

# Children with and without Family Risk of Reading difficulties

Emergent literacy, home literacy environment at  
onset of formal reading instruction, and literacy  
skills after two years of schooling

by

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## List of Publications

The present thesis is based on the following empirical studies:

### **Study I:**

Esmaeeli, Z., Lundetræ, K., & Kyle, F. E. (2018). What can Parents' Self-report of Reading Difficulties Tell Us about Their Children's Emergent Literacy at School Entry? *Dyslexia*, 24(1), 84-105. doi:10.1002/dys.1571

### **Study II:**

Esmaeeli, Z., Kyle, E. F., & Lundetræ, K. (Submitted). Contribution of Family Risk, Emergent Literacy and Environmental Protective Factors in Children's Reading Difficulties at the end of Second-Grade.

### **Study III:**

Esmaeeli, Z. (Submitted). A Model of Home Literacy Environment and Family Risk in Relation to Children's Emergent Literacy.

## Abbreviations

RD	Reading difficulties
FR (of RD)	Family Risk (of RD)
FR children	Children with at-least a parent reporting of RD
FR-one (parent)	Children who only one of the parents reported RD
FR-both (parents)	Children who both of the parents reported RD
Not-FR children	Children who none of the parents reported RD
HLE	Home literacy environment
SES	Socio-economic status

## Summary

Having a parent with reading difficulties, known as family risk, puts a child at high risk of impaired emergent literacy before the onset of reading instruction, and later reading difficulties at school. Another line of research, however, highlights that environmental factors such as the quality and quantity of what parents provide at home (*home literacy environment*) are also crucial for the development of children's emergent literacy and later literacy skills. This thesis used a multi-factor perspective on reading difficulties to investigate the associations between family risk, emergent literacy, the home literacy environment at the onset of formal reading instruction and literacy skills after two years of schooling. Such a multi-factor perspective may combine a range of interplaying factors, including family risk along with early individual differences at the cognitive level (emergent literacy skills) and environmental factors (parents' educational level and the home literacy environment) to assess the protective role of environmental factors against the risk factors such as family risk.

Data from 'On Track' project (på sporet) were used in analysis of three empirical studies. Children were individually assessed in emergent literacy at the onset of reading instruction. At this point, parents' self-report of reading difficulties were used to index family risk, and the home literacy environment was measured through parental reporting. In addition, children were assessed in literacy measures including word reading, spelling and reading comprehension at the end of second grade.

The first study showed that children with family risk were significantly impaired on all measures of emergent literacy (letter knowledge and phonemic awareness), vocabulary, rapid automatized naming and short-term memory at the onset of formal reading instruction. A novel finding was that a significant difference in emergent literacy *within* the group of children with family risk as apparent before the onset of reading

instruction: Children with family risk who both of parents reported reading difficulties, had significantly poorer emergent literacy than both groups of children with only one parent reporting reading difficulties, and children with no family risk. Furthermore, family risk, in a multi-factor model, was significantly associated with children's emergent literacy above and beyond the home literacy environment, the child's gender, vocabulary, and the parents' educational level.

The main aim of the second study was to investigate children's reading difficulties in a multi-factor perspective after two years of formal schooling. Children who performed below the national threshold in at least two of the subtests in reading, spelling and comprehension were identified as having reading difficulties. The results revealed that children with family risk were three times more likely to develop reading difficulties than children without such a risk. The multi-factor model also suggested that children with family risk showed some difficulties in literacy skills that could not be explained in terms of individual differences in emergent literacy, vocabulary, gender, the home literacy environment or parents' educational level.

The main aim of the third study was to investigate the role of protective environmental factors (e.g., home literacy environment and parents' education) against the negative effect of family risk, in children's emergent literacy skills at the onset of formal reading instruction. First, a model of home literacy environment was assessed and three distinct factors were identified: access to print, reading-related activities and parents' reading interest and habits. In a structural equation model, maternal and paternal self-report of RD (as a proxy for family risk) along with their educational level were added as direct and indirect predictors of children's emergent literacy while accounting for the home literacy environment. The results suggest that family risk explain some additional variance in emergent literacy that cannot be explained by parents' educational level and the home literacy environment. However, and perhaps more importantly, this multi-factor model highlights a



complex interplaying role for the relationship between family risk and environmental protective factors (the home literacy environment and parents' education) in association with children's emergent literacy skills. Therefore, the protective role of environmental factors on emergent literacy skills against the negative influence of family risk cannot be ruled out in children with family risk of reading difficulties.

Taken together, the findings presented in this thesis reveal that the association between family risk, children's emergent literacy and their literacy skills is indeed a complex relationship, which involves with environmental factors. It seems that children's emergent literacy and later literacy skills and their literacy experiences in the home environments may not be independent of family risk. However, a high parents' educational level and a rich home literacy environment appear to operate as protective factors against a risk factor such as family risk. These findings suggest there are reasons to believe that it is possible to change and reduce the influence of family risk through environmental protective factors such as a rich home literacy environment.



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# **1 Introduction**

## **1.1 Outline**

The first chapter of this thesis serves as a general introduction and sets out its main aim. The second chapter discusses in greater depth the dominant models previously used to explain reading difficulties in terms of individual differences as well as genetic, cognitive and environmental influences. The third chapter presents the aims of the three empirical studies carried out while the fourth chapter focuses on the methods used in those studies and the fifth one discusses their results. Finally, the sixth chapter presents a general discussion of the findings from the three empirical studies, and overall conclusions including the limitations of the current research, the need for future studies and the implications of the findings.

## **1.2 Main aim of this thesis**

Literacy skills provide a crucial foundation for success in education, professional life and everyday settings. Most children do learn to read and write successfully, but the prevalence of reading difficulties is 5–15% among school age children across different languages and cultures (American Psychiatric Association, 2013). ‘Developmental reading difficulties’ (RD), also referred to as ‘dyslexia’, typically refers to unexpected impairments in the process of reading and spelling acquisition that are not due to extraneous factors such as sensory intelligence, acuity deficits, socio-economic disadvantages or similar factors (Vellutino, Fletcher, Snowling, & Scanlon, 2004). There is growing evidence suggesting that RD can be prevented in many children through early intervention (Fletcher, Lyon, Fuchs, & Barnes, 2007; Lovett et al., 2017; Torgesen, 2002). It is indeed of considerable concern from both theoretical and practical perspectives to investigate individual differences, skills and environmental inputs that underpin reading development or RD. A better understanding of the ways in which

individuals with RD differ from their peers without RD may result in more reliable early identification and intervention programmes. So far, a number of models that attempt to explain individual differences in literacy skills have been proposed. The explanatory factors most often included in these models are cognitive deficits (such as individual differences in early pre-literacy skills), genetic factors, family risk of RD or environmental factors such as home literacy environment (HLE) and socio-economic status of the family or parents' educational level.

In a meta-analysis study based on cognitive deficits, Lonigan, Schatschneider, and Westberg (2008) reported that pre-school emergent literacy (e.g. letter knowledge and phonemic awareness) are the best predictors of literacy outcomes. Further, in line with behavioural-genetic studies, it has been found that when RD are present in a close family member of a child (i.e. a parent or an older sibling), there is a higher-than-normal probability that the child will also manifest RD (Snowling & Melby-Lervåg, 2016). This is referred to as 'family risk' (FR) of RD in the literature. Another well-documented fact is that environmental factors such as early literacy exposure and experiences that the parents provide in the home, known in the literature as the 'HLE', are crucial to the development of children's pre-literacy skills (Burgess, Hecht, & Lonigan, 2002; Sénéchal & Young, 2008).

The present thesis investigates, in three empirical studies, a multi-factor model of RD combining several interplaying factors: FR (as a proxy for genetic factors), early individual differences at the cognitive level (emergent literacy and oral-language skills) and environmental factors (e.g. the HLE and parents' educational level). This model is based on the multi-deficit model suggested by (Pennington, 2006; van Bergen, van der Leij, & de Jong, 2014b). In relation to their multi-deficit model of RD, van Bergen, et al. (2014b) discuss how FR (as a proxy for genetic factors) may operate as a risk factor increasing the likelihood of developing RD because it can exert a negative influence both on emergent literacy and on later literacy skills. Environmental factors, by



contrast, can operate either as additional risk factors or as protective factors (Pennington, 2006; van Bergen, et al., 2014b). Therefore, living in a family with a low parental educational level or a poor HLE can be considered an additional environmental risk factor. Not surprisingly, parental educational levels are typically reported lower in the group of children with FR (FR children) than the group without FR (not-FR children). In addition, several studies have documented that FR children tend to have a less rich HLE than not-FR children (Dilnot, Hamilton, Maughan, & Snowling, 2017; Hamilton, Hayiou-Thomas, Hulme, & Snowling, 2016; Scarborough, 1991). Hence it can be hypothesised that FR children, who tend to experience a less rich HLE, are exposed to an additional environmental risk that not-FR children are usually spared. In families with a rich HLE or a high level of parents' educational level; however, environmental influences may also operate as protective factors, suggesting that they may reduce the likelihood of developing RD. The possibility of disentangling such different effects is a particular advantage of using multi-factor models in which it is possible to investigate the function of the HLE or the parents' educational level as environmental factors protecting against a risk factor such as FR of RD.

Taking the multi-factor perspective, the main aim of the present thesis is to examine the association between family risk of RD, emergent literacy and HLE at the onset of formal reading instruction, and literacy skills after two years of formal schooling. It is expected that FR children will perform poorer in emergent literacy and later literacy skills than not-FR children. The results of the three studies carried out will contribute to the existing literature, especially when it comes to FR of RD, in several ways: First, and perhaps most importantly, the results will be discussed in a multi-factor model in which the interaction of the HLE, parents' educational level and FR can be analysed. These studies are the first to investigate the likelihood of FR of RD using a multi-factor model encompassing environmental protective factors. Second, given the limited availability of data on the association between FR and the HLE

(Snowling & Melby-Lervåg, 2016), the results of the present thesis – especially of Study III – will extend the HLE literature with regard to the issue of FR of RD. Last but not least, this thesis is the first Norwegian multi-factor study on FR of RD.

Using the multi-factor model, the thesis aims to answer three main questions in three empirical studies:

- ***Study I:*** What can parents' self-reported RD (as a proxy for FR) tell us about their child's emergent literacy at school entry?
- ***Study II:*** What is the role of FR in a multi-factor model for the prediction of RD that includes FR, emergent literacy, parents' educational level, the HLE and the child's gender?
- ***Study III:*** What role does the HLE play for children's emergent literacy at the onset of formal reading instruction in a multi-factor model including FR, the HLE and parents' level of education?

## **2 Reading Difficulties**

A number of models have been proposed to explain how and why children differ in literacy skills and hence to identify children who are at risk of reading and writing difficulties. In order to provide a brief overview of the literature, the following discussion will focus on models that are the most relevant to the aims of the present study.

### **2.1 Emergent literacy and other cognitive skills**

Though literacy in the sense of being able to read and write is obviously a learned skill, it has been argued that becoming literate is a developmental and continuous process that begins concurrently and interdependently with oral language during the preschool years and before formal schooling (Lonigan, Burgess, & Anthony, 2000; Whitehurst & Lonigan, 1998). On this view, often referred to as the ‘emergent-literacy perspective’, the first step of literacy development consists of the building of a foundation of emergent literacy at the pre-school age, which influences the later development of reading skills at school (Whitehurst & Lonigan, 1998). The construction of this foundation involves exchanges between the children and their environment (i.e. home, kindergarten, etc.), and the process is influenced by the child’s cognitive development and by general maturational processes with large individual differences and variations from one child to the next. According to Whitehurst and Lonigan (1998), emergent literacy consists of ‘the skills, knowledge, and attitudes that are presumed to be developmental precursors of reading and writing, and the environments that support these developments’. It is clear that emergent literacy is a powerful predictor both of later reading achievement (Scarborough, 2001) and of reading difficulties (Elbro, Borstrom, & Petersen, 1998; Elbro & Petersen, 2004; Pennington & Lefly, 2001; Pennington et al., 2012). The National Early Literacy Panel (NELP) in the United States conducted a meta-analysis to identify early cognitive

skills that can predict later literacy outcomes, concluding that cognitive pre-literacy skills such as oral language, emergent literacy skills, rapid automatized naming (RAN) and short-term memory (STM) at the pre-school age are associated with children's later literacy outcomes (Lonigan et al., 2008). The NELP also found that, among early cognitive skills, code-related emergent-literacy skills (e.g. letter knowledge and phonemic awareness) and RAN are moderate to strong predictors of literacy outcomes when measured before the onset of formal reading instruction. Furnes and Samuelsson (2010), who studied and compared Scandinavian (Norwegian and Swedish) and English-speaking children, found that pre-schoolers' letter knowledge, phonemic awareness and RAN were all significantly associated with first-grade reading and spelling difficulties in both samples. However, when it came to the prediction of reading and spelling difficulties in the second grade, the predictive factors were similar to those for the first grade when it came to the English-speakers, whereas RAN was the only significant predictor for the Scandinavian children.

In summary, it is well documented that pre-school emergent literacy is fundamental to children's later literacy development. However, both emergent literacy and literacy skills are subject to substantial genetic influences, which will be discussed in the next section.

## **2.2 Genetic factors and reading difficulties**

A substantial number of behavioural-genetic studies of twins have identified genetic factors as important risk factors in the development of emergent literacy and oral language (Byrne et al., 2013; Christopher et al., 2013; Coventry, Byrne, Olson, Corley, & Samuelsson, 2011; DeThorne et al., 2006; Hart et al., 2009; Hayiou-Thomas, 2008; Samuelsson et al., 2005; Samuelsson & Lundberg, 2003; Samuelsson et al., 2007). For example, Samuelsson et al. (2005), in a sample of twins from the United States, Australia, Sweden and Norway, reported moderate heritability for phonological awareness while the shared-

environment effect was small. In a later investigation of the same sample, Byrne et al. (2006) found that phonological awareness, RAN and verbal memory were subject to substantial genetic influence in the pre-school years. In a three-year longitudinal study of pre-schoolers, Hart et al. (2009) found that, with respect to the development of expressive vocabulary, the effects of both genes and the shared environment were statistically significant. The genetic influences were moderate, whereas the environmental effect was small: the HLE as reported by the children's mothers accounted for only 6–10%, depending on the year, of the total variance in assessed vocabulary.

Moreover, a large body of twin studies has shown that there is a link between both genetic and environmental factors and the development of later literacy skills (Elwér, Keenan, Olson, Byrne, & Samuelsson, 2013; Friend et al., 2009; Harlaar, Spinath, Dale, & Plomin, 2005; Hart, Logan, et al., 2013; Samuelsson et al., 2008; Taylor & Schatschneider, 2010). Hart, Logan, et al. (2013) found that both genetics and the shared environment influenced the development of reading skills from the first grade onwards. In another study, Hart, Soden-Hensler, Johnson, Schatschneider, and Taylor (2013) explored the role of the family's socio-economic status (SES) as an environmental moderator of genetic and environmental influences on reading comprehension, concluding that both genetic and environmental influences are important factors underpinning individual differences in comprehension outcomes. More importantly, their findings highlighted the complexity of the impact exerted by the environment on genetic influences when it comes to literacy achievement. This latter finding supports the argument for using a multi-factor model of RD, where environmental factors may contribute as risk factors or as protective factors counteracting the influence of the genes.

In summary, behavioural-genetic studies of twins have provided strong evidence that while genetic factors play a significant role in the

development of emergent literacy, oral language and subsequent literacy skills, these skills are also affected by environmental factors.

### **2.3 Environmental factors: the home literacy environment**

The earliest attempts to determine the effects of the environment on children's literacy development focused on the SES of the family, conceptualised as including the parents' levels of education and/or income. In line with this, research found a substantial gap in emergent literacy between children with low and high SES (Burgess et al., 2002; Lonigan, Burgess, Anthony, & Barker, 1998; Raz & Bryant, 1990). For example, Lonigan et al. (1998) reported that three-year-old children with a low-SES background performed poorer on emergent literacy than children with high-SES background. Some researchers have suggested that a key reason for such variation in children's literacy-related skills might be differences in the home literacy environment (HLE) between middle-class families and parents with low SES (Phillips & Lonigan, 2009). There is indeed evidence that parents with higher income and/or education levels are more likely to read to their children (Phillips & Lonigan, 2009). Further, Phillips and Lonigan (2009) point out that while SES may be a good proxy for the attitudes, activities and opportunities existing in a family when it comes to literacy and reading, it does not identify what is actually happening in a home as measures such as HLE.

Further, research found a clear link between the HLE and children's emergent literacy and oral-language skills. However, a wide variety of definitions of the HLE have been used in the literature. Shared-reading activities in the home, including the frequency and quality of shared reading with family members, is one the earliest identified and most investigated aspects of the HLE.

### **2.3.1 Shared-reading activities and story-book exposure**

Shared reading is the aspect of the HLE which has been investigated the most, and it has been linked to pre-schoolers' emergent literacy and oral language skills. In the first meta-analysis of HLE research, Scarborough and Dobrich (1994) found that shared reading was consistently associated with concurrent emergent literacy and oral language skills as well as with later literacy outcomes, predicting approximately 8% of the unique variance in children's oral language, emergent literacy and later reading skills. However, the authors argued that only 8% of unique variance is too little to be considered as an effective influence. This conclusion has been criticised based on the claim that the relative weakness of the links found between the HLE and children's performance was due to certain limitations of the earlier HLE research (Burgess et al., 2002; Bus, van Ijzendoorn, & Pellegrini, 1995; Lonigan, 1994). For example, Lonigan (1994) suggested three possible explanations for the limited size found for the impact of shared reading on emergent literacy, oral language and later reading skills. First, methodological problems (i.e. small sample sizes and the use of not very appropriate measures of the HLE and/or children's outcomes) in many of those studies indicate that they should be interpreted with caution. Lonigan argues, for example, that because methodologically good and poor studies had been equally weighted in the meta-analysis, the effects of the HLE had probably been underestimated. Second, the indirect links between the HLE, oral language, emergent literacy and later literacy skills was not investigated in earlier HLE research – nor considered in the meta-analysis study, in which Scarborough and Dobrich (1994) concluded the observed effect of the HLE was too small. According to Lonigan (1994), if the indirect effect of the HLE on children's literacy outcomes, via indirect pathways such as emergent literacy, was taken into account, this would yield larger estimates of the HLE effect. Third, even such small effects of the HLE on emergent literacy, observed at an

early stage, are likely to have a consistent, long-term impact on children's literacy skills and therefore cannot be ignored when it comes to the development of those skills. In another meta-analysis carried out at about the same time, shared reading was also found to predict approximately 8% of the unique variance in children's oral-language, emergent-literacy and later reading skills (Bus et al., 1995). However, when the authors standardised the effect sizes using Cohen's *d* across the studies and weighted the effects according to the sample sizes, they found a vast variety of effect sizes among the 29 studies they analysed, with Cohen's *d* ranging from 0 to 1.51. They reported medium-sized effects of shared reading on oral language ( $d = 0.67$ ), emergent literacy ( $d = 0.58$ ) and reading ( $d = 0.55$ ).

Most of the research reviewed in these two meta-analyses used a single aspect – shared reading – as a proxy for the HLE. However, the HLE encompasses more than just shared reading. Several other studies, beginning with Sénéchal, Lefevre, Thomas, and Daley (1998), have used story-book exposure as a measure of the HLE. This is defined as the variety of resources and opportunities (access to print) provided to children in the home besides the shared-reading activities. Frijters, Barron, and Brunello (2000) found that storybook exposure and children's literacy interest together accounted for significant variance in oral vocabulary (21%) and in early written language, as measured by letter-name and letter-sound knowledge (18%). Entering phonological awareness first in a hierarchical regression eliminated the unique contribution of storybook exposure to written language but not to vocabulary. The authors argued that the HLE might be directly related to vocabulary whereas the relationship between storybook exposure and written language might be mediated by phonological awareness (Frijters et al., 2000). These findings provided evidence for the additional indirect association between the HLE and later literacy outcomes that had been suggested by Lonigan (1994).



### 2.3.2 Formal versus informal HLE

Further, the HLE has been subdivided into two domains: formal and informal (Evans, Shaw, & Bell, 2000; Levy, Gong, Hessels, Evans, & Jared, 2006; Puglisi, Hulme, Hamilton, & Snowling, 2017; Sénéchal, 2006, 2011; Sénéchal & LeFevre, 2001, 2002, 2014; Sénéchal et al., 1998). Sénéchal et al. (1998) was the first to introduce two different HLE domains: *informal* and *formal* HLE. The informal HLE includes activities providing more informal or implicit interaction with print, such as shared reading and access to print, where parents expose their child to written language but the focus is not on written language. The informal HLE has usually been measured using storybook exposure. The formal HLE, on the other hand, encompasses activities and experiences that provide more formal or explicit interaction with print, such as parents' teaching about letters, sounds, word reading and spelling.

Sénéchal et al. (1998) reported that both storybook exposure and parents' teaching correlated positively with preschoolers' oral- and written-language skills. However, for the Grade 1, storybook exposure was associated only with oral language skills and parents' teaching was associated only with written language skills. Based on this finding, they argued that different kinds of literacy experiences in the home (formal vs informal) were related to different kinds of oral and written skills. Similarly, Sénéchal (2006) reported that parents' teaching directly predicted children's letter knowledge in kindergarten and their reading fluency in the fourth grade whereas storybook exposure directly predicted their kindergarten vocabulary and indirectly predicted their fourth-grade reading comprehension.

Based on this dichotomy between formal and informal HLE, Puglisi et al. (2017) examined the association between the HLE (measured as storybook exposure and parents' teaching) and children's language and literacy skills one year after school entry. In line with previous research, storybook exposure was found to predict children's language and literacy

skills whereas parents' teaching predicted only their literacy skills. However, the authors suggest that while the HLE correlates with children's literacy outcomes, it may in fact not be the cause of the variation observed, since the correlation was no longer statistically significant when the mothers' language skills had been controlled for.

In summary, these findings about formal versus informal HLE indicate that the various pathways that lead to reading development outcomes have their roots in different domains of the HLE. For example, storybook exposure is more strongly related to oral language skills while parents' teaching is more strongly associated with literacy skills. It is also worth noting that the studies that used two HLE domains (formal and informal) instead of the single measure of shared reading also had certain limitations. First, the informal HLE measured as storybook exposure encompassed the two aspects of 'access to print' and 'shared reading' in a single-factor model. Second, these studies did not account for the way in which parents may act as role models for their children through their own reading interest and habits (Burgess et al., 2002; Scarborough, Dobrich, & Hager, 1991; Torppa et al., 2007b). This is in fact a third important aspect of the HLE besides shared reading and access to print, known as parents' reading interest and habits. Baker and Scher (2002) found that parents who appreciated reading as an enjoyable pastime conveyed a positive perspective on reading to their children, either directly through their words or indirectly by providing literacy-related activities and experiences at home. This positive parental attitude towards reading contributed positively not only to their children's reading motivation but also to their developing emergent literacy and reading skills, and to their choice of leisure activities.

### **2.3.3 (Informal) HLE as passive and active HLE**

Burgess et al. (2002) argue that, in most previous research, the (informal) HLE was viewed simplistically as either SES or shared reading and the approaches taken were relatively simplistic, univariate ones. For this

reason, some of those studies either failed to identify a link between the HLE and children's later literacy outcome or found only a weak association. In an attempt to reduce this limitation, Burgess et al. (2002) defined the HLE into *active* and *passive* HLE. To some extent this distinction resembles the informal and formal HLE, which was introduced earlier by Sénéchal et al. (1998). However, in their definition of the HLE, the formal HLE (i.e. parents' teaching) did not actually include at all while both active and passive HLE are representing the informal HLE. Burgess et al.'s active HLE includes activities where the parents engage the child directly in reading and related activities (e.g. visiting the library, shared book reading) whereas the passive HLE defines how parents indirectly expose the child to the word of literacy (e.g., the extent to which the parents themselves appreciate and engage in reading activities). The active HLE was assessed using questions about the onset of shared reading and the time the child spent watching TV. On the other hand, the passive HLE was assessed using questions about parents' reading interest and habits including how much time the parents spent watching TV, how many books they read themselves each month and how often the child observed the parents reading. Burgess et al. found that the active HLE was a more important contributor than the passive HLE to development of oral language, letter knowledge, phonological sensitivity and word-decoding skills.

