Anna-Kaija Eloranta

A Follow-up Study of Childhood Learning Disabilities

Pathways to Adult-age Education, Employment and Psychosocial Wellbeing

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Editors
Noona Kiuru
Department of Psychology, University of Jyväskylä
Päivi Vuorio
Open Science Centre, University of Jyväskylä

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ABSTRACT

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This study examined the relations of childhood learning disabilities (LDs) to education, employment and psychosocial wellbeing in adulthood. The first aim was to find out to what extent childhood reading disability (RD) continues into adulthood and its links with various adult-age outcomes. The second aim was to study the relations of subtypes of childhood LDs (RD, mathematical disability (MD), RD+MD) to depression, anxiety and unemployment in adulthood. The third aim was to explore which factors in childhood and adolescence affect the relations of childhood LDs to adult-age outcomes. Two datasets were examined: 1), a sample of 48 adults with childhood RD and 37 matched controls without documented childhood RD (Studies I and II), and 2), life-long register-based data on 430 individuals with childhood LDs (RD, MD, or RD+MD) and 2 149 matched controls (Study III), with annual diagnose-based allowances and reimbursements available. Nineteen (39.6%) adults with childhood RD were found to have continuing reading fluency problems (adult-age RD). Rapid automatized naming (RAN) was slower and unemployment more frequent in the group with adult-age RD than in the non-adult-age RD and control groups. Educational attainment was lower in the childhood RD group than in the controls. In the childhood RD group, the lower the reading skills, the more problems were reported in adult-age psychosocial wellbeing. Childhood LDs were related to diagnosed depression and anxiety and with unemployment. Differences between the subtypes of LDs in adult-age outcomes were minor. Adolescence was pivotal in predicting adulthood: along with childhood RAN and RD, support experienced in adolescence explained adult reading fluency. Moreover, psychiatric problems in adolescence mediated the relation of LDs to adult-age depression, anxiety and unemployment. As it was shown that it is not the LD as such but rather the continuity of the difficulty and the secondary problems related to the LD that influence later life, the findings call for a holistic approach in LD research that includes cognitive, psychosocial and environmental factors in a lifespan perspective. Special educational and social support for individuals with LDs should be extended beyond adolescence, as they have benefits at both the individual and societal level.

Keywords: learning disability, reading disability, mathematical disability, adult, follow-up, longitudinal, depression, anxiety, education, unemployment

TIIVISTELMÄ (FINNISH ABSTRACT)

Eloranta, Anna-Kaija
Seurantatutkimus lapsuudessa todetuista oppimisvaikeuksista: Polut koulutukseen, työllistymiseen ja psyykkiseen hyvinvointiin.
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Tässä tutkimuksessa tarkasteltiin lapsuudessa todettujen oppimisvaikeuksien yhteyksiä koulutukseen, työllisyyteen ja psyykkiseen hyvinvointiin aikuisiässä. Ensimmäinen tavoite oli tutkia, missä määrin lukemisen ja kirjoittamisen erityisvaikeus (lukivaikeus) jatkuu aikuisuudessa ja jatkumisen yhteyksiä aikuisikään. Toinen tavoite oli tutkia eri oppimisvaikeustyyppien (lukivaikeus, matematiikan vaikeus ja yhtäaikainen luki- ja matematiikan vaikeus) yhteyttä masennukseen, ahdistukseen ja työttömyyteen aikuisena. Kolmas tavoite oli tunnistaa mitkä tekijät lapsuudessa ja nuoruudessa vaikuttavat oppimisvaikeuksien ja aikuisiän yhteyksiin. Tutkimuksessa käytettiin kahta aineistoa: 1) aineistoa 48 aikuisesta, joilla oli lapsena todettu lukivaikeus ja heidän 37 verrokistaan, joilla ei ollut todettu lukivaikeutta ja 2), rekisteriaineistoa 430 oppimisvaikeustaustaisen aikuisen ja 2149 verrokin vuosittaisista, diagnoosien pohjalta saaduista korvauksista. Lukivaikeustaustaisista aikuisista 19:llä (39.6%) oli yhä lukusujuvuuden vaikeus. He olivat hitaampia nopeassa sarjallisessa nimeämisessä ja työttömyys oli heillä yleisempää kuin verrokeilla ja aikuisilla, joiden lukivaikeus ei ollut jatkunut. Lukivaikeustaustaiset aikuiset raportoivat sitä enemmän psyykkisen hyvinvoinnin ongelmia mitä heikompi lukusujuvuus oli. Lukivaikeustaustaisten aikuisten koulutustaso oli keskimäärin matalampi kuin verrokkien. Lapsuuden oppimisvaikeudet olivat yhteydessä masennukseen, ahdistukseen ja työttömyyteen aikuisena riippumatta oppimisvaikeuden tyypistä. Nuoruusvaihe osoittautui keskeiseksi: nuoruudessa koetun tuen määrä lähiympäristöltä oli osaltaan yhteydessä siihen, jatkuivatko lukusujuvuuden ongelmat. Lisäksi psykiatriset ongelmat nuorena lisäsivät riskiä aikuisiän masennukseen, ahdistukseen ja työttömyyteen. Tulokset osoittavat, että oppimisvaikeus ei sinänsä ole suoraan yhteydessä aikuisiän ongelmiin, mutta vaikeuden jatkuminen tai vaikeuteen liittyvät toissijaiset ongelmat vaikuttavat aikuisikään. Tulosten perusteella oppimisvaikeustutkimuksessa tarvitaan kokonaisvaltaista otetta, jossa huomioidaan sekä kognitiiviset että psykososiaaliset tekijät eri elämänvaiheissa. Erityisopetusta ja sosiaalista tukea henkilöille, joilla on oppimisvaikeus tulisi jatkaa myös nuoruusiän yli, koska sillä on merkitystä niin yksilöllisellä kuin yhteiskunnallisella tasolla.

