they inadvertently capture additional aspects that create a dissociation between the results of the two methods. For example, direct skill assessments provide a snapshot of a person's reading skill or even subskill on that specific day, whereas self-reports reflect a person's history of various experiences with reading in general (including childhood, educational, and professional experiences). Indeed, previous research has confirmed that people's perceptions of their own reading abilities are likely to be affected by their interactions with teachers, relatives, friends, and professional colleagues (Deacon et al., 2012; Leavett et al., 2014; Snowling et al., 2012).

Sample 1

Both parental self-reports and their directly assessed skills predicted children's reading skills in our study. However, specific sample characteristics considerably contributed to the differential results in the two samples. In the prospective FR sample (JLD), parental self-reports and skill assessment scores were almost equally predictive of children's

FIGURE 2
Regression Paths and Residual Correlations in the Full Accuracy Model (JLD)



Note. *$p < .05$, **$p < .01$, ***$p < .001$.

reading skills at most time points. In particular, our analysis revealed that when added as the only predictor, both methods were significant for predicting reading fluency from Grade 1 to age 23, explaining on average 6%–7% of variance at each time point. The situation with reading accuracy, however, was slightly different. FR identified with either method predicted between 4% and 15% of the variance in accuracy at most time points except for the first and the last ones (Grade 1 and age 23). The lack of prediction of the accuracy in Grade 1 means that children's FR status was not related to their likeliness to make mistakes at this time point. To some extent, this finding might be explained by the fact that most Grade 1 children are still in the early phases of reading development and can make mistakes, whether or not they have familial risk for dyslexia. However, it is also important to note that the accuracy measure for Grade 1 was based on a simple word reading task which ultimately had a strong ceiling effect in both samples. In this task, children were given a fixed time to go through as many word reading items as possible. The ceiling effect in such a task is understandable because children could spend as much time as they needed to correctly respond and were also able to stop if they felt that the items were too difficult. Therefore, different approaches (e.g., slow and careful with only few items completed vs. quick and skillful with a lot of items completed) might have resulted in similar reading accuracy scores despite reflecting different competences. At later time points, more demanding tasks (including a pseudoword reading task) were used, and they yielded more mistakes, particularly among children with FR. At age 23, similar to Grade 1, participants were all equally likely to make few mistakes, which explains the lack of prediction of accuracy at this time point. However, such skewness toward being very accurate should be expected in adult Finnish samples regardless of the measures selected, as most Finns manage to achieve similarly high levels of reading accuracy during early school years (Seymour et al., 2003; Soodla et al., 2015). At the same time, children with FR tend to have a slightly lower level of accuracy during early school years, but this improves with age and the performance gap eventually closes (Eklund et al., 2015). Indeed, Finnish studies indicate that early reading difficulties often resolve over time (Eloranta et al., 2019; Torppa et al., 2015).

Importantly, when we split the participants into the at-risk and control groups and separately performed the same analysis for each group, both self-reports and skill assessments stopped being predictive of children's skills at almost all time points. This likely indicates that both FR identification methods effectively identified parents at the lowest and highest ends of distributions. However, when we only considered the opposite ends of the parental skill distribution, either high-risk or low-risk participants, variation was insufficient, which made the previously found

associations non-significant. What is also important is that dividing the JLD sample into the FR group and controls made each subsample rather small. This could be another reason why both parental measures lose their predictive power when used within the subsamples.

An investigation of whether skills could predict over and above self-reports showed that directly assessed parental skills did not offer a clear predictive advantage over self-reports. Additive predictive effects of parental skills and self-reports were observed for children's accuracy and fluency at age 23 as well as for accuracy in Grades 2 and 3, suggesting that the inclusion of both self-reports and direct assessments better predicts children's reading skills (compared with the inclusion of only self-reports).