In summary, Burgess et al. (2002) argued that the HLE is not a unitary concept but consists of a variety of reading-related components including various attitudes, resources and activities in the home. Further, they argued that these reading-related components of the HLE are inter-related and may exert an impact on various developmental and educational outcomes. However, their HLE measure was narrow as it encompassed only two aspects of the HLE: shared reading and parents' literacy interest and habits. The aspect of access to print measured as the variety of reading-related resources (e.g. the number of children's books in a household) was not included in their measure of HLE, though it was

defined in their definition of HLE and would have fit well with their concept of passive HLE. Moreover, for their measure of the active HLE, they included only the onset (i.e. not the frequency) of shared reading and the frequency of watching TV. Such limitations could be a possible explanation for their failure to find statistically significant correlations between the passive HLE and children's oral-language or emergent-literacy skills. In addition, Burgess et al. (2002) did not examine the indirect effect of the HLE, especially of the passive HLE, even though Frijters et al. (2000) had found such an additional indirect association between the HLE and later literacy outcomes as had been suggested earlier by Lonigan (1994).

#### ***2.3.4 (Informal) HLE and parents' reading interest and habits***

Similarly to Burgess et al. (2002), some other studies have included the aspect of parents' reading interest and habits in their HLE measure. For example, Weigel, Martin, and Bennett (2006) investigated the relationship between the aspects of story-book exposure (including shared reading and access to print) and parents' reading interest, belief and habits on the one hand and children's print knowledge, emergent writing and oral-language skills on the other. They found that parents' literacy interest, belief and habits were associated not only with storybook exposure in the home but also directly with some components of children's emergent literacy such as print knowledge and receptive language. Their findings suggested that if parents themselves engaged more often in literacy activities when their children were three years old, the children were likely to score higher in print knowledge and receptive language one year later. The authors argued that parents' reading interest, belief and habits played a central role in children's literacy and language development because parents who were more interested in literacy and who believed in the importance of their role in that context tended to

engage their children more often in reading-related activities in the home.

Torppa et al. (2007b) also modelled children's development of phonological awareness before school age in association with the development of vocabulary and letter knowledge, the HLE, children's reading interest and their early reading skill. The HLE measure used encompassed reading-related activities at home, access to print and parents' reading interest and habits. It was found that the effect of the HLE on phonological awareness was mediated by vocabulary skills and that the only aspect of the HLE that predicted vocabulary development was reading-related activities.

In summary, Weigel et al. (2006) did take a multi-aspect approach to the investigation of the HLE by including storybook exposure and parents' reading interest and habits in their HLE measure, but they examined storybook exposure as a single factor including shared reading and access to print in line with previous research. Torppa et al. (2007b) also took a multi-aspect approach, but they only used these aspects as separate factors and did not investigate explicitly a model of HLE that includes all three aspects of shared reading, access to print and parents' reading interest and habits in a three-factor model.

### ***2.3.5 Summary and discussion***

Burgess et al. (2002) suggested that the HLE was not a unitary construct but a complex one encompassing a variety of resources (e.g. access to print), activities (e.g. shared reading) and attitudes (e.g. parents' literacy interest and habits). However, their measure of HLE that encompassed two aspects: active and passive HLE, did not include the component of access to print that according to their own definition, could have been part of the passive HLE. Sénéchal et al. (1998) defined the informal (as opposed to the formal) HLE as a unitary construct encompassing

exposure to print, which in turn consisted of access to print and reading-related activities as a single factor.

Based on the dichotomy of active and passive HLE suggested by Burgess et al. (2002), it can be assumed that Sénéchal et al.'s concept of exposure to print consists of two distinct factors, one passive (access to print) and one active (reading-related activities). Hence it can be hypothesised that the HLE can be structured as a two-factor model consisting of the passive HLE (including access to print and parents' literacy interest and habits) and the active HLE (including reading-related activities). However, it is equally possible that the HLE may be better reflected by a three-factor model including access to print, reading-related activities and parents' reading interest and habits. This broad perspective of the HLE that has included questions regarding all three aspects of reading-related activities, access to print and parents' reading interest and habits, has been suggested before (Niklas & Schneider, 2013; Torppa et al., 2007b). However, these studies has not empirically investigated the model of HLE as a three-factor measure. The present thesis investigates the factor structure of the (informal) HLE by including the three aspects of shared reading, access to print and parents' reading interest and habits. The formal HLE (i.e. parents' teaching of letters, sounds and word reading or writing) is not addressed in this thesis because the focus of the HLE is on the onset of formal reading instruction. The formal HLE mostly comes into play when the child has started learning how to read and write.

Including different aspects of the HLE in the model is important because previous research has suggested that different aspects of the HLE are associated with different emergent-literacy and literacy skills (Burgess et al., 2002; Lonigan, 1994; Scarborough & Dobrich, 1994; Sénéchal, 1997, 2006, 2011; Sénéchal & LeFevre, 2001, 2014; Sénéchal et al., 1998; Sénéchal & Young, 2008; Weigel et al., 2006). However, previous HLE research has identified a clear association between these two

aspects of access to print and parents' reading interest and habits and children's emergent literacy.

## **2.4 Parents' literacy skills as a predictor of children's literacy outcomes**

Another line of research has found strong links between children's reading skills and their parents' literacy skills (Torppa, Eklund, van Bergen, & Lyytinen, 2011; van Bergen, Bishop, van Zuijen, & de Jong, 2015; van Bergen, de Jong, Maassen, & van der Leij, 2014a; van Bergen, de Jong, Plakas, Maassen, & van der Leij, 2012; van Bergen, van Zuijen, Bishop, & de Jong, 2016). For instance, van Bergen et al. (2016) showed that paternal and maternal reading fluency explained independent, similarly large proportions of variance in children's reading fluency. Together, parental reading fluency explained 17% of this variance. In another study, moderate correlations were found between children's and parents' reading skills:  $r \approx .35$  for fathers and  $r \approx .50$  for mothers (van Bergen et al., 2012). In a study including children with family risk of reading difficulties, Torppa et al. (2011) found that parental reading skills predicted children's reading and spelling outcomes in the third grade even after controlling for the children's pre-school skills.

Further, Puglisi et al. (2017) found that the HLE in terms of storybook exposure was not a significant predictor of children's language or literacy skills after controlling for the effects of the mothers' language and phonological abilities. Therefore, they suggest that the effects of storybook exposure reflect genetic influences since it can be assumed that mothers with good language skills will pass on genes that confer good language skills, even though it is impossible to disentangle purely genetic influences from gene-environment correlation in a design such as the one used by them. Based on these results they conclude that children's early language and literacy development is not determined only by the HLE (indexed by storybook exposure) but also by the mother's linguistic ability.

## **2.5 Family risk of reading difficulties**

In line with the findings from such behavioural-genetic studies, research on family risk (FR) of reading difficulties (RD) has shown that, when there is an incidence of RD in the close member of family (a parent or an older sibling), there is a higher-than-normal probability that the child will also manifest RD (Snowling & Melby-Lervåg, 2016).

### **2.5.1 Family risk, emergent literacy and oral language**

The earliest FR studies of English-speaking children reported poorer emergent literacy in FR children who were later identified as actually having reading difficulties (FR-RD children) than in children without FR (not-FR children). However, FR children who were not later identified as having RD (FR not-RD children) did not perform significantly poorer than not-FR children on any emergent-literacy tasks (Gallagher, Frith, & Snowling, 2000; Scarborough, 1990, 1991).

By contrast, in an FR study of Danish-speaking children carried out by Elbro, Borstrøm, and Petersen (1998), FR not-RD children also scored significantly lower than not-FR children on certain emergent literacy tasks at pre-school age, suggesting that an emergent literacy deficit was present in all FR children even before the onset of formal reading instruction. Later on, an American study similarly found that English-speaking FR not-RD children had some deficits in tasks relating to phonological and literacy skills at pre-school age, even though these FR not-RD children were considered to be typical readers at the end of the second grade (Pennington & Lefly, 2001). At pre-school age, these FR not-RD children had scored significantly lower than not-FR children, particularly in verbal short-term memory and RAN. Whereas, they had been on a par with not-FR children on tasks tapping explicit phonological awareness. These findings were in line with those of Elbro et al. (1998), which also suggested that FR was a continuous risk rather than discrete



one, which was reported earlier by some other researchers (Gallagher et al., 2000; Scarborough, 1990, 1991).

Similarly, Snowling and various colleagues (Carroll & Snowling, 2004; Nash, Hulme, Gooch, & Snowling, 2013; Snowling, Gallagher, & Frith, 2003; Snowling, Muter, & Carroll, 2007) found that FR of RD is continuous and for some literacy measures, FR not-RD children showed deficits that resembled those of FR-RD children at pre-school age. For example, Snowling et al. (2003) found that, on nursery rhyme and letter-knowledge tasks, FR-RD children performed significantly poorer than FR not-RD children, who in turn performed worse than not-FR children did. Snowling et al. (2003) argued that FR not-RD children shared a deficit with the FR-RD children on tasks requiring transcoding between letters and sounds (grapheme-phoneme skill) in non-word reading and phonetic spelling measures although these 6-year old, FR not-RD children did not fulfil criteria for RD later at the age of eight. In a follow-up study, Snowling et al. (2007) found that FR was long-standing in nature and that there was no catch-up in literacy skills for FR children between the ages of eight and thirteen. At the age of eight, 66% of FR children were found to manifest RD; hence, the remaining 34% were defined as FR not-RD children. These FR not-RD children appeared to compensate their weakness in decoding skills by using their good language skills and so did not manifest RD at the age of eight despite having had some deficits in non-word reading and phonetic-spelling skills at the age of six. Yet, the follow-up study showed that these eight-year-old FR not-RD children were later significantly less fluent at reading than not-FR children at the age of thirteen, and actually they were as slow as FR-RD children on timed tasks. Based on these findings, Snowling et al. (2007) suggested that RD of developmental origin, for example those attributable to FR, are continuous in nature and tend to persist rather than resolve.

A similar picture emerges from the Jyväskylä Longitudinal Study of Dyslexia (Lyytinen, Ahonen, et al., 2004; Lyytinen, Aro, et al., 2004;

Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010; Torppa, Poikkeus, Laakso, Eklund, & Lyytinen, 2006), which concerns children speaking Finnish, a language that is orthographically more transparent than Danish and English. For example, Lyytinen, Aro, et al. (2004) reported that the majority of the FR children scored at least 1 SD below the average of the not-FR children on decoding tasks at school entry. The FR children also manifested group differences on a number of measures of language outcomes, including phonological and morphological skills, which had been collected repeatedly from the age of three. In another study, vocabulary delays were found in FR children from the age of two, deficits in inflectional morphology, phonological sensitivity and letter naming were found at the age of three, and poor comprehension of verbal instructions emerged by the age of five (Torppa et al., 2010).

Furthermore, van Bergen and various colleagues (van Bergen, et al., 2014a; van Bergen et al., 2012; van Bergen et al., 2011; van Bergen et al., 2016) have found evidence supporting the claim that FR of RD is a continuous risk in Dutch-speaking children as well.

In fact, in a meta-analysis of FR research, Snowling and Melby-Lervåg (2016) found that FR children universally develop emergent literacy and oral language more slowly than not-FR children. This finding indicates that FR is continuous and the signs of RD (or a ‘deficit in emergent literacy’) can be traced from the pre-school age onwards in FR children. In this meta-analysis, group differences in favour of not-FR children were found for measures of letter knowledge ( $d = 0.47$ ), phoneme awareness ( $d = 0.56$ ), vocabulary ( $d = 0.65$ ), RAN ( $d = 0.61$ ) and verbal short-term memory ( $d = 0.45$ ) at pre-school age. However, the authors also stress that, even though there is a universal group deficit in emergent literacy, the reported effect sizes differed between studies depending on the choice of assessments, the age of the groups and – most pertinently – the type of criteria used to identify poor readers. Accordingly, the prevalence was lower for studies that used more conservative criteria.

Overall, approximately 29% to 66% of FR children have been reported to develop RD.

In this context, it is worth mentioning that some studies have also provided evidence about a link between FR and oral language skills by comparing FR children with children with speech language impairment (Carroll & Snowling, 2004; Nash et al., 2013). Carroll and Snowling (2004) found that both FR children and children with speech-language impairment were at high risk of RD. These two high-risk groups performed significantly poorer than normally developing controls of similar age and educational experience on measures of phonological processing and phonological learning such as phonological awareness and word-recognition skills. The authors suggested that a problem of phonological processing might be the shared risk factor and that it could be traced to poorly specified phonological representations in both groups. In another study, Nash et al. (2013) identified a broad range of language difficulties in FR children, finding that one-third of the FR children met the criteria for specific language impairment (SLI). Interestingly, however, even after the FR children with SLI had been removed from the FR group, the remaining FR children showed significantly poorer phonological skills than typically developing controls.

In summary, there is evidence supporting the claim that family risk of RD is a continuum risk, and FR children universally, regardless of language, manifest deficits in preschool emergent literacy and oral language skills.

### ***2.5.2 Similar prediction pattern for literacy outcomes in FR and not-FR groups of children***

The finding of clear group differences in emergent literacy and oral language skills between FR and not-FR children raises some questions concerning the prediction patterns of literacy outcomes in these two

groups. For example, can this group difference in emergent literacy and oral-language skills influence the prediction pattern for later literacy outcomes between these two groups? Moreover, are these patterns similar or different?

In a three-year longitudinal study, Pennington and Lefly (2001) compared predictors of RD between FR and not-FR children: The prediction pattern did not vary much by age in the not-FR group because phonological awareness was the main (and usually the only) predictor, accounting for between 18% and 39% of the outcome variance. In the FR group, by contrast, the prediction pattern varied markedly by age: letter knowledge was the dominant predictor at the age of five to six whereas phonological awareness became the dominant predictor later by the age of seven. Therefore, the authors suggested that the FR children underwent a developmental shift at the age of seven, which the not-FR children had usually undergone at the age of five (i.e. before the onset of formal reading instruction). They further concluded the predictors of literacy skills did not in fact vary depending on FR status: both FR and not-FR children showed a similar developmental shift from letter-name knowledge to phoneme awareness as the main predictor of later literacy skills, but this shift happened two years later in FR children. Similarly, Torppa et al. (2007b) found that, even though FR children had poorer emergent literacy skills, the prediction pattern for phonological awareness and early reading was similar between the FR and not-FR children even when the HLE was controlled for.

In summary, previous longitudinal prediction studies have all – not surprisingly – shown similar predictive links to later reading outcomes from emergent literacy via letter knowledge, rapid naming and phoneme awareness in both FR and not-FR children (Aro et al., 2009; Cardoso-Martins & Pennington, 2004; Pennington & Lefly, 2001; Torppa et al., 2011; Torppa et al., 2010; Torppa et al., 2006; Torppa et al., 2007b). However, letter knowledge may remain a predictor for a longer period in FR children than in not-FR children (Snowling & Melby-Lervåg, 2016).

In other words, even though FR children had poorer emergent literacy skills, the pattern of prediction for later literacy outcomes is similar in FR and not-FR children. However, despite the large body of research showing the similarity of prediction patterns between FR and not-FR children, there are limited data on the concurrent predictive roles of FR and emergent literacy with regard to children's later literacy outcomes or RD.

### ***2.5.3 FR as a predictor of literacy outcomes and RD***

Elbro, Borstrom et al. (1998) were the first to test unique predictors of RD at the beginning of the second grade, examining six different groups of indicators: emergent literacy, linguistic awareness, basic language abilities, phonological representations, basic cognitive abilities and family background (including FR status). The model of prediction that they finally adopted after backwards stepwise selection, yielded three statistically significant predictors of RD: letter naming, phoneme identification and phonological representations. FR did not predict children's RD in their final model.

Different results were reported from a study taking a clinical approach (Puolakanaho et al., 2007), where a series of regression analyses were performed to explore what combinations of measures were the most sensitive and specific when it came to predicting individual risk of RD across ages (from 3.5 years to the second grade). Letter knowledge and RAN emerged as significant predictors of RD at the ages of 3.5 and 5.5 years while letter knowledge and phonemic awareness were significant at the age of 4.5 (no measure of RAN was available for this age). In addition, FR status was found to be a significant predictor of RD at all ages. The Nagelkerke  $R^2$  values explained 32–35% of the variance in the three age-specific models.

The role of FR status in children's literacy outcomes – not for the prediction of RD – was examined in a study by Carroll, Mundy, and

Cunningham (2014). Their results showed that FR was a unique predictor of children's reading and spelling outcomes, after controlling for speech production, oral language and phonological processing. The authors argued that FR children showed literacy deficits that could not be fully explained in terms of their emergent literacy and oral language skills.

In summary, findings from studies on the prediction of RD (Puolakanaho et al., 2007) and reading outcomes (Carroll et al., 2014) have confirmed that FR status, in addition to emergent literacy and oral language skills, makes a unique contribution to the prediction of differences in children's literacy outcomes. However, neither of these previous study included environmental factors (e.g. the HLE and parents' level of education) in the prediction models.

#### **2.5.4 *FR and the HLE***

It is believed that the HLE is associated with the family's background – not just its SES, but the genetic background as well, given that biologically related family members share both genes and certain aspects of their environment (Hart et al., 2009). Hence it is expected that parents who themselves have RD are less likely than other parents to expose themselves to the world of literacy, and consequently FR children may experience a less advantageous HLE than children growing up in not-FR families (Dickinson & Sparague, 2001). For example, severely dyslexic adults are reported to have usually a more negative attitude towards reading than adults with only mild dyslexia (Leinonen et al., 2001). Such circumstances might result in a less rich HLE for FR children, for example.

In a comprehensive study, Torppa et al. (2007b) investigated the HLE (operationalised as shared reading, access to print and parents' literacy interest and habits; in addition, the child's own interest in reading was also studied) of families participating in the Finnish Jyväskylä Study.

They found evidence that the associations between the HLE, phonological awareness, vocabulary, letter knowledge and emergent reading were highly similar in FR and not-FR children. It turned out that shared reading predicted only vocabulary, not letter knowledge, emergent reading or phonological awareness. In addition, the authors found that the frequency of shared reading by parent and child at home did not differ significantly between FR and not-FR children across the ages studied (from two to six). It should be noted that the parents' educational level did not differ between FR and not-FR families in this study. However, parents with RD were less active readers themselves than parents without RD, suggesting that FR children had less positive reading models at home.

In contrast, research in England has shown that parents with RD expose their children to fewer literacy-related activities in the home than parents without RD (Dilnot, Hamilton, Maughan, & Snowling, 2016; Hamilton et al., 2016; Scarborough et al., 1991). Dilnot et al. (2016) found that FR children experienced more environmental adversities than not-FR children. The environmental factors were the HLE and SES including the parents' level of education and occupations, which were used to predict children's 'reading readiness' (early word reading, letter knowledge and phoneme deletion) at school entry.

In another study, Hamilton et al. (2016) investigated the HLE based on the formal–informal dichotomy of Sénéchal and LeFevre (2002). The informal HLE or aspect of storybook exposure included parents' familiarity with children's literacy while the formal HLE included parents' instruction based on how often the parents taught their children to recognise letters, read words and write words. Structural equation modelling was used to test a two-group (FR and not-FR) longitudinal path model predicting word reading and reading comprehension. The developmental relationships between the HLE and literacy (word reading and reading comprehension) were almost similar in FR and not-FR children. The authors also examined indirect effects, reporting a

statistically significant indirect effect of SES on word reading via storybook exposure and emergent decoding. Parents' instruction was also a significant predictor of word reading, but only via emergent decoding. When it comes to reading comprehension, significant indirect effects were observed for both storybook exposure and parents' instruction, via oral language, emergent decoding and word reading, in both FR and not-FR children. In summary, the HLE as using storybook exposure and parents' instruction at the age of four, predicted word reading and reading comprehension two years later, via emergent literacy and oral language skills at the age of five. In addition, group differences in storybook exposure (the frequency of shared reading and the number of children's books in the home) between FR families and not-FR families were also reported. However, when family SES was controlled for there remained no statistically significant group differences. The authors suggested that the HLE differences seen between FR and not-FR families in their study might be related to the parents' educational level and/or SES.

In summary, several FR studies have reported that the frequency of shared-reading at home did not differ significantly between the FR and not-FR groups, even though parents of FR children were less active readers themselves than parents of not-FR children (Elbro, Borstrom, et al., 1998; Lyytinen, Ahonen, et al., 2004; Torppa et al., 2007a; Torppa et al., 2006). In those studies, which were conducted in Finland and Denmark, there was no significant difference in the level of parental/maternal education between FR and not-FR groups. Equivalent maternal education might in fact explain the non-significance of the differences in various HLE aspects between these groups. By contrast, studies where FR families reported a lower level of parental education than not-FR families, have shown that parents with RD exposed their children to fewer shared-reading activities than parents without RD (Dilnot et al., 2016; Hamilton et al., 2016; Scarborough et al., 1991). The disparity in the associations found between the HLE and FR is probably



due to such differences in parents' educational level. The group differences in parents' educational level observed in some cases between FR and not-FR families are not surprising (Snowling & Melby-Lervåg, 2016) and could explain the findings of significant differences in the HLE between FR and not-FR families (Hamilton et al., 2016). However, there is limited research on the HLE of FR children (Snowling & Melby-Lervåg, 2016) where a rich HLE or a home literacy intervention (Niklas, Cohrssen, & Tayler, 2016; Niklas & Schneider, 2015) can support the development of children's emergent literacy and oral language skills. Therefore, more research is required to investigate the role of such protective environmental factors in children's emergent literacy outcomes.

### ***2.5.5 Summary and discussion***

There is converging evidence that FR persists over time, and FR children universally have deficits in pre-school emergent literacy, oral language and later literacy skills (Snowling & Melby-Lervåg, 2016). However, there are some limitations concerning previous FR studies that this thesis would like to address through three empirical studies. First, those previous FR studies included FR children who had at least one parent or an older sibling with RD. This means that the samples of FR children studied potentially included children with one, two or three (or more, if both parents and several siblings had RD) family members with RD. Such heterogeneity might affect the identification of FR and the conclusions about its influence on children's outcomes in terms of emergent literacy and later literacy skills. We know from genetic studies that a child with several family members with RD may be at greater risk of developing RD than a child with only one affected family member (Wolff & Melngailis, 1994). However, no previous FR study has reported differences within the broader group of FR children (between FR children with only one family member with RD and FR children with two family members with RD). In this thesis, FR is indexed by parents'

reports of RD (children who have an older sibling with RD but no parent with RD are excluded). This provides (a) an opportunity to empirically test children's emergent literacy and HLE within the group of FR children (one parent reporting RD vs both parents reporting RD), specifically in Study I, which has not previously reported. Further, it makes it possible to (b) empirically investigate the association between FR and the HLE in families, in which reporting of RD is included only for parents, not siblings. As previously Snowling and Melby-Lervåg (2016) pointed out, already having an older child with RD in the family might make parents more aware of the issue and more prone to seek support at an earlier stage, which might confound findings regarding the links between children's emergent literacy, later literacy outcomes and the HLE.

The second limitation of previous FR studies also concerns the sample, specifically the method of recruitment. In most of those studies, the researchers advertised for participants and parents volunteered for their children to take part in the study. In addition, the sample sizes were usually small. Snowling and Melby-Lervåg (2016) discuss how volunteer parents may be more likely to be already aware of the issue of FR and more likely to be highly motivated to ensure that their children will obtain the best opportunities possible. Hence the performance of the FR children in emergent literacy and literacy skills may to some extent reflect the HLE of these volunteer families. In this thesis, this issue is addressed through the recruitment of a large sample of children starting primary school. To have a close to representative sample, primary schools whose scores on the national reading tests had been close to the national mean ( $2.0 \pm 0.1$  on a scale from 1 to 3) in two of the three previous years were invited to participate (Lundetræ, Solheim, Schwippert, & Uppstad, 2017). Further, the children were not recruited *as* FR and not-FR children, but they were allocated to the FR and not-FR groups after recruiting schools.