Avainsanat: oppimisvaikeus, lukivaikeus, matematiikan oppimisvaikeus, aikuisuus, seuranta, pitkittäistutkimus, masennus, ahdistus, koulutus, työttömyys

Author's address

Anna-Kaija Eloranta
Department of Psychology
PL 35
FI-40014 University of Jyväskylä
Email: anna-kaija.eloranta@jyu.fi

Supervisors

Docent Tuija Aro
Department of Psychology
University of Jyväskylä, Finland

University researcher Vesa Närhi
Department of Education
University of Jyväskylä, Finland

Professor emeritus Timo Ahonen
Department of Psychology
University of Jyväskylä, Finland

Reviewers

Professor Julia Carroll
Centre for Global Learning, Education and Attainment
Coventry University, United Kingdom

Professor George Hynd
College of Education
University of Georgia, United States of America

Opponent

Professor George Hynd
College of Education
University of Georgia, United States of America

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LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following three original studies:

I Eloranta, A-K., Närhi, V. M., Eklund, K. M., Ahonen, T. P. S., & Aro, T. I. (2019). Resolving reading disability – Childhood predictors and adult-age outcomes. *Dyslexia, 25,* 20-37.

II Eloranta, A-K., Närhi, V., Ahonen, T., & Aro, T. (2019). Does childhood reading disability or its continuance into adulthood underlie problems in adult-age psychosocial well-being? A follow-up study. *Scientific Studies of Reading, 23,* 273-286.

III Eloranta, A-K., Närhi, V. M., Muotka, J. S., Tolvanen, A. J., Korhonen, E. L., Ahonen, T. P. S., Aro, T. I. (2019). Psychiatric problems in adolescence mediate the association between childhood learning disabilities and later wellbeing. Submitted manuscript.

Taking into account the instructions given and comments made by the co-authors, the author of this dissertation conducted the analyses and wrote the reports of the three individual publications as the first author. She also actively participated in the planning and realization of the data collection.

FIGURE

TABLE

CONTENTS

1 INTRODUCTION

Specific learning disabilities (LDs) are a group of neurologically based disorders that hamper the development of certain cognitive functions related to academic skills, that is, reading or mathematical skills, thereby making learning more difficult or slower than expected for approximately 5 to 15 percent of children (American Psychiatric Association, 2013). Research on LDs has for the most part focused on school-aged children and adolescents. It has also focused strongly on the impact on learning of different types of LDs and on the cognitive factors underlying LDs, as in the associations of phonological awareness or rapid automatized naming (RAN) with reading disability (RD), which are among the most extensively studied topics (see Araújo, Reis, Petersson, & Faísca, 2015; Georgiou & Parrila, 2013, for reviews).

However, as the existing research widely accepts that these disabilities are persistent and typically continue through adolescence into adulthood (e.g., Gerber, 2012; Maughan et al., 2009), LDs do not merely affect the school years or a specific skill domain but can also have an impact on adult life in multiple ways. Metaphorically, LDs are like an extra backpack that the individual carries throughout the school career and beyond, the weight of which does not necessarily lighten over the years. Instead, the backpack may be further packed with loads of diverse kinds over the years; these may initially be related to the primary difficulty of formal learning but may later also be related to problems in acquiring further education (McLaughlin, Speirs, & Shenassa, 2014), in working life (e.g., McLaughlin et al., 2014), and in self-esteem (Carawan, Nalavany, & Jenkins, 2015), mood, and other domains related to mental wellbeing (Wilson, Armstrong, Furrie & Walcot, 2009). Thus, while the specific cognitive deficit itself may be understood as an obstacle on its own, the secondary problems may be of equal or even greater hindrance to the individual during the life course. Hence, studying LDs longitudinally and in a broader context that goes beyond academic skills, school achievement or cognitive deficits is of paramount importance.

