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Early cognitive predictors of PISA reading in children with and without family risk for dyslexia

Kenneth Eklund[a,*], Minna Torppa[b], Sari Sulkunen[c], Pekka Niemi[d], Timo Ahonen[e]

[a] Faculty of Education and Psychology, University of Jyväskylä, Finland
[b] Department of Teacher Education, University of Jyväskylä, Finland
[c] Department of Languages, University of Jyväskylä, Finland
[d] Department of Psychology, University of Turku, Finland
[e] Department of Psychology, University of Jyväskylä, Finland

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ABSTRACT

This study examined language skills and pre-literacy skills (phonological awareness, rapid naming, and letter knowledge) before school-age as predictors of PISA reading at age 15 in two groups of children, with (n = 88) and without (n = 70) family-risk for dyslexia. Moreover, effects of family-risk on these early predictors, reading fluency, and PISA reading were examined while controlling the effect of gender. Children were followed from age 2 to 15. Family-risk had a significant effect on early language and pre-literacy skills, reading fluency and PISA reading. A similar model predicting PISA reading fitted the data well in the Family-risk and the No family-risk group. Language skills explained a good portion and pre-literacy skills to a lesser extent the variance in PISA reading. Altogether 68% of the variance in PISA reading was explained in the Family-risk group and 44% in the No family-risk group. Findings suggest that family risk sets children at elevated risk to develop long-standing difficulties in language and literacy and that the early language and pre-literacy skills are strong predictors of reading as far as PISA reading at age 15.

1. Introduction

It is well documented that a substantial proportion, 34%–66%, of children with a family history of dyslexia have severe difficulties in reading and spelling acquisition during their first grades at school (Pennington & Lefly, 2001; Puolakanaho et al., 2007; Scarborough, 1990; Snowling, Callagher, & Frith, 2003). For most individuals these difficulties sustain into adolescence even in transparent orthographies (Eklund, Torppa, Aro, Leppänen, & Lyytinen, 2015; Landerl & Wimmer, 2008; Torppa, Eklund, van Bergen, & Lyytinen, 2015). Not only have children with dyslexia compromised pre-literacy skills, i.e., phonological awareness, rapid automatized naming, and letter knowledge (e.g. Boets et al., 2010; Snowling et al., 2003; Snowling, Muter, & Carroll, 2007; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010; van Bergen et al., 2010; van Bergen, de Jong, Plakas, Maassen, & van der Leij, 2012), but also difficulties in early receptive and expressive vocabulary (see Snowling & Melby-Lervåg, 2016, for review and meta-analysis), another cornerstone of reading comprehension besides word identification (Perfetti & Hart, 2001). In our prior report from the Jyväskylä Longitudinal Study of Dyslexia (JLD), we found not only that children with a family history of dyslexia were overrepresented in the subgroup of slow decoders, but also that twice as many children with family-risk for dyslexia compared to control children were in the group of poor readers, with poor performance in both word recognition and reading comprehension in Grade 2 (Torppa et al., 2007). In the present study, we extend our investigation until Grade 9 (age 15–16) and broaden our reading outcome from reading fluency and reading comprehension to PISA reading literacy. We examine to what extent children's performance in PISA reading can be predicted by early language skills, on one hand, and pre-literacy skills, i.e., phonological awareness, rapid naming, and letter knowledge through reading fluency at school age, on the other hand. Moreover, the effect of family-risk on these early predictors and reading measures, as well as on their associations is examined while controlling for the effect of children's gender.

1.1. PISA reading literacy

The OECD Program for International Student Assessment (PISA), conducted once every three years from the year 2000, was to “set up to measure how well young adults near the end of compulsory schooling

* Corresponding author at: Faculty of Education and Psychology, P.O. Box 35, 40014 University of Jyväskylä, Finland.
E-mail addresses: Kenneth.M.Eklund@jyu.fi (K. Eklund), Minna.P.Torppa@jyu.fi (M. Torppa), Sari.Sulkunen@jyu.fi (S. Sulkunen), peknie@utu.fi (P. Niemi), Timo.P.S.Ahonen@jyu.fi (T. Ahonen).

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are prepared to meet the challenges of today's knowledge societies" (OECD, 2002, p. 3). Reading is one of the three target areas assessed in PISA, the other two being mathematics and science. In reading, PISA intends to assess skills which go beyond decoding and reading comprehension, i.e. reading literacy, that involve "an individual's capacity to: understand, use, reflect on and engage with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society" (OECD, 2009, p. 14). In other words, decoding and reading comprehension are seen as basic skills that enable readers to employ reading as a tool for the acquisition of new information, although, to make full use of printed material, other skills are needed as well. The skills claimed to be required for success in PISA reading literacy tasks include decoding, knowledge of words, grammar and other linguistic skills, textual structures and features, and metacognitive knowledge (OECD, 2009). To assess these skills, several texts which challenge students' ability to find, select, interpret and evaluate information are included in the PISA reading tasks (OECD, 2009).

Research on cognitive prerequisites, not to mention predictors, related to PISA reading literacy is limited. This is understandable as "improving the quality of education" (OECD, 2002, p.12) has been the major policy initiative in the Organization for Economic Co-operation and Development (OECD), not the origin of students' literacy skills per se. According to a study of Arnbak (2012), concurrently measured word recognition and vocabulary together explained about 40% of the variance in PISA reading scores. Artelt, Schiefele, and Schneider (2001) showed that concurrently measured decoding speed explained about 13% of the variance in PISA reading literacy. Finally, in a recent study with Finnish students focusing on gender differences in PISA reading, concurrently assessed reading fluency was found to be the main predictor of PISA reading explaining approximately 15% of its variance (Torppa, Eklund, Sulkunen, Niemi, & Ahonen, 2018). However, no cognitive measures were included in that study.