Third, data on the HLE of children with FR of RD are scarce (Snowling & Melby-Lervåg, 2016) and mixed. Some researchers did not find any differences in the HLE between FR and not-FR families (Elbro, Borstrom, et al., 1998; Lyytinen, Ahonen, et al., 2004; Torppa et al., 2007b) whereas several studies have reported a relatively disadvantageous HLE for FR children compared with not-FR children (Dilnot et al., 2016; Hamilton et al., 2016; Scarborough, 1991; Scarborough et al., 1991). The parents' educational level has been suggested as an explanation for such inconsistent results regarding the association between FR of RD and the HLE, but no previous study has actually carried out an empirical investigation on the association between FR, parents' level of education and the HLE. This thesis, specifically through Study III, has studied the links between FR, parental level of education and the HLE to shed light on the protective role of environmental factors against a risk factor such as FR of RD.

Last but not least, the links between FR, parental education, the HLE, children's emergent literacy and their later literacy outcomes have not previously been investigated using a multi-factor deficit model. In multiple cognitive-deficit models, FR has been found to be a significant and unique predictor of children's RD at the beginning of the second grade when emergent literacy was controlled for (Puolakanaho et al., 2007), and it has also been found to be a significant additional risk factor with respect to reading and spelling skills after controlling for speech production, language and phonological processing (Carroll et al., 2014). However, environmental protective factors were not accounted for in previous FR studies. The present thesis aims to expand our understanding of the role of FR and emergent literacy in children's literacy difficulties while controlling for oral language (vocabulary) and environmental protective factors such as parents' level of education and the HLE, using a multi-factor model.

The next chapter will discuss the multi-factor model of RD and how this model has been applied in three empirical studies of the present thesis.

### **3 The present thesis: From single-deficit models to multi-factor models of RD**

Given the importance of early identification and intervention, a growing body of research has examined various possible models that can be used to predict RD from a range of factors including biological (genetics, FR and parents' reading skills), cognitive (emergent literacy deficits) and environmental ones (the HLE, SES and parents' educational level). These factors has been discussed earlier in Chapter 2. The majority of previous FR studies have used such models that mostly included single or multiple cognitive perspective to investigate the association between FR, children's emergent literacy and their later literacy outcomes. However, the majority did not include environmental factors such as the HLE that can have substantial influence on development of both emergent literacy and later literacy skills.

#### **3.1 *Single and multiple deficits models of RD***

Pennington (2006) discuss that *single cognitive deficit* models are primarily proposed to provide a complete causal account of the development of reading by including four levels of analysis: etiology, brain mechanisms, cognition and behaviour symptoms. However, these models have mainly focused on the symptoms level that define RD, which make it possible to identify and remediate reading problems as early as possible. As a result of single cognitive models, phonological difficulties have been found to be an early sign of RD or to represent a cognitive explanation for unexpected reading difficulties (Stanovich & Siegel, 1994). Despite their simplicity, such single cognitive deficit models guided, either explicitly or implicitly, early research on the cognitive as well as genetic causes of RD (Pennington, 2006), even though the literature has clearly discussed the interplaying roles of etiology (e.g. genetics or biology), cognitive development, brain

mechanisms and environmental influences. However, even when it comes to defining RD at the cognitive level, a single cognitive deficit model has its limitations, because the development of literacy is obviously a complex process that depends on a range of developmental cognitive and pre-literacy skills, not only phonological processing skills. For instance, a single cognitive deficit model cannot identify potential subtypes of cognitive deficits affecting both phonological and non-phonological processing skills. Pennington (2006) has argued that each cognitive subtype, therefore, requires its own distinct single cognitive deficit or a model of multiple cognitive deficits in order to explain different signs of RD even at the cognitive level. In other words, multiple deficit cognitive models are needed to explain children's difficulties in a range of pre-literacy skills. For instance, the *dual deficit model* has been widely used to explain the existence of both phonological and non-phonological deficits (Pennington, Cardoso-Martins, Green, & Lefly, 2001). Non-phonological skill is related with symbol processing speed measured usually by rapid automatized naming (RAN). Wagner and Torgesen (1987) point out the tasks of RAN require certain non-phonological skills (e.g. visual coding) along with phonological ones in order for a person to name pictures or symbols as accurately and quickly as possible.

Cognitive deficit models have also been criticized on a number of other counts such as genetic overlap or comorbidity between RD and other developmental disorders. For example, the comorbidity between RD and *attention deficit hyperactivity disorder* (ADHD) cannot be fully explained by cognitive models (for a comprehensive review, see Pennington, 2006). Finally, and more importantly, cognitive models cannot explain the effect of environmental factors whereas multi-factor models can include environmental factors as well as cognitive and other interplaying factors.

### **3.2 Multi-factor models of RD**

While it seems likely that research using cognitive models (single- or multiple-deficit ones) is necessary to define RD at the behavioural and symptom level, such models are not sufficient to cover other aspects such as environmental factors. Further, behavioural-genetic studies have shown that the etiology of RD and other developmental disorders can be explained more adequately by combining various aspects relating to genetic, cognitive and environmental factors as well as the interaction between these factors. Hence, Pennington (2006) suggests the use of multi-factor models of RD including factors of all three types. He argues that multi-factor models are more complex than single cognitive deficit models, but this complexity is necessary in order to account for observations at the various levels of interaction. This multi-factor model includes the associations among a variety of inter-related factors such as FR (a proxy for genetics), early individual differences at the cognitive level (emergent literacy and oral language skills) and environmental factors (the HLE and parents' educational level).

### **3.3 The present thesis**

The present thesis consists of three studies based on the multi-factor model of RD suggested by Pennington (2006), and van Bergen, et al. (2014b). Based on this multi-factor model, it is expected that FR may reveal some risk factors for children's emergent literacy and later literacy skills, and FR children would experience a less rich literacy environment than not-FR children. However, environmental factors such as having parents with higher education and/or a rich HLE might operate as protective factors that enhance children's literacy skills either directly or indirectly via their emergent literacy skills. Figure 3-1 presents the associations between FR, emergent literacy, oral-language, the HLE and parents' educational level at the onset of formal reading instruction and children's literacy outcomes at the end of the second grade from a multi-factor perspective.

In this multi-factor model, parents' (high) level of education is positively associated with the HLE as an environmental protective factor, which is also positively associated with children's cognitive factors at the onset of formal reading instruction and with their later literacy skills. In addition, FR of RD, as a risk factor, is negatively associated with both environmental factors and with children's emergent literacy, oral language skills and literacy skills. The grey arrows represent other known and unknown effects that may exert an influence at each level.

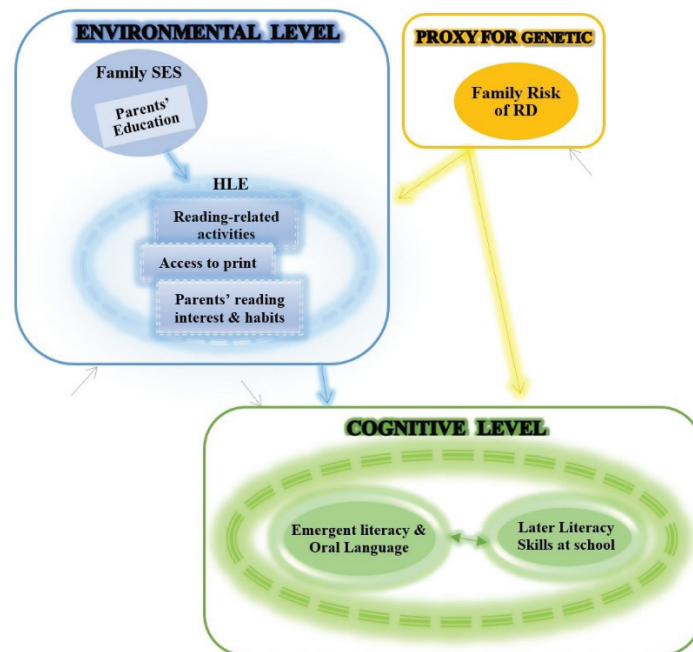


Figure 1 –A multi-factorial perspective on development of literacy skills

RD = reading difficulties; FR (family risk) of RD = having a parent with RD; SES = socio-economic status; HLE = home literacy environment.

### **3.4 Aims and research questions of the three empirical studies**

#### **3.4.1 Study I**

Esmaeeli, Z., Lundetræ, K., & Kyle, F. E. (2018). What can Parents' Self-report of Reading Difficulties Tell Us about Their Children's Emergent Literacy at School Entry? *Dyslexia*, 24(1), 84-105. doi:10.1002/dys.1571

A meta-analysis of previous FR studies has shown that FR children universally develop emergent literacy and later literacy skills more slowly than not-FR children (Snowling & Melby-Lervåg, 2016). However, it is pointed out in this meta-analysis that data on the HLE are rare, and that data on the HLE of FR children is even more rare. *Study I* is the first study that aims to investigate the association between FR, emergent literacy and environmental factors such as the HLE and parents' educational level in a multifactor-model.

Based on the existing literature, the following research questions and hypotheses guided Study I: (1) Can parents' self-report of RD (as a proxy for FR status) identify between-group and within-group differences in emergent literacy and the HLE at the onset of formal reading instruction? It is expected that children whose parents reported RD would display poorer emergent literacy than not-FR children, and that children with both parents reporting RD would have even poorer emergent literacy skills than those with only one parent reporting RD. Further, it is hypothesized that families where no parent reported RD would have the richest HLE while those with both parents reporting RD would have the least rich HLE. (2) Does FR status predict emergent literacy after controlling for the HLE, children's interest in literacy, the years of kindergarten, gender, vocabulary and parental level of education? It is hypothesised that parents' self-report of RD would be a unique predictor of children's emergent literacy after controlling for these background variables. Here it should be noted that, in line with the findings from



several earlier studies (Torppa et al., 2007a; Torppa et al., 2006), group differences in the control variable relating to children's interest in literacy were not expected at the onset of formal reading instruction.

### **3.4.2 Study II**

Esmaeeli, Z., Kyle, E. F., & Lundetræ, K. (Submitted). Contribution of Family Risk, Emergent Literacy and Environmental Protective Factors in Children's Reading Difficulties at the end of Second-Grade.

Pennington (2006) argued that RD is a complex developmental disorder involving the interaction of various risk and protective factors which can be either genetic or environmental in nature (or conceivably both). These risk and protective factors (at the genetic and environmental levels) thus influence the development of children's emergent literacy (at the cognitive level), which is a prerequisite for the development of later literacy skills (at the behavioural level). With regard to this multi-deficit model, it has been argued that FR, as a proxy for genetic factors, may operate as a risk factor increasing the likelihood of RD because it can exert a negative influence on both emergent literacy and later literacy skills (Pennington, 2006; van Bergen, et al., 2014b). Environmental factors, however, can operate as either risk or protective factors. Therefore, although the HLE may not be directly associated with children's later RD, its indirect influence via emergent literacy (Frijters et al., 2000; Sénéchal, 2006) should be controlled. However, no previous study has investigated the association between FR and children's literacy outcomes while controlling for environmental protective factors such as the HLE and parents' educational level. *Study II* aims to use a multi-factor model to investigate whether FR predicts children's later RD after controlling for emergent literacy and environmental protective factors such as the HLE and parents' educational level. Two research questions are asked: (1) Do FR children perform poorer on literacy tasks than not-FR children, and are FR children more likely to be categorised as having RD at the end of the second grade? (2) Does FR contribute to children's

second-grade RD above and beyond emergent literacy, vocabulary, parents' level of education and the HLE as measured at the onset of formal reading instruction?

### **3.4.3 Study III**

Esmaeeli, Z. (Submitted). A Model of Home Literacy Environment and Family Risk in Relation to Children's Emergent Literacy.

While it is clear that there is an association between the HLE, children's emergent literacy and their oral language skills, the definitions of the HLE used in the literature are broad and varied. Burgess et al. (2002) suggested that the HLE is a complex concept which can be described as encompassing a variety of *resources* (access to print), (reading-related) *activities* and *attitudes* (parents' literacy interest and habits). However, their HLE measure in fact included two aspects: *active* and *passive* HLE; it did not include the component of access to print (which, according to their definition of HLE, could be included in the passive HLE). Sénéchal et al. (1998) defined (*informal*) HLE as exposure to print, which was based on two measures of (a) access to print and (b) reading-related activities but in one factor. Starting from the dichotomy of active and passive HLE suggested by Burgess et al. (2002), exposure to print can be considered to consist of two distinct factors: a passive one (access to print) and an active one (reading-related activities).

It is therefore hypothesised that the HLE can be modelled either using a *two-factor* model including the passive HLE (including access to print and parents' literacy interest and habits) and the active HLE (including reading-related activities), or using a *three-factor* model including access to print, reading-related activities and parents' reading interest and habits. This latter three-factor model has not been explicitly investigated previously. The first aim of *Study III* is to test the factor structure of (*informal*) HLE using one-, two- and three-factor models. The second aim is to investigate the association between the HLE and FR while

controlling for parents' educational level. Parents' educational level has been suggested as a possible explanation for the inconsistent findings of previous studies with regard to the association between the HLE and FR of RD (Esmaeeli, Lundetrae, & Kyle, 2018; Hamilton et al., 2016). It is expected that a high parental level of education will operate as a protective factor against the negative influence of FR on the HLE. The third and final aim of Study III, is to test the associations between the HLE and children's emergent literacy at the onset of formal reading instruction while controlling for parental level of education and FR. Based on the multi-factor model of RD (van Bergen, et al., 2014b), it is expected that FR will operate as a risk factor for emergent literacy difficulties in children. But parental level of education and the HLE (which may not be free of the influence of FR) might operate as protective environmental factors against the negative influence of FR on children's emergent literacy skills.

## 4 Methods

### 4.1 Context of the study

In Norway, formal reading instruction for children begins in the first grade, in August of the year of their sixth birthday. Most primary-school students (96.7%) are enrolled in public (i.e. non-private) schools (Utdanningsdirektoratet, 2016). The language in which students learn how to read, Norwegian, has a semi-transparent orthography, which is for example, more regular than that of English but less regular than that of Finnish.

Parents' level of education rather than their level of income was used as a proxy for socio-economic status (SES) since previous research has shown that the former is a stronger predictor of Norwegian children's educational outcomes than the latter (Løken, 2010).

### 4.2 On Track project (*på sporet*)

The three empirical studies included in the present thesis are based on data from an on-going longitudinal project in which I have contributed as the data manager: Training a group of assistance from scoring the measures to entering the data to the SPSS program. *On Track (På sporet)* that focuses, among others, on early identification and intervention by applying a group-randomised controlled-trial design allowing robust evaluation of intervention outcomes relative to an equivalent control group (Lundetræ et al., 2017). The On Track project recruited a convenience sample of 19 primary schools whose average score on the national reading tests had been close to the national mean ( $2.0 \pm 0.1$  on a scale from 1 to 3) in two of the three previous years. These schools were also expected to enrol at least 40 first-grade students in the autumn of 2014 (Lundetræ et al., 2017). The 19 participating schools were randomly allocated to one of four conditions as intervention and control groups. Altogether, 1,171 six-year-old children joined the project at the

beginning of the first grade. All students are screened at school start and tested at the end of grade 1, grade 2 and grade 3 as well as at the start of grade 5 by trained testers.

As the present thesis deals with group differences and prediction, not with the effect of intervention, the samples for each of three empirical studies included only the control groups from the On Track project in which no intervention has been made.

### **4.3 Participants**

In *Study I*, the sample was established after the first-point assessment performed at the beginning of the first grade (the onset of formal reading instruction in Norway). After the exclusion of children with Norwegian as a second language ( $n = 193$ ), bilingual children ( $n = 83$ ), children with hearing problems ( $n = 28$ ), drop-outs ( $n = 29$ ) and children whose parents did not answer whether they themselves had experienced reading difficulties (RD) or did not know about the biological parents' reading skills ( $n = 74$ ), the sample for Study I consisted of 821 children. For 634 of them, neither parent reported having had RD. These children make up the group without family risk (not-FR group). For the remaining 187 children, one or both parents reported RD identified as children with family risk (FR group). In addition, the FR children were divided into two groups: FR-one, consisting of children with only one parent self-reporting RD ( $n = 165$ ), and FR-both, consisting of children with both parents self-reporting RD ( $n = 22$ ).

The sample used in *Study II* to examine the prediction of second-grade RD included only children from those schools that had randomly been assigned to the control condition ( $n = 260$ ). Second-language speakers, children with hearing problems and children whose parents did not provide information about RD within the family were excluded from the sample. Hence, the total sample in Study II was 208 children. Similarly to Study I, parents' self-report of RD was used to allocate their children

to FR and not-FR groups. There were 159 children in the not-FR group and 49 in the FR group. Among FR children, only three children had both parents self-reporting RD.

Participants were included in *Study III* after the screening carried out at the beginning of the first grade. Children whose parents did not provide information about RD within the family, second-language speakers and children with hearing problems or other known disabilities were excluded from the final sample. As Study I had shown that children with both parents having self-reported RD had poorer emergent literacy and a less rich home literacy environment (HLE) than children with only one parent self-reporting RD, children with both parents reporting RD were excluded from Study III. This was because the inclusion of those children could have biased the interpretation of the results regarding the relationship between FR and the HLE. In the final sample of 794 children, 634 had no parent self-reporting RD (not-FR children) whereas 160 had one parent self-reporting RD (FR children).

#### **4.4 Measures and procedure**

The results of the present thesis rely on data obtained through the parents' questionnaire regarding FR of RD and the HLE, as well as data from several measures for children's outcomes in emergent literacy and vocabulary at the onset of formal reading instruction (at the beginning of the first grade) and literacy skills (reading, spelling and reading comprehension) at the end of the second grade.

##### **4.4.1 Parents' questionnaire: FR and the HLE**

###### **FR status**

FR status was obtained through a parents' questionnaire, in which parents were asked the following question: 'Has anyone in the child's biological family experienced "reading and writing difficulties"?', which

was to be answered separately for the mother and the father (response options: ‘yes’, ‘no’ and ‘don’t know’).

### **The HLE and the children’s interest in literacy and letters**

Base on previous research, different components of the HLE were measured using the parents’ questionnaire (Burgess et al., 2002; Dilnot et al., 2017; Hamilton et al., 2016; Niklas & Schneider, 2013; Torppa et al., 2007b).

*Access to print* was assessed using the following items: (a) ‘How many children’s books do you have at home?’ (response options: 1 (‘none’) to 5 (‘more than 40’)) and (b) ‘How old was your child when you first started reading to her or him?’ (response options: 1 (‘Never read to our child’) to 5 (‘before the age of 2’)).

*Reading-related activities* was assessed using the following four questions: (a) ‘How often do you read to your child?’; (b) ‘How often does your child watch TV?’; (c) ‘How often does your child play TV/computer/tablet/mobile-phone games?’; and (d) ‘How often do you visit a public library with your child?’ (response options in all cases: 1 (‘never’) to 5 (‘several times a week’)).

*Parents’ reading interest and habits* was assessed using questions regarding how often they themselves read (a) books and (b) newspapers and magazines (response options: 1 (‘never’) to 5 (‘several times a week’)) as well as the item ‘I only read if I have to’ (response options: 1 (‘completely disagree’) to 4 (‘completely agree’)).

*The child’s interest in literacy and letters* was assessed using the items (a) ‘My child often asks to be read to’ and (b) ‘My child takes an interest in letters’ (response options: 1 (‘completely disagree’) to 4 (‘completely agree’)).

## Procedure

At the onset of formal reading instruction (beginning of first grade), Norwegian schools require that the parents attend a welcome meeting. The On Track research team presented information about the project and about reading difficulties at these meetings at each participating school, inviting the parents to give consent for their children's participation in the project. The parents received a brochure with further information about the project, a parental-consent form and a questionnaire regarding FR of RD and the HLE. 'Reading and writing difficulties' is a familiar term that is in common use at schools and in the media in Norway. This was also briefly discussed at the parents' welcome meeting as mentioned earlier.

### 4.4.2 *Emergent literacy and oral language at the onset of formal reading instruction*

**Letter knowledge** was assessed using a 15-item multiple-choice test. The child was asked to listen to a pre-recorded letter sound on the tablet and respond by pressing one of four letters shown on the touch screen. With regard to reliability, Cronbach's  $\alpha$  was .85.

**Phonemic awareness** was assessed using two tasks (first-phoneme isolation and blending) which each consisted of eight items of increasing difficulty and which were both automatically discontinued after two subsequent errors. (a) In the *first-phoneme isolation* task, the tablet screen showed a picture. The examiner pointed at the picture, said the word for the object depicted and asked the child about the first sound of that word. The child's oral response was scored and recorded on the tablet by the examiner. Cronbach's  $\alpha$  was .92. (b) The *blending task* required the child to blend a set of separately pronounced phonemes into the corresponding whole word. In each item, four pictures appeared on the screen, and the task was pre-recorded: 'Here you see a picture of /ri/, /rips/, /ris/ and /ring/ [the Norwegian words for "ride", "red currant",



“rice” and “ring”]. Listen carefully and touch the picture that goes with /r/-/i/-/s/ (presented phoneme-by-phoneme, one per second)’. Cronbach’s  $\alpha$  was .86.

**Vocabulary** was tested using an abridged version (20 out of 40 words) of the Norwegian vocabulary test (Størksen, Ellingsen, Tvedt, & Idsøe, 2013). A picture appeared on the screen, and the child was asked to name it. With regard to reliability, Cronbach’s  $\alpha$  for the 20 items of the abridged version was .83, which is consistent with the  $\alpha$  value of .84 for the full standardised 40-item version.

**Rapid automatized naming (RAN)** was assessed using a matrix where the children were asked to name familiar objects presented repeatedly in random order. The examiner, first, practised the task with the child to make sure that he or she knew the name of each object and understood the procedure. The objects pictured were the sun, a car, an aeroplane, a house, a fish and a ball. All of the corresponding Norwegian words are monosyllabic. The task consisted of two trials, each involving a four-by-five stimulus matrix. The child was asked to name each item as quickly and accurately as possible from left to right and from top to bottom. The time required to complete the task (in seconds) and the number of naming errors were recorded.

**Short-term memory (STM)** was measured using Digit Span Forward from the Wechsler Intelligence Scales for Children (Wechsler, 1991). The examiner read aloud, one digit per second, and the student’s responses were scored on the tablet. Cronbach’s  $\alpha$  was 0.83.

**Word reading** was assessed using a test including eight words which ranged from easy to difficult and represented a variety of letters and letter sequences (VC, CV, CVC, VCV, CVC, CVCC and CVCCV – all of which are frequent in Norwegian). The words appeared on the screen one at a time, and the child was asked to read the word aloud. Cronbach’s  $\alpha$  was .92.

**Spelling** was assessed on the basis of ten words representing a variety of phonemes and phoneme sequences and ranging from easy to difficult (CV, VC, VCV, VCC, CVC, CVCV, CVCC, and CVCVC – all of which are frequent in Norwegian). There was a practice trial during which the examiner wrote the word down while sounding out each letter and asked the child to do the same. For the test items, each target word, was first introduced in a short sentence. Then the examiner repeated the target word and asked the child to write it (e.g. ‘Father has a blue hat. Write *hat*.’). Cronbach’s  $\alpha$  was .93.

### **Procedure**

The test battery was individually administered and scored on a digital tablet between two and five weeks after the start of the first grade. The testing was carried out by a team of 18 trained testers who were experts in the field of reading instruction and individual testing. In a quiet classroom at the respective school, the child and the tester sat together with a tablet. The testers were trained to ask and guide the child through the whole process in a fixed order. Each measure was associated with one or two examples to ensure that the child understood the task. For more information, please see the protocol study (Lundetræ et al., 2017).

#### ***4.4.3 Literacy skills at the end of the second grade***

The participants’ literacy skills at the end of the second grade were assessed using the Norwegian national screening test of reading, spelling and reading comprehension, which was administered at the respective schools by a group of trained testers. The aim of this screening test is to identify students who perform below the national threshold (i.e. the 80th percentile of the national sample).