Sample 2

In the VUOKKO sample, where participating families were unselected for their skills, parental skills were not predictive of children's reading skills but parental self-reports were (explaining 7% of children's reading fluency in Grade 1). As previously noted, highly educated parents with solid reading skills were overrepresented in this sample. Moreover, parents with lower skills were more likely to withdraw from assessments while being just as likely to submit a self-report compared with parents with higher skills. This is most likely why self-reports were significantly predictive of children's reading fluency, whereas the same association between parental and children's skills observed in the entire JLD sample could not be found in the VUOKKO sample—a large number of parents from the lowest end of distribution did not participate in the skill assessments. This is a common characteristic of unselected samples of adults that may lead to the underestimation of associations between parental measures and children's measures. In view of this, systematic missingness may possibly be reduced using parental self-reports rather than assessments.

Our skill assessments in the JLD sample were almost as predictive of children's reading as what was previously reported in the Dutch context by van Bergen et al. (2014), who found that direct skill assessments explain 11% of variance in children's reading fluency at age 9. Their study design was very similar to JLD, with approximately half of the parents having dyslexia. Later, van Bergen et al. (2016) additionally collected an unselected sample in which parents with higher education and skill levels were somewhat overrepresented, similar to VUOKKO. At the same time, in the Dutch study, parental skills were still significantly predictive (explaining 17% of variance in children's reading), which is different from the results we obtained with the VUOKKO data. Notably, however, the Dutch sample (van Bergen et al., 2016) had hardly any missing values in the parental skill assessment scores (they were available for both parents in each family), and this is likely the key difference between their sample and VUOKKO that led to the differential results.

Is There a Need to Expand Assessment Batteries?

A more comprehensive assessment battery would have probably provided a much bigger predictive advantage (Grigorenko et al., 2020). A relevant problem with short reading assessments for adults is that they fail to identify those with resolved difficulties (Deacon et al., 2012; Tamboer et al., 2014). This can lead to an inaccurate estimation of FR because parental difficulties experienced in childhood may be just as important predictors of children's reading difficulties as parental reading difficulties experienced in adulthood. As was previously found in the Finnish context, only 40% of those identified as poor readers in childhood confirm their status as adults (Eloranta et al., 2019). In view of this, greater predictive power of parental skill assessments may be achieved by adding cognitive tasks that reveal the cognitive deficits underlying resolved reading difficulties. For example, Eloranta et al. (2019) reported that adults with resolved reading difficulties still underperformed on processing speed, phonological skills, and verbal comprehension in comparison to controls. Importantly, Grigorenko et al. (2020) argued that skill assessments need to be broad and comprehensive; otherwise, identifications of difficulties are not sufficiently reliable regardless of the specific skill assessment employed.

However, testing, especially with extensive assessment batteries, is often not feasible. Therefore, self-reports are an important measure that requires more systematic evaluation. Our results suggest that a multi-item comprehensive self-report can be approximately as predictive of children's reading skills as brief testing. Indeed, the 12 self-report items we used tapped for the most part the same variance as the selected skill assessments. Our prediction based on a more comprehensive self-report was notably better than that reported in studies employing only one yes-or-no self-concept of ability question (Esmaeeli et al., 2018, 2019; Khanolainen et al., 2020; Salminen, Khanolainen, et al., 2021), as these studies explained only around 1%–3% of variance in children's reading. Relying on a single self-concept of ability question is problematic because adults inevitably evaluate their reading level by comparing their skills with those of their reference group, which may drastically differ from one adult to another. A person who has average skills and a reference group with high skills is likely to evaluate their own reading to be poorer than it really is. In contrast, having a reference group with poor skills may lead a person to evaluate their reading as better than it is. Among children and adolescents, this big-fish-little-pond effect has been well documented both in international research (Chiu et al., 2017; Marsh et al., 2007,

2018) and in Finland, which has an unselective school system (Vasalampi et al., 2020).

We recommend future research to avoid single items and to opt for the use of questionnaires with multiple items presenting a variety of dyslexia-related struggles. Moreover, we deem it particularly important to not only focus on current difficulties, but also include multiple questions about childhood, especially when expanding assessment batteries with cognitive tests is not possible. As the correlation table in Appendix A shows, the self-report items related to parental childhood difficulties were those that most strongly correlated with children's early reading skills (in both samples). These childhood-related questions seem to be particularly useful for identifying children whose parents have resolved difficulties, but further research on this topic is needed.