Despite the risks presented by LDs, a considerable proportion of individuals with LDs do not encounter problems or suffer from continuation of the cognitive deficit caused by their specific LD, and cope well in adulthood. A

few celebrated follow-up studies have examined LDs in the life course and investigated not only the continuity of the disability and its secondary consequences but also investigated possible protective factors (e.g., Maughan et al, 2009; Werner, 1993; Undheim, 2009). However, longitudinal studies of LDs that have used documented childhood data and followed individuals into adulthood remain rare. Hence, current knowledge of the factors that may have implications for the adult-age outcomes of individuals with childhood LDs, such as education, employment or psychosocial wellbeing, is poor. These factors may be multi-level, for example, the cognitive factors underlying the LD and the related psychological, social or societal factors, and thus call for a multi-level approach. Moreover, while most longitudinal studies have focused on RD, as it is the most prevalent disability, they have not necessarily controlled for possible comorbidities with other LDs, such as mathematical disabilities (MD), or for psychosocial problems. This makes it difficult to conclude which of the potential underlying factors impact or mediate adult-age outcomes.

The aim of the present research was to extend the existing literature by scrutinizing the continuum of LDs in a sample of individuals with a documented childhood LD. To address this challenge, two datasets derived from the same sample were used: one comprising individual assessment data gathered from adults with childhood RD but no comorbid problems, and another larger dataset combining childhood neuropsychological assessment data with adult-age data drawn from national registers, including groups with documented childhood RD, MD or both and a control group. These two datasets enabled a detailed examination of whether distinct types of LDs (i.e., RD, MD, and comorbid RD+MD) have different associations with adult-age outcomes and examination of the associations between several childhood factors and adult-age outcomes. The target adult-age outcomes in the present research were reading skills and cognitive skills along with education, employment and psychosocial wellbeing.

1.1 Defining LDs

LDs refer to an array of various disorders that derive from neurological dysfunction and that interfere with the acquisition and use of such skills as reading, writing, reasoning, or mathematics (National Joint Committee on Learning Disabilities, NJCLD, 1990/2016). LDs occur independently of other disabilities (e.g., intellectual or sensory disabilities, emotional problems), language or cultural differences, or of deficient teaching, but may exist concomitantly with these conditions (NJCLD, 1990/2016).The prevalence of LDs is estimated to be 5 to 15 percent internationally (American Psychiatric Association, 2013). Although each specific LD has distinct characteristics, differentiating and defining LDs is considered problematic for several reasons (Fletcher, Lyon, Fuchs, & Barnes, 2018; pp. 11-18). One problem in defining LDs is that they are rather unanimously agreed to exist on a continuum and be normally distributed, meaning that the skills of individuals with LDs compared

to peers without LDs do not manifest qualitative differences (Fletcher et al., 2018). Due to this dimensional nature of LDs, specifying a cut-off criterion for an LD is always somewhat arbitrary, since a natural, absolute cut-off for a deficit in the skill in question does not exist.

Another reason for the difficulty in defining LDs is that comorbidity, that is, the co-occurrence of different LDs and of LDs and other developmental disorders, such as attention-deficit hyperactivity disorder (ADHD) or speech and language disorders, is typically present in the same individual (Fletcher et al., 2018; Wilson et al., 2015). Of children diagnosed with either RD or ADHD, 15 to 30 percent have subsequently been found to have the other disorder as well (Mayes, Calhoun, & Crowell, 2000; Willcutt et al., 2012). Comorbidity between MD and ADHD, although more rarely studied (see Peterson et al., 2017), has been found to be around 18 to 30 percent (Capano, Minden, Chen, Schacher, & Ickowicz, 2008; Mayes et al., 2000). Moreover, estimates of the comorbidity of RD and MD vary between 30 to 70 percent (Badian, 1999; Koponen et al., 2018; Kovas et al., 2007; Landerl & Moll, 2010). Thus, comorbidity is relatively common, despite differences in estimates owing, for example, to whether it is measured in clinical or in population-based samples. Each disability has its own distinct characteristics, and these may hamper the individual's life in different ways. Some earlier findings have suggested that problems related to LDs, such as problems of psychosocial wellbeing, may accumulate if LDs overlap (Willcutt et al, 2013). Therefore, controlling for comorbidity, which has not been done sufficiently often in earlier research on LDs, is essential if the aim is to examine aspects related to a specific LD.