**Word reading** was assessed using a test which consisted of 14 items and had a time limit of 2 minutes. For each item, a picture was presented along with four visually similar (real) words, one of which corresponded

to the picture (e.g. a picture of a wasp (*veps* in Norwegian) accompanied by the words *vest* ‘west’, *visp* ‘whisk’, *veps* and *vips* ‘suddenly’). The child was asked to read all the words as fast as possible and to mark the word that matched the picture. The maximum score was 14 and Cronbach’s  $\alpha$  was .74.

**Spelling** was assessed using a test involving 14 words with a variety of phonemes and phoneme sequences. The target word was first introduced to the child in a short sentence and then repeated for the child to write it down (e.g. ‘Father has a blue hat. Write *hat*.’). The number of correctly spelled words was measured, and the maximum score was 14. Cronbach’s  $\alpha$  was .84.

**Reading comprehension** was measured using two sub-tests, a sentence-based test and a text-based one. In the sentence-based comprehension test, the child read ten sentences, each providing some information about a picture. The picture and the sentences pertain to a story about two trolls going into the woods and things that the trolls saw there. The child was told, ‘There are several things to see in the woods. Find out what they saw and mark those things with a cross on the picture.’ For example, after reading one of the sentences, the child was supposed to mark ‘the top of the tallest tree’. The text-based comprehension test included five multiple-choice questions. There were four short texts about children who explained where they wished to go on holiday. The time limit was 20 minutes, so as to provide the students with sufficient time. The maximum total score for the two sub-tests was 15. Cronbach’s  $\alpha$  was .85.

### **Procedure**

The testing was carried out by a team of trained testers who were experts in the field of reading instruction and testing. The test battery (the national screening tests) was administered at the respective schools in a small group consisting of fewer than 15 students. All measures were pen-and-paper based and the testers had been trained to guide the group through the whole process in a fixed order. Each measure was associated

with one or two examples to ensure that the group understood the task. In addition, during the training session the testers used guidelines that encouraged them to monitor how the individual students managed and how they responded to the test.

#### **4.5 Validity and reliability of the measures**

All of the tests used in this thesis were administered as part of the On Track project. These tests were all originally designed in Norwegian, except the test for short-term memory, which was adapted from the English version (Wechsler, 1991).

##### ***Family risk (FR)***

The present thesis used parents' self-report of RD as a proxy for FR status, for four reasons. (1) The term for 'reading and writing difficulties' used in the parents' questionnaire is a familiar term in Norway, as it is frequently used at schools and in the media. In addition, the On Track research team discussed and provided some information about RD at the welcome meetings. (2) The On Track project, unlike most previous FR studies, had a large sample ( $N = 1,171$ ), meaning that in practice it would have been impossible to directly assess parents' reading skills (some 2,242 mothers and fathers would have had to be tested). (3) It is now well established that there is an association between FR of RD and children's difficulties in emergent literacy and later literacy skills (Snowling & Melby-Lervåg, 2016). (4) It is widely accepted that parental self-report of RD can be a valid, reliable and time-saving tool to screen for RD among parents and hence to identify FR children (Leavett, Nash, & Snowling, 2014; Lefly & Pennington, 2000; Snowling, Dawes, Nash, & Hulme, 2012).

The findings of the three studies included in the present thesis show levels of impaired emergent literacy in FR children at the onset of formal reading instruction which are in line with the findings from previous FR

studies. FR status had been confirmed by corroborating measures used in addition to parents' self-report of RD in the majority of these previous FR studies. The findings of this thesis indicate that parents' self-report of RD has reasonable internal consistency and reliability when it comes to identifying children with FR of RD.

### ***Home literacy environment (HLE)***

The results presented in the present thesis rely on parents' questionnaires to measure the HLE, and this is what most previous research has done as well. It has been discussed that parents' questionnaires are an indirect measure and that they may be open to social-desirability bias, which might have caused parents to report, for example, reading to their children more frequently than they really do. However, given the pattern of parents' responses, which covered the full range from low to high rates of reading-related activities at home, etc., such bias might not be of great concern in the present data. This is in line with the discussion in Hart, Ganley, and Purpura (2016) with regard to their measure of the home mathematics environment. In addition, the HLE results have been found to correlate with children's outcomes on the various measures of emergent literacy, which suggests that convergent validity was obtained in the present study.

Another possible concern is that parents with reading problems and/or poor confidence in their reading skills – who typically ought to report having RD – might not be comfortable with the task such as a questionnaire. To reduce the potential impact of this issue, the questionnaire was designed to contain short, simple, multiple-choice questions for parents to answer at home, at their own pace.

Further possible concern about the HLE measure relates to who answered the questionnaire. The parents were free to decide in this matter and in most cases the child's mother was the one who filled in the questionnaire – not surprisingly, given the role typically played by

mothers in the home and the fact that they are usually the main caregivers. Mothers were over-represented in this respect both in the whole sample and in the two groups of children with and without FR. As discussed in Study III, each step of the analysis was tested on a separate data set including data only from questionnaires answered by mothers ( $n = 498$ ) and it was consistently found that the results were similar to those obtained from the whole sample.

Confirmatory factor analysis was performed on the data from the questionnaire using the Mplus software. The overall goodness of fit (Brown, 2006) indicated that the HLE model fits the data adequately: the root mean square error of approximation (RMSEA) was .05, the comparative fit index (CFI) was .94 and the Tucker–Lewis index (TLI) was .91). Factor-loading estimates revealed that the indicators were moderately to strongly related to their purported factors and to components of the HLE (the range of  $R^2$  values was .52–.78), indicating that the various items used for this measure have reasonable internal consistency and reliability.

### ***Emergent literacy at the onset of formal reading instruction and literacy skills at the end of the second grade***

The vocabulary test was an abridged version (20 out of 40 items) of a standardised Norwegian vocabulary test (Størksen et al., 2013). The other emergent-literacy tests used at the onset of formal reading instruction were developed within the On Track project. The literacy measures applied at the end of the second grade are based on the Norwegian national screening test (Norwegian Directorate for Education & Training, 2015). Information about the reliability (Cronbach's  $\alpha$ ) of the vocabulary test and of the individual measures of emergent literacy and literacy has been provided in Section 4.2. The results indicate that the various sub-scale items have reasonable internal consistency and

reliability. All tests were also administered by a group of trained testers and had previously been validated in a large representative sample as a national screening test (Utdanningsdirektoratet, 2016).

#### **4.6 Internal and external validity of the results**

**Internal validity**, according to Shadish, Cook, and Campbell (2002), refers to the extent to which the causal relationships observed in a study are consistent and reliable. In correlational studies, the transparency and testability of the relationships found are crucial in order for such relationships to be inferred. Correlational studies such as those included in the present thesis do not technically allow causal relationships to be inferred; however, Shadish et al. (2002) argue when the associations are clear and testable, the internal validity can be considered good as well. The present thesis has identified a clear association between FR and children's emergent literacy and later literacy skills, in line with the meta-analysis of FR research carried out by Snowling and Melby-Lervåg (2016).

Another factor of importance to internal validity is the action taken in a study to control for confounding factors that might have influenced the associations. The present thesis controlled for environmental confounding factors (i.e. the HLE and parents' educational level) with respect to the associations between FR and children's emergent literacy and later literacy skills. Unlike previous studies, the findings from this thesis show the direct and indirect effects of the HLE on children's emergent literacy and literacy outcomes.

**External validity** refers to the extent to which the results can be generalised to other contexts, situations and groups (Shadish et al., 2002). The sample studied in the present thesis comes from the On Track project, which recruited a convenience sample consisting of primary schools located in the largest municipalities within close travel distance of the Norwegian Reading Centre at the University of Stavanger. To

ensure that this sample was as representative as possible, only schools that (a) expected more than 40 children to be enrolled in the first grade and (b) had scored close to the national average on the national reading tests in at least two of the three previous years were invited to participate in the project (Lundetræ et al., 2017). Of the 25 schools that fulfilled these criteria, only 19 schools confirmed their participation within a deadline of two weeks. The parents of 97.7 percent of the students enrolled in these 19 schools consented to participation in the project ( $N = 1,171$  six-year-old children). Because of this large sample, the present thesis has been able to draw upon not only large groups of FR and not-FR children but also a close to representative sample from the participating schools. By contrast, most previous studies recruited their FR samples by advertising for participants and asking parents with RD to participate. In this context, it should be noted that volunteer parents are likely to be already aware of the issue of FR. They are also highly motivated to ensure that their children receive the best opportunities available (Snowling & Melby-Lervåg, 2016). For this reason, the HLE of FR children and their performance in terms of emergent literacy and later literacy skills found in those studies might to some extent reflect this greater awareness and motivation of volunteer families. In the present thesis, the children were subdivided into FR and not-FR groups only after their parents had consented to their participation. This is likely to yield more representative samples of FR and not-FR children, which strengthens external validity and hence makes it more likely that the results are applicable to other context and groups of children.

#### **4.7 Statistics**

In Study I, three sets of analyses were applied. First, to adjust for multiple comparisons and reduce type I error, two series of analyses of variance (ANOVAs) followed by Bonferroni tests (Tabachnick & Fidell, 2007) were run to investigate group differences in emergent literacy, the HLE and children's interest in literacy between FR and not-FR children.



Second, to compare differences in emergent literacy and the HLE between FR children with only one parent reporting RD, FR children with both parents reporting RD and not-FR children, two multivariate analyses of variance (MANOVAs) were performed. Third, a multiple hierarchical regression analysis was used to test whether FR predicted children's outcome in emergent literacy after controlling for the HLE, children's interest in literacy, the number of years spent at kindergarten, gender, vocabulary and parental level of education. All of these analyses were conducted using the IBM SPSS Statistics 21.0 software.

In Study II, an ANOVA was first run to investigate group differences in emergent literacy between FR and not-FR children. The analyses were conducted using IBM SPSS Statistics 21.0. Second, a logistic regression was used to investigate whether FR predicted children's RD at the end of the second grade, above and beyond their pre-school emergent literacy, gender, HLE and parental level of education. This logistic regression analysis was conducted in Mplus 8 using a maximum likelihood estimator (ML).

In Study III, confirmatory factor analysis (CFA) was first used to test the structure of the HLE. Second, structural equation modelling (SEM) was applied to test the association between FR and the HLE after controlling for parents' level of education. Third, SEM was again used to investigate the association between the HLE and children's emergent literacy while controlling for FR and parents' level of education. The measurement modelling and the subsequent structural modelling was conducted in Mplus 8 using a maximum likelihood estimator (WLSMV), which is a robust estimator that does not assume a normal distribution and represents the best option for modelling categorical or ordered data (Muthén & Muthén, 2017).

#### **4.8 Ethical considerations**

The On Track project was approved by the Norwegian Social Science Data Service (NSD), a third-party ethical-oversight agency (Lundetræ et al., 2017). All relevant ethical guidelines have been strictly adhered to, from data collection to results reporting by the research group and presentation in this thesis.

## **5 Summary of findings**

### **5.1 Study I**

In the first study, parents' self-report of RD as a proxy for FR was used to investigate the role of FR in children's emergent literacy and the HLE. In brief, the following findings were made:

(1) Group differences in emergent literacy and the HLE were investigated between FR and not-FR children and between FR-one (only one parent with RD) and FR-both (both parents with RD) children. FR children were significantly impaired compared with not-FR children on all measures of emergent literacy skills. Further, and more importantly, the differences between FR-one and FR-both children were relatively large in letter knowledge, first-phoneme isolation and vocabulary. However, for the measures of blending, word reading, spelling and RAN, both FR-one and FR-both children performed significantly poorer than not-FR children whereas the differences between FR-one and FR-both did not reach significance.

In addition, not-FR families scored significantly higher than FR families for all aspects of the HLE: access to print, reading-related activities and parents' reading interest and habits. When it came to differences in the HLE between FR-one, FR-both and not-FR, parents' reading interest and habits was the only measure on which the not-FR group scored significantly higher than the FR-one group, who in turn obtained significantly higher scores than FR-both. For access to print, the score for FR-one families did not differ from that of not-FR families, but large, significant differences were found between not-FR and FR-both families and between FR-one and FR-both families. In contrast, for reading-related activities, significant differences were found between not-FR and FR-one children and between not-FR and FR-both children, but no significant group difference was found within the FR group (between FR-one and FR-both).

(2) Regression was used to predict children's emergent literacy at the onset of formal reading instruction. Unsurprisingly, FR status was a significantly negative predictor of emergent literacy after controlling for the HLE, for the child's gender, interest in literacy and letters, number of months spent at kindergarten and vocabulary, and for the parents' level of education. None of the three aspects of the HLE nor the time spent at kindergarten or the parental level of education contributed significantly to the model. Besides FR status, the child's gender, vocabulary and interest in literacy and letters were significantly related to emergent literacy outcomes at the onset of formal reading instruction.

## **5.2 Study II**

The main aim of the second study was to investigate children's reading difficulties in a multi-factor model including FR, oral language, emergent literacy and environmental protective factors such as parents' level of education and the HLE. Using the national threshold as cut-off point (i.e. the 80th percentile of the national sample), 42 children (20.2%) were identified as having RD. Those who did not meet this criterion were categorised as typical readers. The findings with respect to the research questions are presented as following:

(1) Literacy outcomes were compared between FR and not-FR children at the end of the second grade. FR children performed significantly poorer than not-FR children only in word reading, with a large effect size. FR and not-FR children did not differ significantly in spelling, while there was a trend towards significance for reading comprehension ( $p = .06$ ). As expected, a significantly higher proportion of FR children than not-FR children were identified as having RD at the end of the second grade.

(2) Two-step logistic regression was used to predict children's second-grade RD based on the data obtained at the onset of formal reading instruction. The HLE was added as an indirect predictor of children's RD

via all components of emergent literacy at Step 1. Letter knowledge and phonemic awareness were found to be significant predictors of children's second-grade RD when controlling for the HLE, parents' education, the children's gender and their interest in literacy. In addition, the mediation values for both letter knowledge and phonemic awareness were significant. The amount of total explained variance ( $R^2$ ) in children's RD was 33.6% at Step 1.

FR was entered at Step 2 both as a direct factor and as an indirect factor via phonemic awareness. Letter knowledge, FR and the indirect effect of letter knowledge via the HLE were significant predictors of children's RD when controlling for the HLE, parents' level of education, the children's gender and their interest in literacy at the onset of formal reading instruction. Significant negative estimate values were obtained for letter knowledge both directly and indirectly via the HLE, indicating that children with good letter knowledge at the onset of formal reading instruction are less likely to develop RD at the end of the second grade. By contrast, FR status yielded a positive significant value and the odds ratio for group differences in reading was higher than one (3.13). In other words, children with a positive FR status were three times more likely to develop RD than children without parents self-reporting RD. At Step 2, the contribution of phonemic awareness was marginal ( $p < .06$ ) and no longer significant either directly or indirectly via the HLE. The amount of total explained variance ( $R^2$ ) in children's RD after adding FR at Step 2 increased by 3.9 points to 37.5%, indicating that FR predicts children's RD above and beyond the HLE, parents' level of education and the child's emergent literacy, gender and interest in literacy.

### **5.3 Study III**

In the third and final study, structural equation modelling was used to test (1) the factor structure of the HLE, (2) the association between the HLE and FR while controlling for parents' level of education and (3) the association between the HLE and children's emergent literacy at the

onset of reading instruction while controlling for FR and parents' level of education. The findings are summarised as follows:

(1) According to criterion-based fit, of the HLE models with different factor structures tested (single-, two- and three-factor models) the one with the best fit to the data was a second-order three-factor model.

(2) This second-order three-factor model of the HLE was used to test the association between FR and the HLE while controlling for parents' level of education. Maternal and paternal self-report of RD (as a proxy for FR) and their level of education were added as direct and indirect predictors of the HLE. The results showed that the model had an adequate fit to the data. To test the mediation effects of parents' education, bootstrapping was also applied. The results for the direct paths (parents' RD → HLE, while controlling for their level of education) showed that maternal RD was not directly associated with the HLE while paternal RD was directly, and negatively, associated with the HLE.

The path of education → HLE, when controlling for parents' RD, was significant only for the maternal path, not for the paternal one. A Wald test was applied to test whether the direct and indirect pathways (from parents' RD to the HLE) differed for maternal and paternal effects. The results showed that the maternal coefficient paths to the HLE did not differ statistically from the effect of paternal RD. This finding suggests that the associations between parents' RD and the HLE do not differ for maternal and paternal RD when the parents' level of education is controlled for.

(3) Maternal and paternal self-report of RD and level of education as well as the HLE were added as direct and indirect predictors of children's outcomes in emergent literacy. The results indicated that, when parents' level of education and the HLE were controlled for, the direct paths (parents' RD → emergent literacy) from both maternal RD and paternal RD remained significant. In addition, the association between the HLE

### *Summary of findings*

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and children's outcomes (HLE → emergent literacy, while controlling for parents' RD and their level of education) was significant and positive.

A Wald test was applied to test whether the direct and indirect pathways (from parents' RD to children's emergent literacy) differed for maternal and paternal effects. The results showed that the maternal coefficient paths to emergent literacy did not differ statistically from the effect of paternal RD. This finding suggests that the associations between parents' RD and children's emergent literacy do not differ for maternal and paternal RD when the parents' level of education is controlled.

## 6 General discussion

Below, the findings from all three empirical studies included in the present thesis will be briefly discussed.

### 6.1 *Emergent literacy skills: children with and without FR of RD*

The findings of the present studies, which are compatible with those of previous FR studies, showed that FR children were significantly impaired compared with not-FR children on all measures of emergent literacy (letter knowledge and phonemic awareness), vocabulary and other early literacy-related skills including RAN, STM, early word reading and spelling at the onset of formal reading instruction (Study I and Study III).

However, the most important finding is probably the significant differences in emergent literacy *within* the group of FR children, which has not been previously reported in FR research. Interestingly, FR-both children (both parents reporting RD) had significantly poorer emergent literacy than both FR-one children (only one parent reporting RD) and not-FR children (no such risk). These results are in line with the findings from Wolff and Melngailis' study of literacy outcomes for children with a genetic history of dyslexia (1994); they reported that children in families with two dyslexia-affected members were not only at greater risk but also more severely impaired than children with only one dyslexia-affected family member.

Besides the differences in emergent literacy and other cognitive pre-literacy skills identified between FR and not-FR children, the findings of Study I and Study III suggest that FR may predict emergent literacy above and beyond parents' level of education and the HLE. Study I showed, using a hierarchical regression model, that FR was significantly



associated with children's emergent literacy before the onset of formal reading instruction, above and beyond the HLE, the child's gender, interest in literacy and letters, months spent at kindergarten and vocabulary, and the parental level of education. Similarly, Study III, using structural equation modelling, showed that both maternal and paternal RD were significantly associated with children's emergent literacy when maternal and paternal level of education and the HLE were controlled for. These associations found between FR and emergent literacy after controlling for environmental factors such as parents' educational level and the HLE support the appropriateness of using a multi-factor model of RD (Pennington, 2006; van Bergen, et al., 2014b). Such a multi-factor model combines a range of interplaying factors, including FR (a risk factor), early individual differences at the cognitive level (emergent literacy skills) and environmental factors (the HLE and parental education).

Taken together, these findings suggest that the impaired emergent literacy in FR children may be associated with the complex interplay between the shared genetic set-up and the shared environment (i.e. the HLE and the parents' level of education). While the interaction among FR, parents' level of education and the HLE was not covered by the aims of Study I, the structural equation modelling of Study III supports the existence of such an interaction. As discussed in Study III, in addition to a direct effect of FR, the findings suggest a complex interplaying effect of FR and environmental protective factors (such as parents' education and the HLE) on children's emergent literacy before the onset of formal reading instruction. Both Study I and Study III were novel in that they identified an association between FR and children's emergent literacy above and beyond environmental factors such as parental level of education and the HLE.

## **6.2 Literacy outcomes and RD at the end of the second grade: children with and without FR of RD**

Study II aimed to investigate children's later literacy outcomes and RD at the end of the second grade. The findings showed that FR status identified significant group differences at the end of the second grade in children's word reading but not in their spelling or reading-comprehension outcomes. One explanation for this could be that the word-reading measure was time-limited while the children had ample time for both the spelling and the reading comprehension tasks. In addition, it should be noted that 'only' 36% of the FR children were actually categorised as having RD by the end of the second grade, indicating that the majority of them (64%) were classified as typical readers or FR not-RD children at that point. Therefore, these FR not-RD children would not necessarily be expected to exhibit difficulties across all literacy outcomes. These findings are in line with those of Snowling and Melby-Lervåg (2016), who reported that while FR children with RD showed persistent difficulties in a range of literacy skills including word reading, spelling and reading comprehension, FR children without RD exhibited difficulties only with respect to some literacy outcomes.

More importantly, Study II predicted children's second-grade RD using a multi-factor model including predictors in three different domains: FR, individual differences in emergent literacy and vocabulary at the onset of formal reading instruction, and environmental protective factors such as parents' educational level and the HLE. Previous FR studies had shown FR to be a unique predictor of children's RD above and beyond emergent literacy (Puolakanaho et al., 2007) and above and beyond emergent literacy and oral language skills (Carroll et al., 2014). The present findings added to those of previous FR studies by applying a multi-factor model to predict children's RD and showing that FR predicts children's RD above and beyond not only vocabulary and emergent literacy but also environmental factors such as the HLE and parents'

educational level. The multi-factor model indicates that children from a family with parents self-reporting RD are three times more likely to be identified as having RD at the end of the second grade than children from a family with no parents self-reporting RD.

Another important and novel finding of the multi-factor model was related to the indirect effect of the HLE as a protective factor counteracting the risk that FR poses for children's second-grade RD. The total indirect effect of the HLE via concurrent emergent literacy on children's second-grade RD was significant. Specifically, the HLE, via letter knowledge and marginally via phonemic awareness, would reduce the likelihood of RD at the end of the second grade. This finding illustrates one of the advantages of applying a multi-factor model where the HLE is explored as an environmental protective factor alongside risk factors such as FR and emergent-literacy difficulties.

The present study is the first FR study to empirically highlight the important protective role of the HLE against the negative effect of FR and emergent-literacy difficulties. In a meta-analysis of FR research, Snowling and Melby-Lervåg (2016) concluded that data on the HLE of FR children are scarce and suggested that an interaction of genetic and environmental risk and protective factors determine where the skills of an individual will fall on the reading-difficulties continuum. The present study represents a first step towards addressing and exploring that suggested interaction between risk and protective factors in order to improve our understanding of children's RD.

### **6.3 *The HLE of children with and without FR of RD***

Both Study I and Study III showed that not-FR families, compared with families with at least one parent reporting RD, provide a richer literacy environment for their children by acting as positive reading role models and by providing literacy-related activities and access to print material. These findings are contrary to those of the Finnish Jyväskylä Study

(Lyytinen, Ahonen, et al., 2004; Torppa et al., 2007b), but more in line with those from research involving English-speaking children (Dilnot et al., 2017; Hamilton et al., 2016; Scarborough, 1991). Interestingly, Study I showed that the impact of FR was especially severe when both parents reported RD. The differences in the HLE *within* the FR group had not previously been explored. Study II in the present thesis, unlike Study I and Study III, showed that the HLE did *not* differ between FR and not-FR children. That finding from Study II was consistent with those of Torppa et al. (2007b) and of Elbro, Borstrom, et al. (1998).

One explanation for such conflicting findings in the previous research and in the three studies of the present thesis (between Study I and Study III; and Study II) might be related to discrepancies in maternal educational levels between FR and not-FR families. In other words, where no difference in maternal educational levels existed between FR and not-FR children, no differences would be observed in the HLE either (Study II). But, where maternal educational levels differed, so did the HLE as reported in Studies I and III.