1.2. Cognitive predictors of reading comprehension

According to the lexical quality hypothesis (Perfetti & Hart, 2001) and the Simple View of Reading (Gough & Tunmer, 1986), word recognition and vocabulary are the basic building blocks for reading comprehension. Efficient decoding has generally been seen as necessary for reading comprehension – one has to decipher letter strings, first in words and ultimately in sentences and texts, to be able to understand their meaning. Well automatized word reading skills free up resources for higher-level processing (Perfetti, 1985), supporting reading comprehension. Empirical findings have revealed a strong link between fluent word reading skills and reading comprehension (for a recent meta-analysis of factors affecting the strength of this relationship, see García & Cain, 2014). The link is very strong in the early grades, after which its role is diminished, particularly in transparent orthographies (for a meta-analysis in different orthographies, see Florit & Cain, 2011), although not ceasing to exist (Artelt et al., 2001; Verhoeven & van Leeuwe, 2008). On the other hand, according to the Simple View of Reading (Gough & Tunmer, 1986), a subgroup of poor comprehenders without difficulties in decoding also exists. Accordingly, several studies have shown that at least average text comprehension is possible also for inaccurate or slow decoders (Catts, Adlof, & Weismer, 2006; Nation, Clarke, Marshall, & Durand, 2004; Torppa et al., 2007).

Moreover, a strong link has also been found between vocabulary and reading comprehension (e.g. Muter, Hulme, Snowling, & Stevenson, 2004; Nation & Snowling, 2004; Torppa et al., 2007; Verhoeven & van Leeuwe, 2008). Vocabulary has been reported to account for the variability of subsequent reading comprehension even after taking into account the effect of word reading (e.g. Olson et al., 2011). Besides vocabulary, linguistic processes involved in the comprehension of oral language, such as parsing sentences, drawing interferences, and integration of information (Hoover & Gough, 1990; Verhoeven & van Leeuwe, 2008), as well as semantic knowledge, syntactic knowledge, and background knowledge have been shown to be tightly connected to reading comprehension (for a review on low-progress readers, see Tan, Wheldall, Madelaine, & Lee, 2007).

1.3. Effects of family-risk for dyslexia on reading development

Children with family-risk for dyslexia are in high risk for performing poorly in PISA reading. This is due to, first, their elevated risk for compromised word reading skills: their risk for reading disability is four to tenfold when compared to children without family-risk (Pennington & Lefly, 2001; Puolakanaho et al., 2007; Scarborough, 1990; Snowling et al., 2003). Second, as the same genes which are largely behind learning disabilities are expected to be behind cognitive abilities as well (the generalist genes hypothesis, see Kovacs & Plomin, 2007; Plomin & Kovacs, 2005), compromised skills of family-risk children are not expected to be restricted to word reading and its pre-requisites, but broader language skills are probably affected, too. According to the ideas of the Multiple deficit model of dyslexia (Pennington, 2006; van Bergen, van der Leij, & de Jong, 2014), the offspring of parents with dyslexia are expected to inherit various amounts of risk factors in several domains from their parents (e.g. Bishop, 2009; Pennington, 2006; Snowling et al., 2003). As a consequence, the inherited risk factors are, at the individual level, expressed in various amounts of word reading difficulties, compromised language skills, and their combinations.

Empirical findings have confirmed that children with dyslexia have compromised pre-literacy skills, i.e., phonological awareness, rapid automatized naming, and letter knowledge (e.g. Boets et al., 2010; Snowling et al., 2003, 2007; Torppa et al., 2010; van Bergen et al., 2010, 2012). They have also been shown to be capable of sight word reading or processing large chunks of graphemes later in their development than their age-mates (Eklund et al., 2015; Zoccolotti et al., 2005). Moreover, family-risk children with dyslexia have been shown to have deficient skills in early receptive and expressive vocabulary (e.g. Snowling et al., 2007; Torppa et al., 2010) already before school age. Even the children with family-risk who do not fulfill the criteria of dyslexia have usually been shown to perform between the level of controls and children with dyslexia in several pre-literacy, language and literacy skills both prior to and after school entry (e.g. Pennington & Lefly, 2001; Snowling et al., 2003; van Bergen et al., 2010, 2012), although these differences have not always been statistically significant (Boets et al., 2010; Eklund et al., 2015; Torppa et al., 2010).

In spite of the compromised pre-literacy skills of family-risk children before school-age the reading comprehension outcome of these children is not clear. On one hand, English-speaking family-risk children with reading disability have been shown to have poor reading comprehension skills at 12–13 years of age (Snowling et al., 2007). On the other hand, family-risk children who do not develop reading problems have been shown to overcome their shortcomings in language skills by the time of formal schooling, and not differing from children without family-risk in their reading comprehension skills at 12–13 years of age (Snowling et al., 2007; Snowling & Melby-Lervåg, 2016). In the present sample family-risk has been shown to be linked to reading comprehension difficulties in grades 1–2 but only when accompanied by reading fluency difficulties: approximately twice as many children were classified as poor readers, i.e. having difficulties both in reading fluency and reading comprehension, in the family-risk group compared to children without family-risk, (17% vs. 9% respectively), (Torppa et al., 2007). The finding is, however, based on very early phase of reading acquisition when reading comprehension is still strongly dependent of reading fluency and it is possible that by the age of PISA assessment in grade 9 the situation has changed.

1.4. Effects of gender on reading skills

Gender differences have been clear in PISA reading performance,