Despite the problems of defining different LDs, a cut-off criterion was applied in all three sub-studies comprising this dissertation. For each LD, the commonly applied cut-off of -1.5 standard deviations in test scores was used. However, in the present clinical sample, this definition of childhood LD can be considered reliable: substantial problems in learning had already been identified at school and/or at home, and the child subsequently referred for clinical assessment. Afterwards, the comprehensive assessment data were scanned and only children who had exhibited a marked learning problem in the assessments, that is, test scores below -1.5 standard deviations either in reading or mathematics or both, were included in the sample. Despite the advantage of a reliable definition of LD, the clinical sample suffers from the limitation that, due to the referral process, it does not represent the LD population in general. Rather, the sample represents individuals with LDs who have been referred for clinical assessment via which they have possibly received counselling and support.

The problematic issue of comorbidity was controlled for in Studies I and II of this dissertation by scrutinizing a sample of individuals with RD but without childhood MD, attention problems or psychosocial problems. This enabled a focus on the associations of a single, specific LD with adult-age reading and cognitive skills, education, employment, and psychosocial wellbeing. Furthermore, different types of LDs (i.e., RD, MD, RD+MD) were studied in a larger sample to more thoroughly examine their associations with adult-age

outcomes related to employment, depression and anxiety, so as to allow comparison of the effects of different subtypes and combinations of LDs.

Reading disability as the most prevalent LD

Reading disability (RD), or dyslexia, is the most common LD (see Shaywitz, Morris, & Shaywitz, 2008), with prevalence estimates ranging from 3 to as high as 20 percent (see Phillips & Odegard, 2017; Snowling, 2013; Youman & Mather, 2013). Owing to its prevalence, RD has been extensively studied, and its characteristics and underpinnings are the most well-known of all LDs (see Fletcher et al., 2018; Shaywitz et al., 2008). RD is defined as a deficit hindering accurate and/or fluent reading of words as well as spelling and decoding skills (International Dyslexia Association, IDA, 2002), with secondary consequences, such as problems in reading comprehension and inadequate reading exposure, that often result in poor vocabulary and general knowledge (IDA, 2002). A deficit in the phonological processes of language has traditionally been considered as the most typical predictor of RD (e.g., IDA, 2002; Carroll, Solity, & Shapiro, 2016; Torppa, Eklund, van Bergen, & Lyytinen, 2015), underlying problems in reading accuracy in particular (e.g., Kairaluoma, Torppa, Westerholm, Ahonen, & Aro, 2013). Rapid automatized naming (RAN), that is, the ability to fluently name successive familiar items such as numbers and letters, is another extensively studied factor typically underlying reading (see Araújo et al., 2015; Georgiou & Parrila, 2013, for reviews), deficit in which has been connected mostly to problems of reading fluency (e.g., Georgiou, Ghazyani, & Parrila, 2018; Heikkilä, Torppa, Aro, Närhi, & Ahonen, 2015; Landerl et al., 2019; Papadopoulos, Spanoudis, & Georgiou, 2016). Recently, RAN has been found to be an even more consistent and universal predictor of reading skills than phonological processing (e.g., Landerl et al., 2019). Despite the well-established strong relation between RAN and reading skills, the question of which cognitive factors underlie this relation remains unresolved and continues to be an interest of researchers in the reading domain (e.g., Georgiou et al., 2018; Heikkilä et al., 2015; Landerl et al., 2019; Papadopoulos et al., 2016). Among several other proposals, two extensively studied possible cognitive factors underpinning the RAN-reading relationship, or common denominators of RAN and reading skills, are general processing speed (e.g., Papadopoulos et al., 2016) and working memory capacity (WM; Cowan et al., 2017; Papadopoulos et al, 2016).

In the case of the two core deficits of RD discussed above, the deficit in phonological processing is known to be persistent (e.g., Svensson & Jacobson, 2006; Wilson & Lesaux, 2001). Moreover, RAN is known to be a strong long-term predictor of RD (Landerl & Wimmer, 2008), and the relation between RAN and reading skills has also been established as persistent (e.g., Araújo et al., 2015, for a review; Vaessen & Blomert, 2010). However, as longitudinal studies of RD extending beyond early adulthood are scarce, findings on the long-term linkages of phonological skills and RAN with reading remain scarce. Hence, owing to the persistent nature of both skill domains, the possible impact of phonological skills