The conflicting findings regarding the association between FR and the HLE, both in the literature and between Study I and Study II, were in fact part of the reason to investigate the association between FR and the HLE in Study III. Maternal and paternal self-report of RD (as a proxy for FR) and their level of education were added as direct and indirect predictors of the HLE in Study III. After controlling for maternal level of education, maternal RD was not directly associated with the HLE, although maternal RD was negatively and significantly associated with maternal level of education. By contrast, paternal RD was significantly, and negatively, associated with the HLE even after controlling for paternal level of education. Paternal RD was also significantly negatively related to paternal level of education. These findings support the significant role of the parents' level of education in the context of the association between FR and the HLE, although this association was found not to be fully mediated by parents' level of education. Both

parental education and the HLE may operate as risk or protective factors – especially in the context of FR, as parents' RD could exert influence on their educational level and on the HLE, either directly or indirectly through their education. The direct effect of FR on the HLE might reflect the direct effect of FR and/or cultural attitudes while the indirect effect of the HLE via educational level might reflect a complex interplaying effect of FR and environmental risk and protective factors.

Study III also used this complex relationship between FR, parental education and the HLE to predict children's emergent literacy before the onset of formal reading instruction. The multi-factor model showed that FR was a unique predictor of children's emergent literacy, as discussed earlier. However, it should be pointed out that there is a complex interaction between such a risk as FR and environmental factors (the HLE and parents' education). This complex interaction highlights the important role of the environmental protective factors on the development of emergent literacy and of later literacy skills.

## **7 Conclusions**

Taken together, this thesis has provided clear evidence for difficulties in FR children across a range of emergent literacy and other cognitive pre-literacy skills before the onset of formal reading instruction as well as in later reading skills at the end of the second grade. These findings add to previous FR studies by demonstrating that parents' self-reports of RD can be used as a single tool to identify children at FR of RD in a large, representative sample.

Further, FR as measured using parents' self-report was found to be a unique predictor of emergent literacy and of second-grade RD in a multi-factor model including factors from three different domains. Specifically, this model includes FR (as a risk factor), environmental factors (parents' educational level and the HLE) and children's cognitive skills (e.g. emergent literacy). Overall, these data support the suggestion made by Pennington (2006) that a multi-factor model, rather than single-factor models, should be used to enhance our understanding of literacy development and RD. No previous FR studies had controlled for environmental factors such as the parents' educational level and the HLE in a multi-factor approach, as this thesis did. The present multi-factor prediction model suggests that children whose parents self-reporting RD, would themselves manifest RD. Moreover, RD in FR children, to some extent, cannot be explained solely in terms of their individual differences in emergent literacy, their gender and differences in their immediate environment such as the HLE and parents' educational level. These findings may reflect the influence of FR as well as the complex interplaying relationship between the effects of FR and those of the HLE on children's emergent literacy before the onset of formal reading instruction.

The present research adds to existing literature on FR in several ways. First, parents' self-report of RD as a proxy for FR status is used to explain

the association between FR and FR children's difficulties in emergent literacy, the differences in their home environments and their second-grade RD. Although the causal mechanisms underlying children's RD cannot be inferred from the correlational research presented in this thesis, the findings, taken together, indicate that there are substantial associations between FR, the HLE, parental level of education, children's emergent literacy at the onset of formal reading instruction and their reading skills after two years of formal reading instruction. The multi-factor prediction model found that children whose parents had self-reported RD were three times more likely to have RD at the end of the second grade than children whose parents had not self-reported RD. This important finding adds to the literature and to our understanding of RD from a multi-factor perspective. More importantly, the present thesis extend literature on how FR as a risk factor and environmental protective factors may contribute in a complicated interplaying manner to the development of children's reading skills.

### **7.1 Practical implications**

The present findings have practical implications for researchers, parents, teachers working with pre-schoolers and primary-school students and for specialists in the field of literacy difficulties. Some of the key implications are the following:

The principal implication concerns the benefit of screening for RD using a simple but valid tool, as parents' self-reports of RD before the children have started school. The findings suggest that parents' self-reports of RD can be used as a good proxy for FR. Hence, researchers in large-scale studies may use this simple yet valuable tool to identify FR children. Many previous FR studies had small sample sizes, possibly because of practical issues surrounding the administration of literacy tests to parents.

## *Conclusions*

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Further, the findings suggest that neither children's development of emergent literacy and their later literacy skills, nor the literacy experiences that they have at home, may be free from the negative influence of FR. However, there are reasons to believe that it is possible to influence and reduce difficulties in emergent literacy and RD to some extent through environmental protective factors such as the HLE.

The pre-school HLE can operate as an environmental protective factor against possible risk factors such as FR and emergent literacy difficulties when it comes to the development of children's emergent literacy and later literacy skills. For families, especially those with one or both parents reporting RD, we should provide information about the crucial role of emergent literacy and about what they might be able to do to enhance their children's emergent literacy. Most parents, with or without RD, are able to provide support for their children's letters-and-sounds learning before school through shared-reading activities in the home and an HLE intervention programme. This might smooth the path of children's later literacy development.

FR children reported having a weaker interest in letters and sounds of letter than not-FR children. Parents, especially in FR families, should be advised to discuss letters and sounds during shared reading.

The findings, specifically those of Study I, indicate that children with both parents self-reporting RD manifested moderate to large deficits in emergent literacy (letter knowledge and phonemic awareness) and vocabulary skills compared with children with only one parent self-reporting RD and, not surprisingly, they showed even larger deficits compared with not-FR children. In addition, families where both parents self-reported having RD also reported a poorer HLE than families reporting RD only for one parent or for neither. Therefore, kindergartens should closely monitor the oral-language and pre-literacy development



of children whose parents have self-reported RD – especially if both parents have self-reported RD.

## **7.2 Limitations and future research**

The present research has several limitations, which may guide future research.

First, like most previous research, the parents' questionnaire was the only source of data on the HLE. In addition, there were no data on parent–child interactions, the use of oral language in the home or the 'formal' HLE (i.e. direct teaching of literacy skills by parents). The present research had a quantitative large-scale design in which children's oral-language skills were assessed using a standardised vocabulary test. Hence, the quality or quantity of spoken language in the home environment was not included in the HLE measure. Qualitative studies of the home environment could shed more light on parent–child interactions and the oral language in home. Future FR studies are needed to assess the possible impact of the quality and quantity of spoken language in the home on the HLE and on children's literacy-related skills such as vocabulary, emergent literacy and later literacy skills. The formal HLE is much more relevant once formal reading instruction has begun whereas the focus of the present study was on the onset of formal reading instruction. There is also a need for future FR research to investigate parents' explicit teaching and instruction of their children, i.e. the formal HLE while the formal reading instruction has begun.

Multi-factor prediction models dealing with different interacting domains may further our understanding of children's literacy development. In this thesis, such models were used to investigate the association between FR, the HLE and children's emergent literacy in Study I and Study III, and between FR and second-grade RD in Study II. The present findings suggest that there are complex developmental interactions between FR, children's individual differences in emergent

literacy and later literacy outcomes. Further longitudinal studies are needed to clarify the development of emergent literacy and later literacy skills across time using such multi-factor models that include FR and protective environmental factors such as the HLE and parents' educational level. Last but not least, future research is also needed to investigate HLE interventions and their impact on children's emergent literacy, especially in FR children.

### **7.3 Final remarks**

Having a parent with RD puts a child at high risk of emergent literacy difficulties and RD. In fact, the likelihood of having RD at the end of the second grade is three times higher for children with FR than for children without such a risk. However, the findings presented in this thesis, taken together, suggest that there are reasons to believe that it is possible to change and reduce the influence of FR through environmental protective factors such as a rich HLE. It seems that emergent literacy development and children's literacy experiences in their home environments may not be independent of a risk factor such as FR. However, the relationship between FR, children's pre-literacy and their literacy skills is a complex one that involves the influence of environmental factors, where a high parents' educational level and a rich HLE appear to operate as protective factors against a risk factor such as FR of RD.

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## **9 Empirical Studies**





## ***Study I***



## ■ What can Parents' Self-report of Reading Difficulties Tell Us about Their Children's Emergent Literacy at School Entry?

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Research has linked family risk (FR) of reading difficulties (RD) with children's difficulties in emergent literacy development. This study is the first to apply parents' self-report of RD as a proxy for FR in a large sample ( $n = 1171$ ) in order to test group differences in children's emergent literacy. Emergent literacy, the home literacy environment and *children's interest in literacy and letters* were compared across different groups of FR children around the school entry. The FR children performed lower in emergent literacy compared with not-FR children. Furthermore, when comparing FR children with one parent reporting RD and children with both parents reporting RD, moderate group differences were found in Emergent Literacy. Finally, parents' self-report of RD was a significant contributor of emergent literacy after controlling for the home literacy environment, children's gender, their interest in literacy and letters, months in kindergarten, vocabulary and parents' education. Our findings suggest that schools should monitor the reading development of children with parents self-reporting RD closely – especially if both parents self-report RD. © 2017 The Authors. *Dyslexia* published by John Wiley & Sons Ltd.

**Keywords:** emergent literacy; family risk; reading difficulties; dyslexia; home literacy environment; parental self-report of reading difficulties

### Key Messages

- The principal implication is the value of screening for reading difficulties with the simple but valid tool 'parents' self-report of reading difficulties (RD)' in preschool years.
- If the parents had themselves faced RD, their children are more likely to experience difficulties in developing emergent literacy.
- The risk of difficulties in emergent literacy is higher when both parents have a history of RD.
- Parents, especially with self-reported RD, should be advised about the role of home literacy environment in the development of their children's emergent literacy.
- Families with both parents self-reporting RD have the fewest children's books at home.
- Family risk children reported less interest in letters than not-family risk children; parents should be advised to discuss letters and sounds during shared reading.
- Schools should monitor the reading development of children with parents self-reporting RD closely – especially if both parents self-report RD.

Reading difficulties (RD) refer to specific difficulties in acquiring reading, writing and basic reading subskills such as word identification and phonological decoding and are not because of extraneous factors such as general learning difficulties, sensory acuity deficits, socioeconomic disadvantage and similar factors (Vellutino,

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Fletcher, Snowling, & Scanlon, 2004). RD can run in families (Pennington & Olson, 2005), and having a parent or a sibling with RD places the child at high risk for RD, known as *family risk* (FR) (Elbro, Borstrom, & Petersen, 1998; Gallagher, Frith, & Snowling, 2000; Pennington & Lefly, 2001; Scarborough, 1990; Snowling, Gallagher, & Frith, 2003; Snowling, Muter, & Carroll, 2007). Previous research has consistently documented lower emergent literacy for children at FR for RD compared with children without FR (not-FR) in the preschool years (Carroll & Snowling, 2004; Elbro & Petersen, 2004; Torppa *et al.*, 2007; Torppa *et al.*, 2012; van Bergen, van der Leij, & de Jong, 2014).

Whitehurst and Lonigan (2001) refer to emergent literacy as early skills, knowledge and attitudes related to print, which originate and develop throughout the preschool years. The National Early Literacy Panel conducted a meta-analysis and reported that letter knowledge, concepts about print, oral language (such as vocabulary) and phonological sensitivity (e.g. phonemic awareness) are the components of emergent literacy that are most predictive of children's later reading success (Lonigan, Schatschneider, & Westberg, 2009). It is now clear that early individual differences in emergent literacy can strongly predict both later reading achievement (Pinto, Bigozzi, Vezzani, & Tarchi, 2016; Scarborough, 2001; Snow, Burns, & Griffin, 1998; Wagner & Torgesen, 1987) and RD (Bigozzi, Tarchi, Pezzica, & Pinto, 2016; Elbro *et al.*, 1998; Pennington *et al.*, 2012; Pennington & Lefly, 2001; Snowling & Hulme, 2013).

In a recent meta-analysis, Snowling and Melby-Lervåg (2016) provide a comprehensive review of FR studies that have compared FR children with not-FR on emergent literacy. They report group differences in favour of not-FR children on measures of letter knowledge ( $d = 0.47$ ), phoneme awareness ( $d = 0.56$ ), vocabulary ( $d = 0.65$ ), rhyme ( $d = 0.90$ ), rapid automatized naming (RAN) ( $d = 0.61$ ) and verbal short-term memory (STM) ( $d = 0.45$ ) at preschool age. They found that the reported effect sizes differed between studies depending upon the language context, choice of assessments, age of the groups and, most pertinently, the type of criteria used to identify poor readers: the prevalence was lower for studies that used more conservative criteria. Overall, the meta-analysis found that FR children perform significantly poorer in emergent literacy compared with not-FR. However, no studies have investigated within-group differences of FR children in order to compare emergent literacy between FR children who had only one parent with RD (FR-one) and FR children who had both parents with RD (FR-both). On the basis of genetic studies, we know that having both parents with RD may put the child at higher risk for RD rather than having one parent with RD (Wolff & Melngailis, 1994).

Prior research on FR for RD has tended to include a direct measure of parents' literacy skills in addition to parents' self-report of RD (Carroll & Snowling, 2004; Snowling & Melby-Lervåg, 2016; Torppa *et al.*, 2012). This was partly because the validity and reliability of self-report of RD had not been documented and also the majority of FR studies had relatively small sample sizes, allowing for parents' literacy skills to be directly assessed. However, a growing body of FR research is currently based on parents' self-report of RD, and it is now considered to be both a valid and reliable measure (Leavett, Nash, & Snowling, 2014; Lefly & Pennington, 2000; Snowling, Dawes, Nash, & Hulme, 2012) and a time-saving instrument for estimating RD in adults (Snowling *et al.*, 2012). For example, Leavett *et al.* (2014) found that adults who self-reported as having RD had significantly poorer skills in word reading and spelling.

In the current study, we use parents' self-report of RD as a single proxy for FR status. The main aim is to investigate group differences in emergent literacy between not-FR and FR children and to explore possible within-group differences in FR children with one parent reporting RD (FR-one) and FR children with both parents reporting RD (FR-both) while controlling for background variables such as home literacy environment (HLE), parental education, children's gender, months in kindergarten and their oral language skills (vocabulary).

The HLE, which includes home literacy activities such as shared reading, children's access to print and parents' own reading interest and habits, is another important factor for children's emergent literacy (Lonigan, Burgess, & Anthony, 2000; Whitehurst & Lonigan, 2001). However, several FR studies have reported that the frequency of child–parent shared reading at home did not significantly differ between the FR and not-FR groups, even though parents of FR children were less active readers themselves than the not-FR parents (Elbro et al., 1998; Lyytinen et al., 2004; Torppa et al., 2006, 2007). These studies were conducted in Finland and Denmark, in which the parental/maternal education level did not significantly differ between FR and not-FR groups. Equivalent maternal education might be the reason for the non-significant differences in HLE aspects between these groups. In contrast, research in England has shown that parents with RD exposed their children to fewer shared-reading activities compared with not-FR parents (Dilnot, Hamilton, Maughan, & Snowling, 2017; Hamilton, Hayiou-Thomas, Hulme, & Snowling, 2016; Scarborough, Dobrich, & Hager, 1991).

In line with these results, van Bergen, van Zuijlen, Bishop and de Jong (2016) have recently found that HLE correlated significantly with children's reading fluency. In addition, paternal and maternal reading fluency explained independent and similarly large proportions of variance in children's reading fluency: together, parental reading fluency explained 17% of variance in children's reading fluency. In another study, moderate correlations were found between children and parents' reading skills:  $\sim 0.35$  for fathers and  $\sim 0.50$  for mothers (Van Bergen et al., 2012). In addition to HLE, children's interest in literacy has been found to be strongly associated with the development of emergent literacy in FR children (Torppa et al., 2007). Because the development of emergent literacy, like other developmental skills, seems to be a multifactorial process involving both genetic and environmental factors, individual differences in children's emergent literacy are likely to be associated with FR status (which in turn is related to the variation in their parents' reading skills) and parental education besides HLE and children's interest in literacy. Specifically, the second aim of the present study is to compare different aspects of HLE and children's interest in literacy in groups of children differing in FR status based upon their parents' self-report of RD. The final aim is to explore the associations between FR status and children's emergent literacy before the onset of reading instruction while controlling for different aspects of HLE, children's interest in literacy, years in kindergarten, gender, vocabulary and parental education. On the basis of the existing literature, the research questions for the current study and our hypotheses are as follows:

1. Can parents' self-report of RD identify between-group and within-group differences in emergent literacy skills? We expect that children identified by parents' self-report of RD will display lower skills in emergent literacy compared

with not-FR children and that children with both parents self-reporting RD have even lower emergent literacy than children with only one parent self-reporting RD.

2. Is there an effect of FR status on the HLE and children's interest in literacy? We expect that not-FR families will report the richest HLE and that the FR-both will obtain the lowest score in aspects of HLE. However, group differences are not expected in children's interest in literacy before formal instruction of reading because some earlier studies have not reported such differences (Torppa *et al.*, 2006, 2007).
3. Does FR status predict emergent literacy after controlling for HLE, children's interest in literacy, years in kindergarten, gender, vocabulary and parental education? We hypothesize that parents' self-report of RD is a unique predictor of children's emergent literacy after controlling for background variables including HLE, children's interest in literacy, years in kindergarten, gender, vocabulary and parental education.

## METHODS

### Participants

The sample was selected from an ongoing Norwegian large-scale longitudinal project (On Track), with 1171 participating 6-year-old first graders. The majority of parents (97.7%) gave their consent for participation. The study was reviewed and approved by the Norwegian Social Science Data Service, a third-party ethical oversight agency. Based on exclusion of children with Norwegian as second language ( $n = 193$ ), bilingual ( $n = 83$ ), hearing problems ( $n = 28$ ), dropout ( $n = 29$ ) or parents who did not answer whether they had experienced RD or did not know about biological parents' reading skills ( $n = 74$ ), the sample for the present study was 821 children living in two municipalities in the southwest of Norway. In Norway, formal reading instruction starts in grade 1, and 96.7% of primary-school students are enrolled in public schools (i.e. non-private) (Utdanningsdirektoratet, 2016). Norwegian is a semi-transparent orthography that is more regular than English and less regular than Finnish. Parents' educational level was used as a proxy for socioeconomic status because previous research has shown that in Norway, parental level of education is a stronger predictor of educational outcomes than parents' income (Løken, 2010).

### Family risk

Each participating school held a welcome meeting for parents before the new children started at school. The 'On Track' team presented the project, including information about RD at these meetings. Parents were invited to take part in the study and received an information brochure and a parental consent form. At the beginning of the first grade, participating parents answered a questionnaire relating to demographics, HLE, familial risk of RD, the student's language background and his or her health. FR status was obtained through the question 'has the child's biological mother and/or father experienced "reading and writing difficulties"?' and the response options were 'yes', 'no' or 'don't know'. 'Reading and writing difficulties' is a familiar term in Norway, relating to specific problems

with word recognition and spelling. The term is frequently used in schools and the media, and it was discussed at the welcome meeting.

While 634 children had no parent self-reporting a history of RD (not-FR), 187 children had one or both parents with a self-reported history of RD (FR). In addition, the FR children were divided into two groups: FR-one, children with only one parent self-reporting RD ( $n = 165$ ), and FR-both, children with both parents self-reporting RD ( $n = 22$ ).

Attendance in kindergarten did not statistically differ between FR (98.9%) and not-FR (99.5%) groups. FR and not-FR groups did differ in parental educational level (mothers' educational level:  $X^2 (N = 819, 2) = 39.96, p < 0.001$ ; fathers' educational level:  $X^2 (N = 817, 2) = 33.91, p < 0.001$ ). In fact, both mothers and fathers in the not-FR group had significantly higher levels of education than the FR-one and the FR-both groups. However, group differences in parental education between FR-one and FR-both did not reach significance. Table 1 presents the children's characteristics by group.

#### Procedure and Measures

The test battery was individually administered and scored on a digital tablet between 2 and 5 weeks after school started in grade 1. The testing was carried out by a team of 18 trained testers who were experts within the field of reading education and individual testing. The parents answered a questionnaire on demographics, HLE, FR based on parents' self-report of RD and the child's interest in literacy and letters and their language background and health. The parents' questionnaire was the only paper-pencil-based measure in the study.

#### Emergent literacy measures

*Letter knowledge* consisted of a 15-item multiple-choice test. The child was asked to listen to a pre-recorded letter sound on the tablet and respond by pressing

Table 1. Children's characteristic by group based on the parents' self-report of RD

			FR			
			Not-FR	FR (all)	FR-one parent	FR-both parents
Sample size			634	187	165	22
Age (M, sd)			6.22 (0.28)	6.22 (0.30)	6.23 (0.30)	6.11 (0.26)
Gender: boys (%)			47.30	52.40	53.90	40.90
Years in kindergarten (M, sd)			4.61 (0.71)	4.45 (0.94)	4.41 (0.98)	4.78 (0.45)
Parental level of education (%) <sup>a</sup>	Mothers*	Low	3.00	9.10	8.50	13.60
		Medium	23.20	40.60	38.80	54.4
		High	73.70	50.30	52.70	31.80
	Fathers*	Low	3.80	9.10	7.30	22.70
		Medium	33.80	50.80	51.50	45.50
		High	62.30	38.50	39.40	31.80

RD, reading difficulties; FR, family risk; FR-one, FR children who had only one parent with RD; FR-both, FR children who had both parents with RD.

<sup>a</sup>Parental level of education: low, primary school; medium, upper secondary school; high, university/college.

\* $p < 0.001$ .

on one of the four touch-screen letters. The reliability (Cronbach's alpha) was 0.85.

In *first phoneme isolation*, the tablet screen showed a picture, and the examiner pointed to the picture, named it and asked the child about the first sound of that word. The oral response of the child was scored and recorded on the tablet by the examiner. This task contained eight items and Cronbach's  $\alpha = 0.92$ .

The *blending* task required the child to blend a set of separately pronounced phonemes into the corresponding whole word. The test had eight items of increasing difficulty and was automatically discontinued after two subsequent errors. In each item, four pictures appeared on the screen, and the task was pre-recorded: 'Here you see a picture of /ri/-/rips/-/ris/ and /ring/ (ride, red current, rice, ring, in English). Listen carefully and touch the picture that goes with: /r/-/i/-/s/ (presented phoneme-by-phoneme, one per second)' (Cronbach's  $\alpha = 0.86$ ).

*Vocabulary* was tested with an abridged version (20 out of 40 words) of the Norwegian vocabulary test (Størksen, Ellingsen, Tvedt, & Idsøe, 2013). A picture appeared on the screen, and the child was asked to name it. Reliability (Cronbach's alpha) for 20 items in the present sample was 0.83, which is consistent with the 40 items in the standardized sample (0.84).

#### *Reading-related measures*

*Rapid automatized naming (RAN)* included naming familiar objects presented repeatedly in random order. The examiner practised the task with the child and made sure that the child knew the name of each object and understood the procedure of the task. The pictured objects were *sun, car, plane, house, fish and ball*, which are all monosyllabic words in Norwegian. There were four rows of five stimuli in each matrix and two trials. The child was asked to name each item as quickly and accurately as possible from the left to the right and from the top to the bottom. Time to complete the task (in seconds) and naming errors were recorded.

*Short-term memory* was measured with Digit Span Forward from Wechsler Intelligence Scales for Children – III (Wechsler, 1991). The examiner read aloud one digit per second, and the student's responses were scored on the tablet.

*Word reading* included eight words ranging from easy to difficult representing a variety of letters and letter sequences (VC, CV, CVC, VCV, CVC, CVCC, and CVCCV). The words appeared on the screen one at a time. The child was asked to read the word aloud. Cronbach's alpha was 0.92.

*Spelling* involved 10 words with a variety of phonemes and phonemes sequences ranging from easy to difficult (CV, VC, VCV, VCC, CVC, CVCV, CVCC, and CVCVC). There was a practice trial in which the examiner wrote down the word while sounding out each letter and asked the child to do the same. For the test items, each target word was introduced in a short sentence; then, the examiner repeated the target word and encouraged the child to write the word (e.g. 'Father has a blue hat. Write /hat/.'). Cronbach's alpha was 0.93.

#### *Home literacy environment and children's interest in literacy and letters*

On the basis of previous research, different components of the HLE were measured via parents' questionnaires (Dilnot et al., 2017; Hamilton et al., 2016; Niklas & Schneider, 2013; Skwarchuk, Sowinski, & LeFevre, 2014; Torppa et al., 2007).