Implications for Research and Practice

In the literature, FR is an important indicator that contributes to a better understanding of the mechanisms of intergenerational transmission as well as the home literacy environment. In practice, FR identification could facilitate early support. Previous studies using the JLD sample have shown that parental reading difficulties are predictive of children's cognitive development (e.g., Torppa et al., 2006) and that parental dyslexia predicts children's reading skills in Grade 2 even over and above the assessment of their early cognitive skills (Puolakanaho et al., 2007). Extending these findings, we found that FR retains a similar predictive effect on children's fluency during school age and beyond (at age 23).

However, overall, FR was not very useful in the prediction of reading fluency beyond the very beginning of elementary school—that is, once the autoregressors were added into the models—indicating the high stability of children's reading fluency. At the same time, the accuracy model showed that children's relative positions in accuracy were not as stable as in fluency and that in Grade 2, parental assessment scores were significantly predictive of children's accuracy despite the addition of autoregressors, suggesting a higher predictive power of direct assessments than self-reports. Therefore, it is worth highlighting that FR information represented the most value in the JLD sample before children's reading could be directly assessed (i.e., in Grade 1). Indeed, when children's skill are assessed, FR information becomes largely unnecessary, as the most accurate prediction of later performance can be achieved with information about earlier performance rather than with any parental information. Thus, FR identification methods are particularly useful when screening for those at FR for reading difficulties at an early age because this facilitates the development of a system in which at-risk children's reading development can be closely monitored and timely support can be provided.

Finally, our findings have important implications for future research. Our findings clearly demonstrate how sample characteristics can significantly affect study results and therefore its conclusions. In general population samples, special attention needs to be paid toward recruiting more people with difficulties to ensure their adequate representation. Although they may be hesitant to volunteer for assessments, their representation could be improved via oversampling. Moreover, because parental self-reports proved to be no less predictive than direct assessments, they can be considered a valid methodological alternative for research purposes that is less likely to intimidate participants with lower levels of reading skills. However, self-reports must include multiple items and some of them must ask about childhood difficulties. Furthermore, for some of the child outcomes, there was an added effect from parental skill assessments which suggests that the combination of self-reports and skill assessments seems to provide the most accurate FR estimate.

Limitations

Unfortunately, the methods in the two studies were not identical, thus limiting the comparisons between them. Moreover, in the JLD sample, in Grade 1, we used only one reading assessment task for children, as this was the only task that was also available in the VUOKKO sample. However, the association between parental variables and children's fluency found for this time point was similar to those found for other time points when more comprehensive assessments were employed. We also performed additional analyses with other reading tasks used in the JLD Grade 1 assessment battery and obtained similar results (Appendix B).

Conclusion

In conclusion, we highlight that although our findings must be interpreted with caution owing to the specific characteristics of our samples, our results have important implications both for future research and for practice. Importantly, both self-reports and parental skill assessments showed similar predictive power for children's reading; the two methods only slightly complemented each other and thus could be used interchangeably. Moreover, self-reports with multiple items provided a notably better FR estimation in our study than self-reports with a single item employed in previous studies (Esmaeeli et al., 2018, 2019; Khanolainen et al., 2020; Salminen, Khanolainen, et al., 2021). FR estimations may be further improved by adding tests for cognitive skills or more self-report items. This suggestion, however, should be investigated in future studies. Considering the strong autoregressive relations

between skills at different time points, both FR identification methods provide valuable information only when children are at the pre-reading stage; thereafter, children's own skills are the best predictors of their further development.

Conflict of Interest

The authors declare that they have no conflict of interest to disclose.

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APPENDIX A

TABLE A1
Pearson Correlation Coefficients Between Self-report Items and Children's Skills

Sum scores	Fluency Grade 1 (*N*)	Fluency Grade 2 (*N*)	Fluency Grade 3 (*N*)	Fluency Grade 8 (*N*)	Fluency Age 23 (*N*)	Accuracy Grade 1 (*N*)	Accuracy Grade 2 (*N*)	Accuracy Grade 3 (*N*)	Accuracy Grade 18 (*N*)	Accuracy Age 23 (*N*)
1. Childhood-related items in JLD	−.353*** (188)	−.371*** (167)	−.264*** (189)	−.272*** (171)	−.282** (127)	−.237** (188)	−.297*** (167)	−.320*** (189)	−.244** (171)	−.087 (127)