and RAN merit consideration when studying RD, particularly when the continuance and long-term development of RD into adulthood is of interest. Another factor that is important to consider in the research on RD is that the most salient features of reading differ across orthographies. Variation in the consistency of letter-sound correspondences between orthographies has consequences on how different aspects of reading, such as fluency and accuracy, develop (Landerl & Wimmer, 2008; Seymour, Aro, & Erskine, 2003), and hence on how reading problems typically manifest themselves. In orthographies with low consistency in letter-sound connections, like English, reading or spelling accuracy is an adequate indicator of reading skills and is commonly used in defining RD. In contrast, in an orthography with highly consistent letter-sound connections, such as Finnish, high accuracy in reading is typically gained at early stage (Aro & Wimmer, 2003), and reading rate is therefore a more fruitful measure in defining RD. This results in varying definitions of reading problems, the emphasis being either on reading fluency (speed), or on accurate decoding.

On the whole, as it is the most frequent and best-characterized LD, and a substantial number of tests have been developed to measure both the deficit itself and the cognitive factors underlying it, RD provides a clear example of an LD and a good starting point for a study on the long-term impacts of LDs continuing into adulthood. Because comorbidity between RD and other LDs has not been controlled for in earlier research, one aim of this study was to exclude possible comorbid LDs and focus on individuals presenting with RD only. Therefore, RD in the absence of comorbid LDs was the focus in two of the studies comprising this dissertation report.

1.2 Continuity of LDs

Although longitudinal research on LDs beyond early adulthood is scarce, various studies conducted over the years generally agree that LDs typically persist beyond adolescence and that the deficits continue, at least to some extent, in adulthood (Bruck, 1992; Gerber, 2012, for a review; Morris, Schraufnagel, Chudnow, & Weinberg, 2009; Raskind, Goldberg, Higgins, & Herman, 1999; Spreen, 1988; Swanson, 2012, for a review; Undheim, 2009; Wilson et al., 2015). Some findings even suggest that individuals with childhood LD tend to fall behind others in their skills development (Maughan et al., 2009). However, different research findings are not always strictly comparable: as longitudinal studies are by definition of long duration, and as knowledge on specific LDs has markedly increased over the last few decades, the initial criteria set for specific LDs in childhood in earlier studies may be very different from those currently in place. Moreover, at least in the older follow-up studies, the exclusion of disorders other than LDs, such as neurological impairments, has not been systematic (e.g., Spreen, 1988), rendering interpretation of the role of LDs in adult-age outcomes problematic. Furthermore, although comorbidity of LDs is common, few studies have clearly reported controlling for it.

As the most frequent LD, RD has been recognized and studied for longer than other LDs, including longitudinally. These RD studies have yielded rather consistent findings on the continuance of the deficit, agreeing that problems in reading and spelling are persistent (e.g., Bruck, 1992, 1993a; Korhonen, 1995; Landerl & Wimmer, 2008; Maughan et al., 2009; Parrila, Georgiou, & Corkett, 2007; Torppa et al., 2015; Undheim, 2009). This finding seems to be consistent across both clinical (Bruck, 1992; Strehlow, Kluge, Möller, & Haffner, 1992) and population-based (Maughan et al., 2009; Undheim, 2009) samples. Nevertheless, follow-up studies on RD have mostly continued as far as adolescence or the early twenties (e.g., Landerl & Wimmer, 2008; Torppa et al., 2015; Undheim, 2009), with only a small minority extending to later adulthood (e.g., Maughan et al., 2009). Furthermore, the emphasis in the longitudinal RD studies has generally been on English-speaking language environments, while findings on adult-age RD in more consistent orthographies like Finnish (Korhonen, 1995; Torppa et al., 2015) and German (Schulte-Körne, Deimel, Jungemann, & Remschmidt, 2003; Strehlow et al., 1992) are scarce. Some of the rarer findings suggest that in more consistent orthographies, the proportion of individuals with continuing reading problems may be somewhat smaller (Schulte-Körne et al., 2003; Torppa et al., 2015) than in English or other more inconsistent orthographies.

In addition, despite the fact that, across studies, persistent reading problems have been found among the majority of adults with childhood RD, the rates of continuance differ substantially, the proportion of individuals whose RD does not continue into adulthood varying from 7 up to 30 percent (Maughan et al., 2009; Parrila et al., 2007; Undheim, 2009). This indicates that a notable proportion of individuals with a history of RD resolve their childhood deficit. In light of these findings, it is somewhat surprising that little research exists on the potential factors affecting the continuance of RD into adulthood. Despite examination of the cognitive factors underlying RD, such as deficits in phonological processing and RAN that appear to have a bearing on the persistence of RD (Araújo et al., 2015; Svensson & Jacobson, 2006), the possible effects of environmental factors on the continuance of RD remain to be explored. Such factors include special educational support and support experienced from significant others, both of which have been found to be associated with psychosocial wellbeing in individuals with RD (Carawan et al., 2016; Ehrhardt, Huntington, Molino, & Barbaresi, 2013; Stack-Cutler, Parrila, & Torppa, 2015). However, their connections with the continuance of RD has not been addressed.