- (1) The child's access to print was assessed with the following items: (a) How many children's books do you have at home? (1 to 5 (*none to more than 40 books*)). (b) How old was the child when you first started reading to her or him? (1 to 5 (*Never read to the child to before the age of 2*)).
- (2) Literacy-related activities included the four following questions: (a) How often do you read to the child? (b) How often does the child watch TV? (c) How often does the child play TV/computer/tablet/mobile games? (d) How often do you visit a library with the child? (1 to 5 (*never to several times a week*)).
- (3) Parents' reading habits were assessed by questions regarding how often they read (a) books and (b) magazines for themselves (1 to 5 (*never to several times a week*)). Parents' own reading interest was assessed by the item 'I only read if I have to' (1 to 4 (*completely disagree to completely agree*)).
- (4) *Child's interest in literacy and letters* was assessed through the items (a) My child often asks to be read to and (b) My child takes an interest in letters (1 (*completely disagree*) to 4 (*completely agree*)).

## RESULTS

Those variables displaying skewness greater or lower than  $+/-1$  and kurtosis greater or lower than  $+/-2$  were subjected to square-root transformation to enable parametric statistical techniques to be applied. Where there was a negative skew, distributions were reflected before square-root transformation was applied. Skewedness for letter knowledge was  $(-1.34)$ , and RAN was  $(1.25)$ . However, kurtosis's were between  $+/-2$  in all measures. The transformed variables were used in the inferential analyses, whereas the results here are presented for the raw data because the results were the same for both raw and transformed variables.

### Group Differences between FR and Not-FR Children According to Parents' Self-report of RD

Confirmatory factor analysis was conducted on the data from the questionnaire using Mplus program. The overall goodness of fit (Brown, 2014) indicated that our HLE model fits the data well: (root mean square error of approximation (RMSEA) = 0.05; comparative fit index (CFI) = 0.94; Tucker-Lewis index (TLI) = 0.91). Factor loading estimates revealed that the indicators were strongly related to their purported factors and components of HLE (range of  $R^2$ 's = 0.52–0.78). Factor scores for three components of HLE access to print, literacy-related activities, parents own reading habits, as well as one factor for child's interest in literacy and letter, were calculated. To adjust for multiple comparisons and reduce type I error, ANOVA followed by Bonferroni tests (Tabachnick, Fidell, & Osterlind, 2001) were run to investigate group differences in emergent literacy, the three HLE factors and children's interest in literacy. Table 2 presents the group means for the emergent literacy items and the HLE factor scores. Not-FR children scored significantly higher than the FR children in all measures of emergent literacy: letter knowledge ( $d = 0.47$ ), first phoneme isolation ( $d = 0.62$ ), blending ( $d = 0.52$ ), vocabulary ( $d = 0.24$ ), word reading ( $d = 0.63$ ), spelling ( $d = 0.55$ ), RAN ( $d = 0.33$ ) and STM ( $d = 0.26$ ).

Not-FR families scored significantly higher than FR families in all HLE components: access to print, literacy-related activities and parents own reading habits

(Table 2). Less interest in literacy and letters was also reported for the FR children compared with the not-FR children.

#### **Group Differences among FR-one parent, FR-both parents and not-FR children According to Parents' Self-report of RD**

To find out whether group differences could also be observed within the FR group, the FR children were divided into two groups according to their parents' self-report of RD: FR-one and FR-both. Two MANOVAs were computed for emergent literacy ( $F(16, 1618) = 0.89, p < 0.001$ ; partial  $\eta^2 = 0.05$ ) and the three HLE factors and children's interest in literacy and letters ( $F(8, 1570) = 0.94, p < 0.001$ ; partial  $\eta^2 = 0.03$ ). Table 3 shows the mean (emergent literacy items) and factor scores (HLE) for each group and the results of post hoc tests followed up by Dunnett's T3 tests, which is more robust for unequal variances and unequal group sizes while maintaining control over the significance level across multiple tests (Tabachnick *et al.*, 2001).

There was a significant main effect of group for all measures of emergent literacy. The hypothesis that children in the FR-both group would perform at the lowest level in emergent literacy followed by FR-one children, who in turn would be poorer than the not-FR group, was supported for letter knowledge and first phoneme isolation. The group differences between FR-one and FR-both children were relatively large for letter knowledge ( $d = 0.67$ ), first phoneme isolation ( $d = 0.53$ ) and vocabulary ( $d = 0.71$ ). FR-one children scored significantly higher than FR-both children in vocabulary, but there was no difference between FR-one and not-FR groups. For measures of blending, word reading, spelling and RAN, both FR-one and FR-both performed significantly lower in comparison with not-FR children; however, differences between FR-one and FR-both did not reach significance. Moreover, the only group difference in STM ( $d = 0.71$ ) was found between not-FR and FR-both. Generally, our data suggest that FR children with both parents self-reporting as RD have more severe deficits in certain measures of emergent literacy: letter knowledge, first phoneme isolation and vocabulary.

Turning to the HLE factors and the children's interest in literacy and letters, the 'parents' own reading habits' factor was the only measure on which the not-FR group scored significantly higher than FR-one, who in turn obtained significantly higher scores than FR-both. For 'access to print', FR-one children did not differ from not-FR children, whereas a significant large effect was found between not-FR and FR-both groups ( $d = 1.01$ ) and within the FR groups ( $d = 0.85$ ). In contrast, for the component of 'literacy-related activities', significant effects were found between not-FR and FR-one children ( $d = 0.26$ ) and between not-FR and FR-both children ( $d = 0.53$ ), but no significant difference was found within the FR group for this component. Similarly, not-FR children scored higher than both FR-one ( $d = 0.25$ ) and FR-both ( $d = 0.59$ ) on the 'interest in literacy and letters' factor; however, FR-one and FR-both did not significantly differ.

#### **The Role of FR Status (based on Parents' Self-report of RD) in Determining Emergent Literacy at the Beginning of Formal Reading Instruction**

To assess the relative importance of FR status (using parents' self-report of RD) on emergent literacy, a hierarchical regression analysis was conducted. Letter

Table 2. Mean differences (*sd*) and effect sizes in emergent literacy and HLE between not-FR and FR groups based on parents' self-report of RD

	Not-FR (N = 634)	FR (N = 187)	t (df)	Cohen's d	
Children's outcomes in emergent literacy and early reading and spelling at the onset of formal reading instruction	Letter knowledge (0–15)	12.52 (3.19)	10.96 (3.42)	5.50* (288.81)	0.47
	First phoneme isolation (0–8)	5.99 (2.70)	4.19 (3.10)	7.12* (274.68)	0.62
	Blending (0–8)	3.90 (2.66)	2.85 (2.40)	5.10* (332.11)	0.52
	RAN	59.35 (14.23)	64.66 (17.57)	3.78* (261.84)	0.33
	STM ( <i>digit Span</i> )	5.78 (1.55)	5.38 (1.58)	3.02* (819)	0.26
	Vocabulary (0–20)	13.66 (3.24)	12.85 (3.39)	3.36* (819)	0.24
	Word reading (0–8)	3.96 (3.04)	2.22 (2.45)	8.01* (370.52)	0.63
	Spelling (0–8)	2.88 (3.00)	1.36 (2.44)	7.07* (367.48)	0.55
	Access to print <sup>a</sup>	0.05 (0.64)	-0.17 (0.78)	3.46* (260.38)	0.31
	Literacy activities <sup>a</sup>	0.04 (0.69)	-0.15 (0.69)	3.33* (803)	0.27
	Parents reading habits <sup>a</sup>	0.07 (0.68)	-0.21 (0.94)	3.58* (240.29)	0.34
	Child's interest in literacy and letters <sup>a</sup>	0.04 (0.52)	-0.11 (0.60)	2.96* (270.88)	0.27

HLE, home literacy environment; FR, family risk; RD, reading difficulties; RAN, rapid automatized naming; STM, short-term memory.

<sup>a</sup>Factor scores.<sup>\*</sup>Significant at  $p < 0.001$ .

Table 3. Mean differences (*sd*) and effect sizes in emergent literacy and HLE between not-FR, FR-one and FR-both based on parents' self-report of RD

	FR			<i>f</i> test	Cohen's <i>d</i> <sup>a</sup>	
	Not-FR	FR-one	FR-both			
Children's outcomes in emergent literacy and early reading and spelling at the onset of formal reading instruction	Letter knowledge (0–15)	12.52 (3.19)	11.256 (3.23)	8.77 (4.08)	22.7, $p < 0.001$ ; partial $\eta^2 = 0.05$	Not-FR and FR-one*: 0.39 Not-FR and FR-both*: 1.02 <b>FR-one and FR-both*: 0.67</b> Not-FR and FR-one*: 0.56 Not-FR and FR-both*: 1.1 <b>FR-one and FR-both*: 0.53</b>
		5.99 (2.70)	4.38 (3.04)	2.73 (3.19)	33.50, $p < 0.001$ ; partial $\eta^2 = 0.08$	Not-FR and FR-one*: 0.40 Not-FR and FR-both*: 0.61 <b>FR-one and FR-both*: 0.20</b>
Blending (0–8)	3.90 (2.66)	2.90 (2.44)	2.45 (2.04)	81.27, $p < 0.001$ ; partial $\eta^2 = 0.03$	Not-FR and FR-one*: 0.20 Not-FR and FR-both*: 0.20 <b>FR-one and FR-both*: 0.27</b>	
	59.35 (14.23)	64.07 (16.85)	69.12 (22.24)	10.10, $p < 0.001$ ; partial $\eta^2 = 0.02$	Not-FR and FR-one*: 0.20 Not-FR and FR-both*: 0.20 <b>FR-one and FR-both*: 0.71</b>	
RAN	5.78 (1.55)	5.46 (1.60)	4.77 (1.27)	6.60, $p < 0.001$ ; partial $\eta^2 = 0.02$		
STM (digit Span)						

(Continues)

Table 3. (Continued)

	Not-FR	FR		<i>f</i> test	Cohen's <i>d</i> <sup>a</sup>
		FR-one	FR-both		
Vocabulary (0–20)	13.66 (3.24)	13.13 (3.28)	10.73 (3.51)	11.21, $p < 0.001$ ; partial $\eta^2 = 0.03$	<b>FR-one and FR-both: 0.48</b> Not-FR and FR-one: 0.17 Not-FR and FR-both*: 0.87 <b>FR-one and FR-both*: 0.71</b> Not-FR and FR-one*: 0.61 Not-FR and FR-both*: 0.78 <b>FR-one and FR-both: 0.21</b> Not-FR and FR-one*: 0.54 Not-FR and FR-both*: 0.70 <b>FR-one and FR-both: 0.15</b> Not-FR and FR-one: 0.16 Not-FR and FR-both*: 1.01 <b>FR-one and FR-both*: 0.85</b> Not-FR and FR-one*: 0.26
Word reading (0–8)	3.96 (3.04)	2.28 (2.44)	1.77 (2.58)	26.16, $p < 0.001$ ; partial $\eta^2 = 0.06$	
Spelling (0–8)	2.88 (3.00)	1.40 (2.48)	1.05 (2.19)	20.27, $p < 0.001$ ; partial $\eta^2 = 0.05$	
Access to print <sup>b</sup>	0.05 (0.64)	-0.06 (0.69)	-0.74 (0.90)	14.70, $p < 0.001$ ; partial $\eta^2 = 0.04$	
Literacy activities <sup>b</sup>	0.04 (0.69)	-0.14 (0.68)	-0.35 (0.77)	7.32, $p < 0.001$ ; partial $\eta^2 = 0.02$	

(Continues)

Table 3. (Continued)

	FR		Cohen's $d^a$
	Not-FR	FR	
Parents' reading habits <sup>b</sup>	0.07 (0.68)	-0.16 (0.94)	Not-FR and FR-both <sup>**</sup> : 0.53 <b>FR-one and FR-both: 0.29</b>
			Not-FR and FR-one <sup>**</sup> : 0.28 Not-FR and FR-both <sup>**</sup> : 0.79 <b>FR-one and FR-both<sup>**</sup>: 0.45</b>
Child's interest in literacy and letters <sup>b</sup>	0.04 (0.52)	-0.10 (0.59)	Not-FR and FR-one <sup>**</sup> : 0.25 Not-FR and FR-both <sup>**</sup> : 0.59 <b>FR-one and FR-both: 0.35</b>
			Not-FR and FR-both <sup>**</sup> : 0.45 Not-FR and FR-one <sup>**</sup> : 0.25 Not-FR and FR-both <sup>**</sup> : 0.59 <b>FR-one and FR-both: 0.35</b>

HLE, home literacy environment; FR, family risk; FR-one, FR children who had only one parent with RD; FR-both, FR children who had both parents with RD; RD, reading difficulties; RAN, rapid automatized naming; STM, short-term memory.

<sup>a</sup>Effect sizes were reported for both significant and non-significant group differences.

<sup>b</sup>Factor scores.

<sup>\*</sup>Significant at  $p < 0.001$ .

<sup>\*\*</sup>Significant at  $p < 0.04$ .

knowledge, first phoneme isolation and blending were used to make a factor score for emergent literacy. Table 4 shows the correlations of FR status with the other measures of the study. Taking the sample as a whole, FR status was negatively correlated with the HLE factors, children's interest in literacy and letters and the emergent literacy factor.

Table 5 presents results of the hierarchical regression analysis to find out whether FR status is a unique predictor before and after adding control variables. FR status was entered in step 1, and the three HLE factors; the child's gender, interest in literacy and letters, months in kindergarten and vocabulary; and parental educational level were entered as control measures in the second step. The amount of explained variance ( $R^2$ ) before and after including background variables is also presented to show how FR status, with and without controlling variables, predicts variation in children's emergent literacy. To adjust for multiple comparisons and reduce type I error, the Benjamini–Hochberg correction (Benjamini & Hochberg, 1995) was applied within the regression analysis. This correction adjusts the critical  $p$ -value in a stepwise manner based on the number of significance tests included within a particular set of analyses. However, this correction did not change the significant results, and we report the original  $p$ -values in Table 5.

For parental educational level, we used mother – high education and father – high education as the reference groups because high level of education was the largest group among the three levels of education for both mothers and fathers. Parents' educational level was used as a proxy for socioeconomic status as previous research has shown that in Norway, where this study was undertaken, parental level of education is a stronger predictor of educational outcomes than parents' income (Løken, 2010).

The FR status based on the parents' self-report of RD (entered in step 1) accounted for 6.8% of the variance in children's emergent literacy. After adding the background variables simultaneously in step 2, a total of 33.4% of the variation in children's emergent literacy was explained. Unsurprisingly, FR status, based on parents' self-report of RD, was a significantly negative predictor for the children's emergent literacy while controlling for HLE; the child's gender, interest in literacy and letters, months in kindergarten and vocabulary; and parental level of education before the onset of reading instruction. The three HLE factors, number of months in kindergarten and parental levels of education did not significantly contribute to

Table 4. Correlations of family risk (FR) status, parental education, the aspects of home literacy environment, children's interest in literacy and letters, emergent literacy and vocabulary in the whole sample

	1.	2.	3.	4.	5.
1. FR status					
2. Access to print*	–0.17*				
3. Literacy-related activities*	–0.12*	0.32*			
4. Parents reading habits*	–0.16*	0.36*	0.37*		
5. Child's interest*	–0.12*	0.26*	0.43*	0.26 <sup>***</sup>	
6. Emergent literacy*	–0.27*	0.25*	0.24*	0.17*	0.36*

Note:  $n = 821$ ;

\* $p < 0.001$ .

<sup>a</sup>Factor scores of confirmatory factor analysis.

Table 5. Hierarchical regression analyses, predicting emergent literacy at age 6 years before onset of reading instruction

Variable	Step 1			Step 2		
	B	SE B	$\beta$	B	SE B	$\beta$
Family risk status	-0.63*	0.08	-0.26	-0.40*	0.07	-0.17
Access to print <sup>a</sup>				0.08	0.05	0.05
Literacy-related activities <sup>a</sup>				0.02	0.05	0.02
Parents' own reading habits <sup>a</sup>				0.05	0.04	0.04
Child's interest in Literacy and letters <sup>a</sup>				0.37*	0.06	0.20
Children's gender				0.26*	0.06	0.13
Months in kindergarten				0.06	0.04	0.05
Vocabulary				0.10*	0.01	0.34
Mother – low education <sup>b</sup>				-0.08	0.16	-0.02
Mother – medium education <sup>b</sup>				0.11	0.08	0.05
Father – low education <sup>b</sup>				-0.45*	0.15	-0.10
Father – medium education <sup>b</sup>				0.10	0.07	0.05
R <sup>2</sup>	0.068			0.334		
F for change in R <sup>2</sup>	F(1, 782) = 56.95, p < 0.001			F(11, 771) = 27.94, p < 0.001		

<sup>a</sup>Factor scores of confirmatory factor analysis.

<sup>b</sup>Mother – high education and father – high education used as reference groups for parental educational level.

\*Significant at p < 0.001.

the model. Besides FR status, the child's gender, interest in literacy and letters and vocabulary were related significantly to emergent literacy (Table 5).

## DISCUSSION

We examined whether FR status based on parents' self-report of RD could contribute to their children's performance in emergent literacy before formal reading instruction. In particular, we investigated whether having both parents with RD puts the child at higher risk for lower emergent literacy compared with having only one parent with RD, which had not previously been empirically reported.

Our findings extend previous FR studies by demonstrating that parents' self-report of RD can be used as a single measure to determine children at FR risk in a large, representative sample. Our results showed that FR children were significantly impaired compared with not-FR children on all measures of emergent literacy, including letter knowledge, first phoneme isolation, blending, vocabulary, RAN, STM, word reading and spelling. These findings were similar to previous FR studies where parents' self-report of RD was corroborated by detailed reading assessments (Carroll & Snowling, 2004; Elbro *et al.*, 1998; Elbro & Petersen, 2004; Nash, Hulme, Gooch, & Snowling, 2013; Torppa *et al.*, 2007; Torppa *et al.*, 2012).

The most important and novel finding from our study was the significant group differences in emergent literacy within the group of FR children that were apparent even before the onset of reading instruction. As expected, children with two parents self-reporting RD had significantly poorer emergent literacy than either children with only one parent self-reporting RD or children with no parent self-reporting RD. Group differences in emergent literacy were moderate to large



in letter knowledge, first phoneme isolation and vocabulary in favour of FR-one children compared with FR-both children. Unsurprisingly, the largest group difference in emergent literacy was found between FR-both children and not-FR children. These results are in line with the findings from Wolff and Melngailis' study of literacy outcomes for children with a genetic history of dyslexia (1994). Wolff and Melngailis (1994) reported that children in families with two dyslexia-affected members were not only at greater risk but also more severely impaired than children with only one dyslexia-affected family member. The current findings clearly suggest group differences within the FR group in emergent literacy, leaving children with two parents reporting RD with the lowest emergent literacy and thus more likely to experience some difficulties when learning to read, even if they do not go on to develop RD *per se*.

We also found significant differences in children's vocabulary between not-FR and FR groups although the effect size in our study was small ( $d = 0.28$ ) compared with previous studies ( $d = 0.65$ ) (Snowling & Melby-Lervåg, 2016). We had therefore expected that both groups would perform less well than the not-FR group in vocabulary. However, we found that children with one parent self-reporting RD did not significantly differ from not-FR children. Furthermore, children with both parents self-reporting as RD showed large deficits in vocabulary compared with children with only one parent self-reporting as RD ( $d = 0.71$ ), and not surprisingly, they showed even larger deficits compared with not-FR children ( $d = 0.87$ ). To our knowledge, this is the first study to report such a large deficit in vocabulary for FR children with two parents self-reporting as RD. This novel and important finding suggests that children with both parents self-reporting RD are not only at greater risk for RD but also may show severe difficulties because they have a wider range of language difficulties (Carroll & Snowling, 2004; Snowling & Hulme, 2012). Another possible explanation is that deficits in one area (e.g. vocabulary) may act as barriers to progress in another area (e.g. phonological processing skills). For example, according to Walley, (1993), children's vocabulary growth during the preschool years is critical for the development of their phonological representations from holistic or undifferentiated words to segmental forms. This lexical restructuring could be due to the growth of children's vocabulary through experience with spoken language and exposure to print. Interestingly, not only did FR children with two parents self-reporting as RD score lower in vocabulary than FR-one and not-FR groups, but also their parents reported poorer HLE compared with the other groups, especially for the component of children's access to print.

Another important finding in the current study was the differences in HLE components between not-FR and FR groups. Unsurprisingly, the not-FR families reported a better overall HLE than FR children, and large group differences were found for access to print ( $d = 1.01$ ), literacy-related activities ( $d = 0.53$ ) and parents' own reading habits ( $d = 0.79$ ). These results were both similar and different to previous studies looking at FR and components of HLE. In contrast to the Finnish Jyväskylä study (Torppa *et al.*, 2007), but more similar to research in English (Dilnot *et al.*, 2017; Hamilton *et al.*, 2016; Scarborough, 1991), we found significant group differences in the access to print factor between not-FR and FR groups. Specifically, in the current study, parents in the FR group reported fewer children's books in the household than in the not-FR group, while in the Finnish study, no significant differences were reported for this item. Furthermore, when both parents reported having RD (FR-both), they tended to select the minimum

number of books on the scale. However, the significant group difference we found between not-FR and FR groups in the 'parents own reading habits' factor was compatible with the results of both the Finnish Jyväskylä study and HLE research in English. These results suggest that parents who report having RD are less active readers and, as a result, provide fewer incidences of positive reading models to their children, especially when both parents report RD. In contrast to the Finnish studies, our data suggest that parents in FR groups report less frequent literacy-related activities at home compared with not-FR group, and this effect held for both FR-one and FR-both groups. A likely explanation for the disparity in these results is the lack of significant differences in parental educational level between the FR and not-FR groups in the Finnish studies, whereas in the present study and the English context, the parental educational levels were significantly lower in the FR group compared with the not-FR group. The group differences in parental educational levels are not surprising because parental educational levels are typically reported as being lower in FR families (Snowling & Melby-Lervåg, 2016).

Overall, these findings add to the understanding of the impact of parental history of RD on HLE by showing that not-FR families provide the richest literacy environment for their children through positive reading models, literacy-related activities and access to print material than families with at least one parent reporting RD, and the impact is especially severe when both parents report RD. One possible explanation for such differences in the HLE is the combination of influences from both FR (here, parents self-reporting of RD) and parental low level of education in FR families. Because *FR status* is a possible reason for the lower level of parental education in the group of FR children, it could be argued that FR can have a direct negative impact and/or indirect one through parental level of education on the components of HLE.

Moreover, we investigated group differences in the different components of HLE within the FR group, which has not been previously explored. Our data suggest group-level differences within FR groups in some components of HLE (especially in access to print, parental positive model of reading and some items of literacy-related activities like frequency of shared reading).

Equally important, we investigated children's interest in literacy and letters before formal reading instruction. The FR children tended to show less interest in literacy and letters than not-FR children ( $d = 0.25$ ), according to their parents, which was not reported in the Finnish studies (Torppa *et al.*, 2006, 2007). Parents in our study reported about their children's literacy interest by answering two questions about (1) reading interest and (2) interest in letters. Interestingly, no significant group effect was found for the item 'my child often asks to be read to'; however, there was a significant group effect for 'the child's interest in letters. This suggests that FR children are interested in shared reading as much as not-FR children before formal reading instruction, which is more compatible with the results from the Finnish study. Nevertheless, it seems likely that FR children are not enthusiasts of letters and sounds as much as not-FR children before formal reading instruction. These subtle yet important differences in children's reading interests should be taken into account in future research.

As expected, FR status was a unique predictor of emergent literacy before the onset of reading, even after controlling for background variables including the HLE and parental level of education. Besides FR status, children's gender, their interest in literacy and letters and vocabulary were also significant predictors of emergent

literacy. It is notable that none of the HLE factors was a significant predictor, whereas it was assumed that the active HLE factor (literacy-related activities) would be a unique contributor when these activities and the passive factor (access to print) are included simultaneously (Burgess, Hecht, & Lonigan, 2002).