TABLE A1
Pearson Correlation Coefficients Between Self-report Items and Children's Skills (*continued*)

Sum scores	Fluency	Fluency	Fluency	Fluency	Fluency	Accuracy	Accuracy	Accuracy	Accuracy	Accuracy
	Grade 1 (*N*)	Grade 2 (*N*)	Grade 3 (*N*)	Grade 8 (*N*)	Age 23 (*N*)	Grade 1 (*N*)	Grade 2 (*N*)	Grade 3 (*N*)	Grade 18 (*N*)	Age 23 (*N*)
2. Adulthood-related items in JLD	−.155* (187)	−.193* (167)	−.190** (189)	−.229** (171)	−.211* (129)	−.181* (187)	−.191* (167)	−.231** (189)	−.120 (171)	−.107 (129)
1. Childhood-related items in VUOKKO	−.291*** (318)					−.184** (318)				
2. Adulthood-related items in VUOKKO	−.197** (316)					−.007 (316)				

APPENDIX B

Analysis with additional measures available for Grade 1

Child measures in Grade 1

Additional Grade 1 assessments included text reading, word list reading, and pseudoword list reading. The Cronbach's alpha for the fluency composite in Grade 1 was .90. Text reading task used in Grade 1 was the same as the one used in Grade 2 (see the main text of the article for details). Oral word list reading and pseudoword list reading were assessed with the use of 45 items (18 words and 27 pseudowords, each including one to three syllables).

TABLE B1
Descriptive Statistics for All Variables Across Time

	N	Minimum	Maximum	Mean	SD	Skewness (std. error)	Kurtosis (std. error)
JLD sample							
Reading fluency (z-scores)							
Grade 1	189	−6.53	1.50	−.57	1.36	−1.43 (.18)	2.62 (.35)
Reading accuracy (z-scores)							
Grade 1	189	5.60	100.00	92.15	13.28	−4.33 (.18)	22.04 (.35)
JLD sample (controls only)							
Reading fluency (z-scores)							
Grade 1	88	−3.06	1.50	−.02	.92	−.75 (.26)	.53 (.51)
Reading accuracy (z-scores)							
Grade 1	88	19.60	100.00	94.75	9.39	−6.20 (.26)	47.67 (.51)
JLD sample (FR group only)							
Reading fluency (z-scores)							
Grade 1	101	−6.53	1.46	−.93	1.53	−1.21 (.24)	1.37 (.48)
Reading accuracy (z-scores)							
Grade 1	101	5.60	100.00	89.87	15.60	−3.61 (.24)	15.03 (.48)

TABLE B2

Standardized Model Estimates in Simple Linear Regressions Conducted Separately for Each Predictor and for the Controls and FR Group (JLD sample, Grade 1)

	Predictor – Parental self-reports: Estimate (s.e.)			Predictor – Parental skills: Estimate (s.e.)		
Child outcomes	Whole sample	Only FR group	Only controls	Whole sample	Only FR group	Only controls
Reading fluency						
Grade 1	.22*** (.06)	.11 (.09)	.14 (.18)	.24*** (.06)	.04 (.08)	.13 (.10)
Reading accuracy						
Grade 1	.20** (.07)	.05 (.13)	.28** (.09)	.08 (.05)	.05 (.08)	.04 (.08)

Note. *$p < .05$, **$p < .01$, ***$p < .001$. All models were saturated.

TABLE B3

Hierarchical Regressions for Fluency and Accuracy in Grade 1 in JLD (the Whole Sample), Each with Three Steps: 1) Self-reports, 2) Formal Assessments, 3) Interaction between Self-Reports and Formal Assessments

	Parental self-report (step 1)		Parental formal tests (step 2)		Interaction (step 3)	
Child outcomes	ΔR^2	*F* change	ΔR^2	F change	ΔR^2	F change
Grade 1 fluency	.05	9.67**	.02	3.79	.01	2.97
Grade 1 accuracy	.04	8.44**	.00	.50	.00	.02

Note. Changes in *F*: *$p < .05$, **$p < .01$, ***$p < .001$.