Moreover, knowledge of the extent to which the possible continuance of childhood RD impacts adult-age outcomes, like education, employment, and psychosocial wellbeing, is also poor. Issues related to education, employment and psychosocial wellbeing in the context of LDs are discussed in more detail in the following subsections.

1.3 LDs and relations to educational attainment

As LDs, by definition, primarily affect learning, they can be presumed to have consequences on educational attainment. Indeed, the associations of LDs with low educational attainment are well established in earlier research: individuals with childhood LDs were less likely than peers without LDs to attain any formal qualifications after compulsory education (e.g., Esser, Wyschkon, & Schmidt, 2002; Maughan et al., 2009), at least somewhat less likely to achieve high level of education (e.g., Esser et al., 2002; McLaughlin et al., 2014; Undheim, 2003, 2009; Werner, 1993), or generally more likely to drop out or leave school earlier than peers (e.g., Hakkarainen, Holopainen, & Savolainen, 2015; Maughan et al., 2009; Werner, 1993).

In the Finnish educational system, adolescents choose between academic and vocational postsecondary education at the end of their nine years of compulsory comprehensive education. High school is the more academically demanding option and is often followed by an application for entry into an institution of higher education, that is, a university or university of applied sciences, whereas vocational schools provide their students with qualifications for a practical occupation such as a hairdresser or welder. Lack of a postsecondary educational qualification has traditionally been exceptional in Finland, where nearly all students go on to vocational or high school after compulsory education. During the last decade, the dropout rate from postsecondary education has even decreased from year to year, averaging 5 percent over the years 2016 - 2017 (Statistics Finland, 2019). Hence, not gaining a postsecondary educational qualification can be considered an obvious hindrance when seeking to enter the Finnish labor market. In their study of adolescents in the Finnish educational context, Hakkarainen and colleagues (2013; 2015) found that reading and mathematical difficulties identified in grade 9 predicted both the choice of postsecondary education and dropout during postsecondary schooling, adolescents with learning difficulties being more likely to choose vocational education instead of high school, and to drop out from postsecondary education, that is, from high school or from vocational education, within five years after leaving comprehensive school.

Despite these rather compelling findings on the associations of childhood LDs with lower or unfavorable educational outcomes, the links between LDs and education have rarely been further elaborated in earlier research. First, the extent to which the persistence of childhood LDs is associated with educational attainment in adulthood has rarely been studied. One exception is the study by Maughan and colleagues (2009), who investigated predictors of spelling problems in adulthood in their follow-up study of poor readers and controls with normally developing reading skills. They examined the age of completed education and the highest qualification attained as predictors of adult reading skills. Both these variables pertaining to educational attainment were found to be partially associated with the extent of exposure to print thus far in life. Age of

completed education and the highest qualification attained significantly predicted spelling skills in adulthood among both the poor readers and controls (Maughan et al., 2009). This finding, suggesting that educational attainment is predictive of later reading skills, calls for further research on the association of the continuance of LDs after compulsory schooling with further education performance, using a different sample and study design.

Second, examination of the extent to which educational attainment, which can be assumed to be lower among individuals with a history of LDs than among controls, further affects adult life, such as employment or mental health, also awaits clarification. Although commonly considered a critical risk factor for unfavorable development leading to social exclusion (Myrskylä, 2012; OECD, 2016), insufficient education, according to some findings, does not necessarily have a detrimental additional effect on adult mental health problems among individuals with LDs (see Klassen, Tze, & Hannok, 2013, for a review). In the well-known Kauai Longitudinal Study, Werner (1993) showed that, by their thirties, individuals with LDs in childhood were leading a balanced life with low rates of mental health disorders and full employment, despite having markedly lower educational attainment than controls. Hence, owing to these somewhat conflicting earlier findings, further research is needed to clarify in what ways lack of education may affect the life of individuals with LDs in educational settings in Finland. This knowledge would, above all, be of value in designing effective means of supporting students with LDs and encouraging them not to drop out too early.