Among variables for parental education, we found only a significant negative association between father's low education and children's emergent literacy, while this association was absent for mothers with low-education level. A possible reason for this is that in our data the fathers' level of education was significantly lower than the mothers' level of education; however, children's emergent literacy and parental low-education level showed similar strengths of associations ( $\sim 0.24$  for mothers and  $\sim 0.18$  for fathers). In addition, FR status (parents' self-report of RD) was significantly, but negatively, correlated to their children's emergent literacy (approximately  $-0.26$ ). These correlations were lower than the correlations reported by van Bergen *et al.* (2012) for children and parents' literacy skills, because they assessed parents' reading fluency.

Finally, it is noteworthy that parental reports of children's interest in literacy and letters were found to be related to their concurrent emergent literacy. This finding replicated previous research (Frijters, Barron, & Brunello, 2000) that suggested children's literacy interest may be a key driver of the relationship between the HLE and emergent literacy. However, the direction of causality of this relationship is not clear, because all constructs were measured concurrently.

#### **Implication of the Findings for Parents, Teachers and Early Educational Settings**

Overall, the results of this study indicate a substantial influence of parental history of RD on children's emergent literacy performance before reading onset and some components of the HLE. The causal mechanisms underlying the development of children's emergent literacy, however, cannot be inferred from a correlational design such as the present study. It is possible that the self-report of RD is indicating parental confidence in reading, rather than their actual reading skills/difficulties, which is also likely to impact on HLE. Nonetheless, what is important to note is the association between parents' self-reporting of RD, poor HLE and their children's low emergent literacy.

Together, our findings have important implications for practitioners and teachers working with preschool children and first-grade students. Although the language context of the present study is Norwegian, our findings can be generalized to other contexts. Snowling and Melby-Lervåg (2016), in their meta-analysis study, reported that FR children, regardless of the language context, perform significantly poorer in emergent literacy skills than not-FR children at preschool ages, which in turn puts FR children at greater risk for RD. They highlight that these findings, which included studies in both English and Finnish contexts, are consistent across languages, and the effect of orthography is only marginal. The current results in Norwegian, which is a semi-transparent orthography that is more regular than English and less regular than Finnish, are consistent with their findings.

The principal implication is the value of screening for possible risk of RD in children with the simple but valid tool 'parents' self-report of RD' in preschool years. Our findings suggest that parents will report having experienced reading and writing problems if they found them challenging subjects at school. Furthermore, the present study clearly demonstrates that if the parents experienced RD, their

children are more likely to experience difficulties in developing emergent literacy at preschool ages and that the risk of difficulties in emergent literacy is higher when both parents have a history of RD. The parents' self-report of RD is not sufficient to know whether a child will go on to develop RD, but it provides a good starting point for further assessment or attention for preschool children.

Although our data do not allow us to draw inferences about causation, these findings suggest that the early speech and language development of children at FR risk of RD should be monitored closely, especially when both parents have reported experiencing reading and writing problems. Our data clearly showed a broad range of language difficulties, particularly in vocabulary skills of FR children when both parents report having RD.

Another implication concerns reading-related habits and activities in the home. The current study found that the HLE for families where the parents self-reported RD was not as rich as in not-FR families. In addition, exposure to print material is less frequent when both parents self-report RD. Parents, especially those who self-report RD, should be advised about the crucial role of the HLE in the development of their children's emergent literacy and possibly later reading skills. This study indicates that families where both parents self-report RD have the fewest number of children's books at home, fewer than families with only one parent self-reporting RD, who, in turn, reported having fewer books than families with no self-report of RD. Previous research indicated that a richer HLE is associated with enhanced vocabulary skills in early and middle childhood. Niklas and Schneider (2015) found that HLE interventions can have an impact on home learning environments and children's language development including their vocabulary. Parents need to know that they can support their children's emergent literacy by providing them with better access to print and more shared-reading activities.

#### LIMITATION AND FUTURE STUDY

The present study has some potential limitations regarding the measure of HLE. Based on previous research, the HLE measure was a questionnaire designed to capture the home environment from the aspect of the child's access to print, reading-related activities in the home, parents' own reading habits and children's interest in literacy. First, similar to most previous research, the HLE questionnaire was the only measure and there were no data on parent-child interactions. The present study was a quantitative large-scale design; however, future qualitative studies would shed more light on this matter. Second, parents' potential reading problems and/or their confidence in reading, especially in the group of parents who self-reported RD, could raise some concerns regarding their ability to fully comprehend the questionnaire. In order to mitigate the impact of this, we used a specially designed questionnaire containing short, simple, multiple-choice questions for parents to answer at home at their own pace. Third, children's oral language skills were assessed through the vocabulary test, and we did not include a measure of the quality or quantity of spoken language in the home environment as it was not the focus of the current HLE measure. Future studies should assess the possible impact of the quality and quantity of spoken language in the home on children's literacy-related skills such as vocabulary.

## CONCLUSIONS

Despite some limitations, this study provides clear evidence of difficulties across a range of emergent literacy skills in FR children. The present study adds to the literature on FR of RD by using parents' self-report of RD as a single measure for identifying group differences in emergent literacy before the onset of reading instruction. Our findings show impaired emergent literacy and poor HLE in children with parental history of RD in line with previous studies on FR of RD, which included corroborating measures along with parents' self-report of RD to confirm FR status. Furthermore, we found that FR children may also experience less exposure to literacy material in the home compared with not-FR children. The parents of FR children also reported that their children were less interested in letters. These findings suggest that children's experience in their home environments and their interest in letters may not be independent of FR factors. Overall, given the importance of early identification, this study highlights the value of parents' self-report of RD as a single measure, where parental self-report of RD is evidently associated with differences in HLE and in turn correlated with children's emergent literacy. Our findings have critical implications for schools, teachers and early years' settings.

Finally yet importantly, a novel aspect of this study was to investigate group differences in emergent literacy within the FR group, which has not been explored in past FR studies. Children with two parents self-reporting RD showed a broad range of language difficulties compared with children with only one parent self-reporting RD and children with no such risk. This study suggests that parents' self-report of RD can demonstrate FR of RD as early as preschool.

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## ***Study II***



## **Contribution of Family Risk, Emergent Literacy and Environmental Protective Factors in Children's Reading Difficulties at the end of Second-Grade**

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### **Abstract**

It is well established that emergent literacy is a strong predictor of later reading difficulties (RD), and that the home literacy environment (HLE) plays an important role in the development of children's preschool emergent literacy and oral language. RD runs in families and children with a family risk of RD tend to show delays in emergent literacy and might experience a less advantageous HLE. This study examined whether family risk predicts children's second-grade RD in a multifactorial model including both emergent literacy and environmental protective factors such as HLE and parental level of education. Children were assessed for emergent literacy at the beginning of first grade, and were identified as having RD at the end of second grade if they performed below the national threshold in at least two of the subtests in reading, spelling and comprehension. The multifactorial model suggested that children with family risk of RD had RD that could not be explained in terms of individual differences in emergent literacy, gender, interest in literacy, HLE or parental education level. In line with previous research, children with family risk were at increased risk for later RD; however, the HLE and parental level of education operated as environmental protective factors.

Keywords: Reading difficulties, family risk, multifactorial prediction model, emergent literacy, home literacy environment.

Literacy skills provide a crucial foundation for children's later success in educational, professional and everyday settings. Most children learn to read and write successfully; however, the prevalence of reading difficulties across the domains of reading, spelling and reading comprehension is 5-15% among school-age children across different languages and cultures (American Psychiatric Association, 2013). Although reading difficulties (RD), or dyslexia, has many definitions and different criteria, it is generally accepted to refer to unexpected impairments in the process of reading and spelling acquisition which are not due to extraneous factors like sensory intelligence, acuity deficits, socioeconomic disadvantage, and similar factors (Vellutino, Fletcher, Snowling, & Scanlon, 2004). There is accumulating evidence that RD can be prevented in many children through early intervention (Fletcher, Lyon, Fuchs, & Barnes, 2007; Lovett et al., 2017; Torgesen, 2002), and this means that early prediction of RD or identification of at-risk children is of both theoretical and practical interest. Predictors of RD have been extensively investigated in young children in order to identify which variables may identify at-risk children prior to the onset of formal instruction. Predictors have been identified from different domains including cognitive, biological and environmental factors. Cognitive-based factors typically include individual differences in emergent literacy and oral language skills; biological-based factors include a genetic cause or

a history of RD within the family known as family risk (FR); and environmental factors include the home literacy environment (HLE) and parental level of education. The range of predictive factors has resulted in both single and multiple deficit models of RD, in which factors from one or more of these domains have been controlled. For instance, the contribution of FR and emergent literacy skills in children's RD has been investigated previously. However, whether FR predicts RD in a multifactorial model that controls for both emergent literacy and environmental factors such as home literacy environment, and parents' educational level is not clear.

### **Emergent Literacy & Multiple Cognitive Prediction Model**

The term emergent literacy is used to describe a broad range of pre-literacy skills, knowledge, and attitudes that children acquire prior to formal schooling, and which provides a foundation for later literacy development (Whitehurst & Lonigan, 2001). Emergent literacy such as letter knowledge, phonemic awareness, vocabulary and non-phonological processing skills (e.g., rapid automatized naming (RAN), short term memory) have been found to be predictive of children's later RD (Elbro, Borström, & Petersen, 1998; Lonigan, Schatschneider, & Westberg, 2008). This prediction model forms the basis of the widely accepted cognitive deficit models that have mainly focused on early symptoms in order to identify and remediate reading problems as early as possible (Pennington, 2006). The dominant cognitive deficit model of RD is the phonological deficit theory/model, which postulates a core deficit in phonological processing as being causally related to RD (Hulme & Snowling, 2013; Pennington, 2006). Dual deficit models that consist of deficits in both RAN and phonological processing skills have guided other studies (Cardoso-Martins & Pennington, 2004; Catts, Nielsen, Bridges, Liu, & Bontempo, 2015; Pennington, Cardoso-Martins, Green, & Lefly, 2001; Torppa et al., 2013). Moreover, cognitive multiple deficit or multivariate models have been hypothesized which include phonological skills and RAN in addition to short term memory (Bishop & League, 2006; McGrath et al., 2011) or oral language skills (Catts, McIlraith, Bridges, & Nielsen, 2017; McCardle, Scarborough, & Catts, 2001; McGrath et al., 2011; Pennington et al., 2012).

### **Family Risk & Multiple Cognitive Prediction Model**

In line with the multiple cognitive deficit models, research on family risk (FR) of RD has shown that having a history of RD within the family, can put the child at high risk for RD. A meta-analysis of previous studies of FR indicates that approximately 29% to 66% of children with FR (FR children) will develop RD (Snowling & Melby-Lervåg, 2016). This meta-analysis also indicates that FR children universally develop emergent literacy more slowly than children without FR (Not-FR children), which in turn puts them at greater risk for RD. In addition, a large body of FR studies have reported that despite the fact that FR children have poorer emergent literacy, the pattern of prediction for later literacy outcomes are similar in FR and Not-FR children (Aro et al., 2009; Cardoso-Martins & Pennington, 2004; Pennington & Lefly, 2001; Torppa, Eklund, van Bergen, & Lyytinen, 2011; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010; Torppa, Poikkeus, Laakso, Eklund, & Lyytinen, 2006; Torppa et al., 2007). However, data are limited on whether FR and emergent literacy concurrently predict RD. Elbro, Borstrom, and Petersen (1998) found that letter naming, preschool

phoneme identification, and phonological representations were statistically significant predictors of RD at the beginning of Grade 2, while FR was not. In contrast, Puolakanaho et al. (2007), in a multiple cognitive model, found that FR, preschool letter knowledge, phonemic awareness and RAN were significant predictors of RD at the beginning of Grade 2. In another study, Carroll, Mundy, and Cunningham (2014) investigated the roles of FR, emergent literacy and oral language in predicting children's literacy outcomes. Their findings support those of Puolakanaho et al. (2007), suggesting that FR is a unique predictor of children's literacy even after controlling for speech production, language and phonological processing. Carroll et al. (2014) argued that FR children show additional difficulties in literacy that cannot be fully explained in terms of their language and phonological skills. However, they did not include environmental factors such as parental education level or the HLE in their analyses which might have accounted for some of unexplained variance in literacy skills.

### **Environmental Protective Factors and Children' Emergent Literacy & Family Risk**

Environmental factors such as parental education level and the HLE may play important roles in development of children's preschool emergent literacy and oral language. It is clear that the HLE, which refers to the quality and quantity of reading-related activities that parents provide for their children at home, plays an important role in the development of children's emergent literacy and oral language skills (Burgess, Hecht, & Lonigan, 2002; Dilnot, Hamilton, Maughan, & Snowling, 2017; Hamilton, Hayiou-Thomas, Hulme, & Snowling, 2016; Sénéchal & LeFevre, 2002; Torppa et al., 2007; van Bergen, van Zuijen, Bishop, & de Jong, 2016). The HLE is likely to have long-term and consistent influences on children's later literacy skills either directly or indirectly through emergent literacy skills (Frijters, Barron, & Brunello, 2000; Sénéchal, 2006). Frijters et al. (2000) discussed that the HLE was directly related to vocabulary whereas, the relationship between the HLE and later literacy skills was mediated by phonological awareness. Similarly, Sénéchal (2006) reported that HLE directly predicted kindergarten vocabulary and indirectly predicted Grade 4 reading comprehension.

The association between FR and the HLE is less clear and data are limited (Snowling & Melby-Lervåg, 2016). Some studies reported no differences in HLE between FR families and Not-FR families (Elbro, Borstrom, et al., 1998; Torppa et al., 2007), whereas others studies reported a relatively disadvantageous HLE for FR children compared with Not-FR children (Dilnot et al., 2017; Esmaeeli, Lundetrae, & Kyle, 2017; Hamilton et al., 2016). Dilnot et al. (2017) found that FR children experienced more environmental adversities than Not-FR children. The environmental factors in their study, consisting of both HLE, parental education and occupations, predicted children's reading readiness (early word reading, letter knowledge, and phoneme deletion) at school entry. Hamilton et al. (2016) also reported group differences in storybook exposure between FR and Not-FR children. Moreover, Esmaeeli et al. (2017) used parents' self-report of RD to identify FR and Not-FR children, and found a disadvantageous HLE in FR children. In their study, the differences in HLE was even larger when both parents reported RD. A possible explanation for these inconsistent findings regarding associations between FR and the HLE is parental level of education and/or socioeconomic background (Esmaeeli et al., 2017; Hamilton et al., 2016). In the studies in which the HLE did not differ between FR and Not-FR groups, there were no differences

between FR and Not-FR groups in parental education (Torppa et al., 2007) or maternal education (Elbro, Borstrom, et al., 1998). However, there is a clear association between children's emergent literacy and the HLE in both FR and Not-FR children (Dilnot et al., 2017; Esmaeeli et al., 2017; Hamilton et al., 2016).

### **A Multifactorial Model of RD**

Pennington (2006) argued that RD is a complex developmental disorder that involves the interaction of multiple risk and protective factors, which can be either genetic or environmental. Accordingly, these risk and protective factors (at genetic and environmental levels) influence the development of children's emergent literacy skills which are prerequisite for the development of later literacy skills. FR, as a proxy for genetic factors, may operate as a risk factor that increases the likelihood of RD because it can negatively influence both emergent literacy and later literacy skills (Pennington, 2006; van Bergen, van der Leij, & de Jong, 2014). Environmental factors, however, can operate as either/or both risk and protective factors. Therefore, although HLE may not be directly associated with children's later RD, it is important to control for its indirect influence via emergent literacy (Frijters et al., 2000; Sénéchal, 2006). Multifactorial models can be used to explore the effect of environmental protective factors such as parental educational level and the HLE and risk factors such as FR on children's literacy skills. No previous FR study has applied a multifactorial model to investigate whether FR predicts children's later RD after accounting for emergent literacy and environmental protective factors such as the HLE and parental level of education.

The present study aims to answer the following questions: (1) Do FR children perform lower in literacy tasks, and are they more likely to be categorized as having RD at the end of second grade compared with children without FR? (2) Does family risk contribute to children's second-grade RD above and beyond emergent literacy, vocabulary, parents' education and HLE measured at the onset of formal reading instruction?

## **Method**

### **Participants**

For this study, we drew data from an ongoing longitudinal project (xxxx) that has focused on early identification and intervention for RD. Altogether, 1,171 6-year-old children joined the project at the beginning of Grade 1, which marks the onset of formal reading in Norway. In the present study, we only included children from the schools that were randomly assigned to the control condition ( $n = 260$ ). Second-language-speakers, children with hearing problems, and children whose parents did not provide information about RD within the family were excluded from the sample. In total, the sample for the present study was 208 children.

### ***Defining Family Risk (FR)***

The present study uses parents' self-report of RD as an indicator of family risk and a proxy for FR status. Parents or adult's self-report of RD is a valid, reliable and time-saving tool to screen RD among parents and adults (Leavett, Nash, & Snowling, 2014; Lefly & Pennington, 2000; Snowling, Dawes, Nash, & Hulme, 2012), which has consequently and increasingly been used as a proxy for FR status (Carroll & Snowling, 2004; Esmaeeli et al., 2017).

Snowling et al. (2012) argued that self-report is valid, first, because of its strong relationship with directly assessed literacy skills of respondents (parents) and second, due to the association between the parents' self-reporting of RD and emergent literacy difficulties of their children.

In this study, participating schools offered a welcome meeting for parents before children start first grade in school. Our research team presented information about the project and about reading difficulties at these meetings and invited parents to take part in the study. Parents received a project pack containing a brochure giving them more information about the project, a parental consent form, and a questionnaire regarding demographics, the HLE, family risk of RD, the student's language background, and his or her health. We obtained FR status through this questionnaire, which parents completed at home and sent back to school. We asked the following question: "has anyone in the child's biological family experienced 'reading and writing difficulties'?" with separate response options for mother and father ('yes', 'no', or 'don't know'). 'Reading and writing difficulties' was discussed at the welcome meeting with parents. We used parents' self-report of RD to allocate their children into FR and Not-FR groups. The Not-FR group consisted of 161 children from families in which neither parent self-reported RD. Forty-nine children had at least one parent who self-reported RD and formed the FR group. Only three FR children had both parents self-reporting RD. Table 1 presents the background demographics of the sample.

### **Measures at the beginning of Grade 1**

The early predictors of RD were derived from individual assessments at the beginning of first-grade (mean age = 6.21, SD = 0.28). Trained testers individually assessed all students in a quiet place in their local school. The test battery was administered on a digital tablet.

#### ***Emergent Literacy Skills***

*Letter knowledge* consisted of a 15-item multiple-choice test. Children were asked to listen to a pre-recorded letter sound on the tablet, and respond by pressing on one of the four touch-screen letters. Cronbach's  $\alpha = 0.85$ .

*Phoneme isolation*. The tablet screen showed a picture, and the examiner pointed to the picture, named it, and asked the child to produce the first sound of that word. The oral response of the child was scored and recorded on the tablet by the examiner. This task contained eight items and presentation was automatically discontinued if a child made two subsequent errors. Cronbach's  $\alpha = 0.92$ .

*Blending task*. Children were required to blend a set of separately pronounced phonemes into the corresponding whole word. The test had eight items of increasing difficulty and presentation was automatically discontinued after two subsequent errors. In each item, four pictures appeared on the screen, and the task was pre-recorded: "Here you see a picture of /ri/ - /rips/ - /ris/ and /ring/ (ride, red current, rice, ring, in English). Listen carefully and touch the picture that goes with: /r/-i/-s/ (presented phoneme-by-phoneme, one per second)". Cronbach's  $\alpha = 0.86$ .

*Rapid Automated Naming (RAN)* included naming familiar objects presented repeatedly in a random order. The examiner practiced the task with the child and made sure that the child knew the name of each object and understood the procedure of the task. The

pictured objects were *sun, car, plane, house, fish, and ball*, which are all monosyllabic words in Norwegian. There were four rows of five stimuli in each matrix, and two trials. The child was asked to name each item as quickly and accurately as possible from left to right, and top to bottom. Time to complete the task (in seconds) and naming errors were recorded.

*Short-Term Memory* (STM) was measured with Digit Span Forward from Wechsler Intelligence Scales for Children-III (Wechsler, 1991). The examiner read aloud one digit per second and the child's responses were scored on the tablet.

*Vocabulary* was tested with an abridged version (20 out of 40 words) of the Norwegian Vocabulary Test (NVT) (Størksen, Ellingsen, Tvedt, & Idsøe, 2013). A picture appeared on the screen and the child was asked to name it. Cronbach's  $\alpha$  for 20 items in the present sample was .83, which is virtually identical to the 40 items in the standardized sample (Cronbach's  $\alpha = 0.84$ ).

### **Home Literacy Environment (HLE)**

At the beginning of first-grade, different components of the HLE were measured via parents' questionnaires. The measures of the HLE, and children's interest in literacy were constructed in line with previous research (Dilnot et al., 2017; Hamilton et al., 2016; Niklas & Schneider, 2013; Skwarchuk, Sowinski, & LeFevre, 2014; Torppa et al., 2007) as following:

1) **Access to print** was assessed with the following items: (a) How many children's books do you have at home? (1 to 5 (*None to More than 40 books*)). (b) How old was the child when you first started reading to her or him? (1 to 5 (*Never read to the child to before the age of 2*)).

2) **Literacy-related activities** included the four following questions: (a) How often do you read to the child? (b) How often does the child watch TV? (c) How often does the child play TV/computer/tablet/mobile games? (d) How often do you visit a library with the child? (1 to 5 (*Never to Several times a week*)).

3) **Parents' reading interest and habits** were assessed by questions regarding how often they read (a) books, and (b) magazines for themselves (1 to 5 (*Never to Several times a week*)).

(c) Parents' own reading interest were assessed by the item 'I only read if I have to' (1 to 4 (*Completely disagree to completely agree*)).

Structural equation modeling was conducted in Mplus (Version 8.0) to make a three-factor model for the HLE, using robust maximum likelihood estimation the overall goodness-of-fit (Brown, 2014) showed the model had an adequate fit to the data:  $\chi^2(17) = 22.15, p = .18$ ; root-meansquare error of approximation (RMSEA = .04), the comparative fit index (CFI = .95), and the Tucker-Lewis Index (TLI = .92).

### **Literacy Outcomes at the End of Grade 2**

Around the end of second-grade, a group of trained testers applied 'National Screening Test in reading, spelling and reading comprehension' in the local schools. This screening test aimed to identify students who perform below the national threshold (set at the bottom 20 percent of the National sample).

*Word reading* consisted of 14 items, and the time limit was 2 minutes. For each item, a picture was represented along with four visually similar words, one of which corresponded to



the picture. The child was asked to read all the words as fast as possible and to tick the word that matched the picture. For example, a picture of a wasp ('veps' in Norwegian) followed by 'vest', 'visp', 'veps', and 'vips'. The maximum score was 14. Cronbach's  $\alpha = 0.74$ .

*Spelling* involved 14 words with a variety of phonemes and phoneme sequences. The target word was first introduced in a short sentence to the child; then the target word was repeated for the child to write it down (e.g. "Father has a blue hat. Write /hat/"). The number of correctly spelled words was measured, and the maximum score was 14. Cronbach's  $\alpha = 0.84$ .

*Reading Comprehension* involved two sub-tests: (1) a sentence-based comprehension test in which the child read 10 sentences that gave them some information about a picture. The picture and sentences describe two trolls going into the forest and the things that they see there. For example, "There are several things to see in the forest. Find what they see and mark them with a cross on the picture": e.g., the top of the highest tree. (2) A text-based comprehension test including 5 multiple-choice questions. There were four short texts about children explaining where they wished to travel for the vacation. The time limit was 20 minutes in order to provide students with sufficient time. The maximum score for both sections was 15. Cronbach's  $\alpha = 0.85$ .

## Results

Data were examined for missing data, outliers, skewness, and kurtosis. Values for both skewness and kurtosis in all variables were between  $\pm 2$ , and there were no missing values. For the two first sets of analyses, presented in Tables 1 and 2, we used raw data except for HLE and children's interest in literacy, for which factor scores were used. For the main set of logistic regression analyses, we also used factor scores for phoneme awareness based on the items from phoneme isolation and blending.