A third topic in need of clarification with respect to the relation between childhood LDs and educational attainment is the extent to which different subtypes of childhood LD affect education. Since longitudinal studies on LDs extending into adulthood have commonly focused on a single LD, most typically RD (e.g., Maughan et al., 2009; McLaughlin et al., 2014; Undheim et al., 2009), without controlling for other LDs, it remains uncertain whether the findings on the associations of LDs with educational attainment apply to RD alone, to other possible LDs, or to comorbidity. According to some earlier findings, different subtypes of childhood LD may differently predict adult educational outcomes: for instance, mathematical difficulties have been found to be more strongly related to postsecondary education dropout than reading difficulties (Hakkarainen et al., 2015).

A further important consideration, when examining educational attainment, is parental education. Parents' level of education is known to be predictive of children's educational qualification in the general population (OECD, 2018), a finding which may have further implications for children's psychosocial wellbeing outcomes in adulthood (Dubow, Boxer, & Rowell, 2009). Moreover, low parental education has been reported to predict children's learning difficulties (Hakkarainen et al., 2015). These findings indicate that parental educational level should be examined as a possible influential factor in the long-term associations of LDs with adult-age outcomes.

1.4 LDs and relations to employment

The linkages between LDs and employment are less clear than those between LDs and education. Most of the longitudinal studies on LDs that have focused on employment have primarily reported unfavorable outcomes, individuals with childhood LDs being more likely to be unemployed (Caspi, Wright, Moffitt, & Silva, 1998; Esser et al., 2002; Parsons & Bynner, 2002; Undheim, 2003) or less likely to have obtained high income levels (McLaughlin et al., 2014) than controls without childhood LDs. More favorable employment outcomes among individuals with LDs have also been found: employment rates comparable to the contemporary rates in the general population (Madaus, 2006), or even full employment with average occupational status (Schulte-Körne et al., 2003; Werner, 1993) have been reported. A common feature in the samples showing favorable employment outcomes seems to be the presence of a possible protective factor: having a college degree (Madaus, 2006), having attended a comprehensive school specializing in the education and support of students with RD (Schulte-Körne et al., 2003), or middle age, that is, having had time to settle down and build a balanced life (Werner, 1993). These findings call for further learning about the factors that may affect the employment outcomes of individual with LDs.

Given the somewhat scarce and conflicting earlier findings mentioned above, knowledge of the association between LDs and employment, and of the possible factors shaping this association in particular, clearly needs to be extended. The findings of an earlier longitudinal study (Aro et al., 2019) on the same register-based data utilized in this study suggest that long-term unemployment is more common among adults with childhood LDs than among controls with no known LD history. What remains to be looked into is which factors related to the initial LD, such as its continuance or subtype, or additional factors alongside the LD, such as attaining postsecondary education or having psychosocial problems as a child or psychiatric problems as an adolescent, may also have a bearing on employment outcomes in adulthood. With respect to the subtypes of LD, MD has been suggested to have a stronger association with unemployment than RD (Aro et al., 2019; Parsons & Bynner, 2002).

1.5 LDs and psychosocial wellbeing

As well as indicating their effects on educational attainment and employment, earlier research has also suggested that LDs are linked to overall wellbeing. As wellbeing is a broad concept that can be theorized in several ways depending on the context of interest, I shall first discuss the basis on which it is examined in this study.

According to Zaff and colleagues (2003), one way of viewing wellbeing is to divide it into three dimensions: physical, social-emotional, and cognitive. These three dimensions of wellbeing are independently important to the

individual across the life span but also interrelate and affect one another. Physical wellbeing refers to the pivotal domains of living, such as good nutrition, adequate healthcare, and physical activity, whereas social-emotional wellbeing includes aspects like self-concept, self-esteem, autonomy, social relationships, and the ability to handle stress (Zaff et al., 2003). Moreover, various cognitive and language abilities, such as the ability to think and reason, to acquire knowledge, and to communicate thought, constitute cognitive wellbeing, which underlies, for instance, academic success and functional social interaction (Zaff et al., 2003). The three dimensions are closely intertwined and influence each other reciprocally; for instance, functional cognitive abilities like information processing are prerequisites for aspects of social-emotional wellbeing such as empathy or the ability to maintain positive relationships (Zaff et al., 2003). Moreover, academic achievement after the early years in education is reciprocally related to students' self-perception and aspects of motivation (Zaff et al., 2003).

Besides being closely related to one another, Zaff and colleagues (2003) propose that the three dimensions of wellbeing are also highly dependent on individual, interpersonal and environmental influences. For example, situations arise that demand specific social or cognitive competencies that are not appropriate or adequate in another context. Even personal characteristics related to social-emotional wellbeing, such as self-esteem, can vary from context to context (Zaff et al., 2003). Moreover, functional social interaction and supportive social environments, including family, teachers, peers, and aspects of support in the societal system, are among the key factors that promote all elements of wellbeing. Besides contributing to wellbeing simultaneously at different levels, supportive environments also vary in quality and quantity during the life course, from parents as a child's most important social environment to the multiple social networks of an adult (Zaff et al., 2003).