### Descriptive statistics and group differences

Children falling below the national threshold cut-off points (set at the bottom 20 percent of the National sample) in at least two of three measures of word reading, spelling and reading comprehension at the end of Grade 2 were classified as having RD. Using this criterion, forty-two children (20.20%) were identified with RD. Children who did not meet this criterion were categorized as typical readers (TR). Table 1 presents the children's characteristics by group, and group differences in all measures of the study. Attendance in kindergarten, mean age and gender status did not statistically differ between RD and TR groups. Maternal educational level did significantly differ between groups of TR and RD children:  $X^2 (N = 208, 1) = 3.93, p < .05$  but paternal educational level did not. Unsurprisingly, the RD group performed significantly poorly on all measures of literacy outcomes at the end of grade 2 (word reading, spelling and reading comprehension) because these three measures of literacy outcomes were used to identify RD children (see Table 2). As expected, children with RD also performed poorer than typical readers (TR-children) on all measures of emergent literacy at the beginning of first-grade. The effect sizes were medium to large. RD group did not significantly differ in HLE at the beginning of first grade (see Table 1).

**Table 1 Children's characteristic and Means, Standard Deviations, and Group Comparison of Mean**

		<b>Not-FR n = 159</b>	<b>FR n = 49</b>	<i>d</i>	<b>TR n = 166</b>	<b>RD n = 42</b>	<i>d</i>
		<i>M (SD) or %</i>	<i>M (SD) or %</i>		<i>M (SD) or %</i>	<i>M (SD) or %</i>	
<b>Children Characteristics by Groups</b>							
<b>FR status (n, %)</b>	Not-FR	-	-	-	135 (84.9%)	24* (15.1%)	-
	FR	-	-	-	31 (63.30%)	18* (36.70%)	-
<b>Maternal high education<sup>a</sup> (%)</b>		67.9%	57.1%	-	68.7%**	52.4%	-
<b>Paternal high education<sup>a</sup> (%)</b>		59.7%**	40.8%	-	57.8%	45.2%	-
<b>Gender: Boys (%)</b>		45.9%	32.7%	-	43.4%	40.5%	-
<b>Age (Years: M, SD)</b>		6.25 (0.29)	6.27 (0.31)	-	6.27 (0.29)	6.17 (0.28)	-
<b>Years in Kindergarten (M, sd.)</b>		4.62 (0.74)	4.66 (1.01)	-	4.61 (0.77)	4.53 (0.66)	-
<b>Emergent Literacy and HLE at Onset of formal Reading Instruction</b>							
<b>Letter Knowledge (Max. 15)</b>		12.65 (2.95)	11.78 (2.79)	0.30	12.86 (2.75)	10.76 (3.21)	0.70**
<b>Phoneme Isolation (Max. 8)</b>		5.73 (2.87)	4.62 (3.06)	0.37*	5.83 (2.81)	4.02 (3.05)	0.62**
<b>Blending (Max. 8)</b>		4.04 (2.62)	3.12 (2.58)	0.35*	4.07 (2.65)	2.83 (2.38)	0.49**
<b>Vocabulary (Max. 7)</b>		13.60 (3.40)	13.12 (3.49)	0.15	13.74 (3.35)	12.55 (3.52)	0.35*
<b>RAN<sup>b</sup></b>		58.68 (15.94)	63.50 (16.31)	0.30	58.26 (15.29)	66.06 (17.95)	0.47*
<b>Digit span</b>		5.67 (1.49)	5.16 (1.30)	0.36*	5.65 (1.48)	5.12 (1.31)	0.38**
<b>HLE</b>		0.06 (0.95)	-0.20 (1.13)	0.25	0.04 (0.99)	-0.15 (1.04)	0.19
<b>Children's interest in literacy</b>		0.02 (1.02)	-0.07 (0.93)	0.09	0.06 (0.93)	-0.23 (0.93)	0.27
<b>Literacy outcomes measured at end of Grade 2</b>							
<b>Word reading (Max. 14)</b>		11.83 (2.90)	9.84 (3.31)	0.64*	12.33 (2.34)	7.52 (1.22)	1.86**
<b>Spelling (Max. 14)</b>		11.28 (2.52)	10.53 (3.24)	0.26	12.00 (1.78)	7.55 (2.89)	1.85**
<b>Reading Comprehension (Max. 15)</b>		12.69 (2.83)	11.86 (2.69)	0.30	13.38 (1.91)	9.00 (3.11)	1.70**

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

RD, reading difficulties; TR, typical readers including both FR and Not-FR children who did not exhibit reading difficulties at the end of Grade 2; FR, family risk; FR children, children who had one parent with RD; Not-FR children, children with no parents reporting RD; RAN, rapid automatized naming; HLE, home literacy environment.

<sup>a</sup>Parents' level of education: high, university/college.

<sup>b</sup>RAN: It was not reversed; lower score in RAN, higher literacy outcomes

The first aim of this study was to test whether FR children would perform lower in literacy outcomes and more likely to be categorized as having RD at the end of second grade compared with children without FR. As shown in Table 1, FR children performed significantly poorer in phoneme isolation, blending and digit span at the beginning of first-grade. However, there were no differences in their interest in literacy, letter knowledge, RAN, vocabulary or HLE.

Turning to literacy outcomes at the end of second-grade, FR children performed significantly poorer than Not-FR children in word reading only, with a medium to large effect size ( $d = 0.64$ ). FR and Not-FR children did not significantly differ in spelling, while there was a trend toward significance for reading comprehension ( $p = .06$ ). As expected, a significantly higher proportion of FR children were identified having RD than Not-FR children at the end of second grade [ $X^2(1) = 10.88, p < .001$ ].

### Correlations and the multifactorial logistic regressions

Table 2 shows the Pearson and point-biserial correlations of RD and FR status with the other measures in the study. Taking the sample as a whole, RD status was significantly, negatively correlated with all measures of emergent literacy at the beginning of Grade 1, except for RAN, in which higher scores were positively associated with RD. RD was negatively correlated with mothers' high education but not with paternal high education, HLE or children's interest in literacy.

**Table 2 (point-biserial) Correlation among RD-status, FR-status, and other variables in the whole sample (N = 208)**

	1	2	3	4	5	6	7	8	9	10
1. RD Status (+)	-									
2. FR Status (+)	0.23*	-								
3. Mother high education	-0.14**	-0.10	-							
4. Father high education	-0.10	-0.16**	0.41*	-						
5. HLE	-0.07	-0.17	0.62**	0.40**	-					
6. Child's interest in literacy	-0.12	-0.04	0.26**	0.14*	0.56**	-				
7. Letter knowledge	-0.30*	-0.11	0.17*	0.20**	0.30**	0.25**	-			
8. Phoneme Awareness	-0.25*	-0.16**	0.32**	0.26**	0.48**	0.34**	0.48**	-		
9. Vocabulary	-0.15**	-0.03	0.22**	0.13	0.46**	0.24**	0.27**	0.48**	-	
10. RAN <sup>a</sup>	0.20*	0.12	-0.23**	-0.13	-0.31**	-0.15*	-0.33**	-0.37**	0.33**	
11. STM (Digit span)	-0.15**	-0.14**	0.12	0.12	0.19*	0.07	0.21**	0.33**	0.30**	-0.26**

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

FR, family risk; RD, reading difficulties; Parental level of education: high, university/college; RAN, rapid automatized naming; HLE, home literacy environment.

<sup>a</sup>RAN: It was not reversed; lower score in RAN, higher literacy outcomes

While FR, as expected, was positively associated with RD, significant negative correlations were found for phoneme awareness, digit span and paternal high educational level. FR was not significantly related with either HLE or children's interest in literacy.

To test our hypotheses, logistic regression analysis were constructed using maximum likelihood estimator (ML) in Mplus 8.0 (Muthén & Muthén, 2017). The second aim of this study was to extend previous FR research by investigating whether FR remains a significant contributor in children's RD after accounting for children's interest in literacy, gender, HLE and parents' education in a multifactorial model of RD.

Before applying our multifactorial prediction model, we began with two separate structural equation models to test: (a) the associations between emergent literacy and HLE while accounting for parents' education; and (b) the associations between FR and emergent literacy while accounting for parents' education. Finally, we predict children's RD in a multifactorial model which accounts for FR, emergent literacy, HLE, parents' education, gender and children's interest in literacy.

The correlations between each component of emergent literacy and the HLE were constructed while accounting for parents' education, first, for the whole sample, and then for the group of FR and Not-FR children separately. The results for the whole sample showed that the HLE was significantly related with all components of emergent literacy while controlling for parents' education.  $\chi^2(90) = 123.07, p = .01$ ; root mean square error of approximation (RMSEA) = 0.04, 90% confidence interval (CI) [0.02, 0.06], standardized root mean square residual (SRMR) = 0.05, comparative fit index (CFI) = 0.93, Tucker-Lewis index (TLI) = 0.91. Based on previous research (Frijters et al., 2000; Sénéchal, 2006), the HLE was added as an indirect predictor of children's RD via all components of emergent literacy at Step 1 in our multifactorial model, to predict children's RD from preschool emergent literacy both directly, and indirectly via the HLE.

As seen in Table 3, preschool letter knowledge (-.29) and phonemic awareness (-.78) were significant predictors of children's second-grade RD while accounting for HLE, parents' education, gender and children's interest in literacy. In addition, mediation values for both letter knowledge (-.16) and phonemic awareness (-.68) were significant. In other words, the better letter knowledge and phonemic awareness at the onset of formal reading instruction, the less likely the child would develop RD at the end of Grade 2. The amount of total explained variance ( $R^2$ ) in children's RD was 33.6% at Step 1.

The associations between FR and each components of emergent literacy were constructed while accounting for HLE and parents' education. The results showed that FR was significantly associated only with phonemic awareness while accounting for HLE and parents' education. However, HLE was associated with all components of emergent literacy.  $\chi^2(102) = 135.71, p = .01$ ; RMSEA = 0.04, 90% CI [0.02, 0.06]; SRMR = 0.05; CFI = 0.93; TLI = 0.91.

Step 2 tests whether FR predicts children's RD above and beyond emergent literacy, HLE, parents' education, gender and children's interest in literacy at the onset of formal reading instruction. FR was entered at step 2 both as a direct factor and as an indirect factor via phonemic awareness. Letter knowledge, family risk and indirect effect of letter knowledge via HLE were significant predictors of children's RD while accounting for HLE, parents' education, gender and children's interest in literacy at the onset of formal reading instruction (Table 3). Negative significant estimate values were obtained for letter knowledge directly (-.30) and indirectly via HLE (-.17), indicating the better the letter knowledge at the onset of formal reading instruction, the less likely the child would develop RD at the end of Grade 2.

However, FR status provided a positive significant value (.21) and the odds ratio for group differences in reading was higher than one (3.13). In other words, children with a positive FR status were three times as likely to develop RD, compared with children without FR. At Step 2, contribution of phonemic awareness was marginal ( $p < .06$ ) and no longer significant either directly or indirectly via HLE. The amount of total explained variance ( $R^2$ ) in children's RD after adding FR at Step 2, increased by 3.9%, indicating that FR predicts children's RD above and beyond emergent literacy, HLE, parents' education, gender and children's interest in literacy. We also tested a model that included only direct effect of family risk. In this model, the prediction patterns were similar. Letter knowledge along with direct effect of family risk were the only significant direct predictors, and the total explained variance was ( $R^2$ ) 37.9%.

**Table 3 Logistic regression analyses: Contribution of Family risk in Prediction of Second-Grade RD above and beyond Preschool Vocabulary, Emergent Literacy, and HLE (as a mediation between emergent literacy and second-grade RD)**

	Step 1				Step 2			
	Estimate <sup>a</sup>	SE	OR	95% C. I. <sup>a</sup>	Estimate <sup>a</sup>	SE	OR	95% C. I. <sup>a</sup>
<b>Gender (Boys)</b>	0.06	0.10	1.34	[-0.08, 0.22]	0.02	0.10	1.10	[-0.13, 0.21]
<b>Children's interest in literacy</b>	-0.11	0.12	0.77	[-0.41, 0.12]	-0.11	0.12	0.77	[-0.27, -0.01]
<b>Mother-High-Education</b>	-0.14	0.13	0.49	[-0.42, 0.16]	-0.16	0.13	0.47	[-0.52, -0.01]
<b>Father-High-Education</b>	-0.06	0.11	0.76	[-0.42, 0.24]	-0.02	0.11	0.90	[-0.30, 0.36]
<b>Letter knowledge</b>	-0.29**	0.12	0.79	[-0.56, -0.02]	-0.30*	0.12	0.79	[-0.61, -0.06]
<b>Phonemic awareness</b>	-0.78**	0.39	0.36	[-1.67, -0.23]	-0.73+	0.38	0.41	[-1.18, -0.23]
<b>Vocabulary</b>	-0.09	0.14	0.93	[-0.49, 0.28]	-0.14	0.14	0.91	[-0.42, 0.19]
<b>RAN<sup>b</sup></b>	0.16	0.12	1.02	[-0.26, 0.38]	0.16	0.11	1.02	[-0.04, 0.32]
<b>STM</b>	-0.15	0.11	0.78	[-0.43, 0.07]	-0.13	0.11	0.81	[-0.42, 0.07]
<b>HLE * letter knowledge</b>	-0.16**	0.07	-	[-0.37, -0.01]	-0.17*	0.07	-	[-0.35, -0.01]
<b>HLE * phonemic awareness</b>	-0.68**	0.35	-	[-1.53, -0.21]	-0.62+	0.34	-	[-1.07, -0.21]
<b>HLE * vocabulary</b>	-0.05	0.08	-	[-0.29, 0.16]	-0.08	0.08	-	[-0.27, 0.10]
<b>HLE * RAN</b>	0.08	0.06	-	[-0.24, 0.09]	-0.07	0.06	-	[-0.14, 0.02]
<b>HLE * STM</b>	-0.05	0.04	-	[-0.15, 0.03]	-0.05	0.04	-	[-0.13, 0.03]
<b>Total: HLE * emergent literacy</b>	-1.01**	0.47	-	[-2.10, -0.25]	-0.99*	0.45	-	[-1.42, -0.33]
<b>FR status (direct)</b>	-	-	-	-	0.21**	0.09	3.13	[0.01, 0.47]
<b>Total indirect: FR *HLE *emergent literacy</b>	-	-	-	-	0.04	0.04	-	[-0.11, 0.17]
<b>Total: FR (direct) + FR *HLE *emergent literacy (total indirect)</b>	-	-	-	-	0.25**	.08	-	[0.03, 0.36]
<b>R<sup>2</sup></b>	0.336				0.375			

\* $p < .01$ , \*\* $p < .05$ .

FR, family risk; RD, reading difficulties; HLE, home literacy environment; RAN, rapid automatized naming; OR, odd ratio; CI, confidence interval.

<sup>a</sup>Standardized values

<sup>b</sup>RAN: It was not reversed; lower score in RAN, higher literacy outcomes.

## Discussion

The main aim of the current study was to predict children's later RD in a multifactorial model that included predictors across three different domains: FR, children's individual differences in emergent literacy and vocabulary at the onset of formal reading instruction, and environmental protective factors such as parental education level and HLE.

Previous FR studies had shown that FR is a unique predictor of children's RD above

and beyond emergent literacy (Puolakanaho et al., 2007), emergent literacy and oral language skills (Carroll et al., 2014). The findings from the current multifactorial prediction model demonstrate that parents' self-report of RD, as a proxy for FR status, predicts children's RD at the end of second grade above and beyond emergent literacy while accounting for gender, children's interest in literacy, and environmental factors such as the HLE and parental education. Our multifactorial model indicates that children from a family with parents' self-reporting RD are three times more likely to be identified as having RD at the end of second-grade compared with children from a family with no parents' self-reporting RD. In addition to FR, letter knowledge was another significant predictor of children's RD (Puolakanaho et al., 2007), suggesting that the better the child's letter knowledge at the onset of reading instruction, the lower the risk of them having RD at the end of second grade.

An important and novel finding was the indirect effect of preschool HLE as a protective factor against the risk of second-grade RD. Not only did the HLE, via concurrent emergent literacy, reduce the likelihood of RD at the end of second grade, specifically via letter knowledge and marginally via phonemic awareness but the total indirect effects from emergent literacy via HLE were also significant. This is the advantage of applying a multifactorial model, in which HLE was explored as an environmental protective factor besides the risk factors such as FR and emergent literacy difficulties. This study is the first FR study that empirically highlights the important protective role of HLE against the negative effect of FR and emergent literacy difficulties. In a meta-analysis study of FR research, Snowling and Melby-Lervåg (2016), concluded that data on the HLE of FR children are scarce and suggested that an interaction of genetic and environmental risks and protective factors would determine where the skills of an individual would fall on the continuum of reading difficulties. The current study is a first step to address the interaction between risk and protective factors in prediction of children's RD.

A growing body of research (non-family risk studies), had applied cognitive multivariate/multifactorial models to predict children's RD (Bishop & League, 2006; Catts et al., 2017; McCardle et al., 2001; McGrath et al., 2011; Pennington et al., 2012). However, these studies did not include FR or environmental protective factors such as parents' education and HLE. For example, Catts et al. (2017), in a multifactorial model including phonemic awareness, RAN and oral language, found that children with and without RD did not differ significantly in their oral language, RAN or in the co-occurrence of deficits in these areas with phonological deficits. They argued that neither oral language nor RAN served as protective factors for children with a deficit in phonological awareness; however, neither FR nor the HLE was controlled in their study. In *step 1* of our multifactorial model, phonemic awareness was strongly associated with children's RD while accounting for gender, children's interest in literacy, HLE and parental education before adding FR to the model. However, after adding family risk at *Step 2*, phonemic awareness no longer reached significance, although it was marginally associated with children's RD ( $p < .06$ ). Interestingly, the association between children's RD and the indirect effects of phonemic awareness via the HLE failed to reach significance after adding FR to the multifactorial model at *Step 2*.

The majority of previous FR research included a direct measure of parents' literacy

skills in addition to parents' self-report of RD, partly because the validity and reliability of self-report of RD had not yet been documented. In addition, many of these studies had relatively small sample sizes, allowing for parents' literacy skills to be directly assessed. Nevertheless, the handful of studies that have used parents' self-report as a single measure to identify emergent literacy difficulties in FR children (Carroll & Snowling, 2004; Esmaeeli et al., 2017) observed emergent literacy difficulties in FR children compatible with those from FR studies that used literacy tests in addition to parents' self-report of RD. Although the current study is a correlational study and therefore it cannot discuss the causal mechanisms underlying children's RD; our findings extend previous research by demonstrating substantial associations between parental self-report of RD and their children's emergent literacy before formal reading instruction and also with their reading skills after two years of formal reading instruction.

### **Parents' Self-report of RD and Children's Literacy Outcomes in Second Grade**

We found that FR status identified significant group differences in children's word reading at the end of Grade 2 but not in their spelling or reading comprehension. Differences in reading comprehension were however close to significant ( $p = .06$ ). One explanation for this could be that the measure of word reading was timed, while the time frame for both spelling and reading comprehension tasks were reasonable sufficient. In addition, "only" 36% of the FR children had RD, while the majority (64%) of the FR children were classified as typical readers by the end of Grade 2 and therefore they would not necessarily be expected to exhibit difficulties across all literacy outcomes. These findings are in line with those from Snowling and Melby-Lervåg (2016) in which they reported that while FR-RD children showed persistent difficulties in a range of literacy skills including word reading, spelling and reading comprehension, FR-TR children only exhibited difficulties in some literacy outcomes.

Furthermore, parental education, especially maternal education, has been suggested as a possible explanation for the association between FR and HLE. In the present study, maternal education did not differ between FR and Not-FR children, but paternal education was significantly lower in the FR group compared with the Not-FR group (see Table 1). These results are a possible explanation for why the HLE did not differ between FR and Not-FR children, consistent with findings from Torppa et al. (2007) and Elbro, Borstrom, et al. (1998).

The lack of significant difference in maternal education and HLE between FR and Not-FR groups of children is another potential explanation for why FR children performed similarly to Not-FR children in some measures of emergent literacy (e.g., letter knowledge, RAN and vocabulary) and consequently literacy outcomes such as spelling and reading comprehension (Hart et al., 2009; Nation & Snowling, 2004; Niklas & Schneider, 2015; Torppa et al., 2011; van Bergen et al., 2011). These latter findings support the results from the meta-analysis of FR studies indicating that a phonological deficit is a primary risk factor for children with FR of RD (Snowling & Melby-Lervåg, 2016).

### **Limitations and Future Research**

This study had several limitations that may direct future research. The present study relied on parents' questionnaires to measure HLE, similar to the majority of previous research. Parents'

questionnaires are an indirect measure which may be open to social desirability bias; although in the current study, the HLE correlated with children's outcomes on the concurrent measures of emergent literacy suggesting convergent validity. Given the potential disadvantage of questionnaires for parents with RD, we also tried to make our HLE questions as simple as possible with only multiple-choice answers.

The second issue is related to the inconsistent previous findings of HLE in the context of FR, as already discussed. Compatible with some previous studies (Elbro, Borstrom, et al., 1998; Torppa et al., 2007), the HLE did not differ between FR and Not-FR families in our study. However, these results are inconsistent with several other studies (Dilnot et al., 2017; Esmaeeli et al., 2017; Hamilton et al., 2016). We argue that non-significant differences of maternal education might be a possible reason for such incompatible results. However, the association between FR and the HLE, and the role of parental education in this context, remains to be determined in future research.

Third, our multifactorial prediction model suggests the HLE can operate as an environmental protective factor; however, studies on the HLE of FR children are scarce. It remains to be determined in future research which kind of parent-child activities might be more or less effective to help emergent literacy and later literacy development of FR children.

Finally, the current findings suggest there are complex interactions between FR, HLE, children's emergent literacy and their later literacy outcomes. Longitudinal studies are needed to clarify the development of emergent literacy and later literacy skills across time.

### **Conclusion and Implications of the Results**

Our multifactorial prediction model shows that children whose parents' self-reported RD are almost three times more likely to have RD at the end of second-grade compared to children whose parents did not self-report RD. This important finding adds to our understanding of RD and FR of RD, suggesting parents' self-report of RD can be used as a proxy for FR. Consequently, researchers dealing with large scale studies could use this simple but valuable tool. Many previous FR studies had small sample sizes, possibly because of practical issues surrounding the administration of literacy tests to parents.

In addition to theoretical implications, the current findings have practical implications for parents, teachers working with preschoolers and primary school students, and practitioners in the field of literacy difficulties. First, parents' self-report of RD can be a simple but valuable tool to screen at-risk children, although it is not sufficient to identify children with RD. Second, and perhaps most importantly, teachers and practitioners should be aware that the risk of developing later RD is almost three times higher for FR children with emergent literacy difficulties compared with Not-FR children with emergent literacy difficulties. Therefore, practitioners working with preschoolers and kindergarten children should give an extra concern when there is a self-report of RD for parents in addition to emergent literacy difficulties. Third, we cannot rule out the important role of preschool HLE although it was not a direct predictor of children's RD at the end of second grade. As suggested earlier in our multifactorial model, the preschool HLE can act as an environmental protective factor against possible risk factors such as FR and emergent literacy difficulties for the development of



children's emergent literacy and later literacy skills. Hence, families, especially parents with RD or a history of RD, should be advised about the crucial role of emergent literacy and what they might be able to do to enhance or improve their children's emergent literacy in order to smooth the path of literacy development. Most parents, with and without RD, are able to provide support for the learning of letters and sounds prior to school via shared-reading activities in the home.

In conclusion, our data support the use of a multifactorial deficit model (Pennington, 2006; van Bergen et al., 2014) as a way of better understanding literacy difficulties. Our multifactorial prediction model for RD suggests that children whose parents' self-report RD, demonstrate reading difficulties that cannot be explained solely in terms of their individual differences in gender, interest in literacy, emergent literacy, or even differences in their immediate preschool environment such as the HLE and parental level of education. We propose that although FR increases the likelihood of developing RD, the preschool HLE can operate as a protective environmental factor to enhance children's emergent literacy directly and their later literacy skills indirectly.

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## ***Study III***

This paper is not yet published  
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