Together, the social-emotional and cognitive dimensions of wellbeing, discussed above, link to another aspect of wellbeing, namely the construct of subjective wellbeing. Subjective wellbeing refers to "an overall state of subjective wellness" (Bücker, Nuraydin, Simonsmeier, Schneider, & Luhmann, 2018; Diener, 1984), and thus describes peoples' perceptions and evaluations of their lives, primarily with respect to psychological and social dimensions (Keyes & Waterman, 2003). Reflecting the multidimensional nature of wellbeing in general, subjective wellbeing has also been conceptualized in at least two slightly different ways. Bücker and colleagues (2018), drawing on the earlier work of, for example, Diener (1984, 1994) and Diener & Chan (2011), divide subjective wellbeing into (1) affective wellbeing, which includes both pleasant and unpleasant emotional states (such as happiness and depressed mood), and (2) cognitive wellbeing, which reflects individuals' overall sense of satisfaction in life. Keyes and Waterman (2003), in turn, divide subjective wellbeing into three domains (1) emotional, (2) psychological, and (3) social. The domain of emotional well-being comprises the balance of positive and negative emotions throughout life and subjective feelings, commonly measured as the frequency or duration of

certain affective states during a given time period (Keyes & Waterman, 2003). The domains of psychological and social wellbeing reflect positive functioning, psychological wellbeing from a more private and personal perspective and social wellbeing from a more societal perspective (Keyes & Waterman, 2003). Thus, psychological wellbeing covers dimensions such as self-acceptance, positive relations with others, and autonomy, whereas social wellbeing comprises dimensions such as the extent of social integration and the extent of belief in one's own social contribution (Keyes & Waterman, 2003). In sum, regardless of the slight differences between them, the existing definitions of subjective wellbeing agree that it reflects the individual's subjective experience of the affective and psychosocial facets of wellbeing.

In the present study, wellbeing was approached by combining elements from the concepts of social-emotional and cognitive wellbeing as theorized by Zaff and colleagues (2003) and from the concept of subjective wellbeing (see Bücker et al., 2018; Keyes & Waterman, 2003). In this study, the term psychosocial wellbeing was chosen to describe the phenomena of interest. Psychosocial wellbeing was self-rated on five domains: self-satisfaction, self-esteem, persistence in adversity, social functioning, and frequency of self-reported symptoms of depression.

Apart from viewing them as a continuum of individual experiences in different domains, problems of psychosocial wellbeing can also be seen as medical conditions, that is, as diagnosed mental health disorders based on an official classification (e.g., ICD-10). The distinction between the two approaches is important: while individual variation in self-reported psychosocial wellbeing can be substantial, low levels of self-reported wellbeing do not necessarily reflect mental health disorders that exceed the clinical threshold. Nevertheless, sub-threshold problems can also have an impact on an individual's life. In the present study, both self-reported psychosocial wellbeing and the presence or absence of diagnosed mental health disorders were examined as facets of psychosocial wellbeing.

What, then, is the connection between psychosocial wellbeing and LDs? A large number of earlier studies have identified a clear association between LDs and problems in psychosocial wellbeing, both in childhood (e.g., Carroll, Maughan, Goodman, & Meltzer, 2005; Nelson & Harwood, 2011a&b, for reviews; Willcutt & Pennington, 2000) and in adulthood (Cederlöf, Maughan, Larsson, D´Onofrio, & Plomin, 2017; see Klassen et al., 2013, and Livingston, Siegel & Ribary, 2018, for reviews), the findings pertaining for the most part to internalizing problems and mood disorders like depression and anxiety. Moreover, LDs have been found to have milder emotional impacts related to academic failure: individuals with LDs report traumatic school memories with constant struggle, distress and experiences of failure followed by real or experienced stigmatization, and resulting in feelings of unworthiness or inadequacy, that is, low self-esteem (e.g., Ingesson, 2007; McNulty, 2003; Livingston et al., 2018). Low self-esteem is known to pose a risk for later depressive symptoms (Orth, Robins, Trzesniewski, Maes, & Schmitt, 2009).

Hence, it can be inferred that negative school experiences precede and increase the risk for later problems in psychosocial wellbeing: the backpack, first containing distress related to academic failure, eventually fills with more general psychological distress. Alternatively, some findings suggest that there is a shared genetic base that increases the risk of mental health problems in individuals with LDs, at least in the case of RD (Cederlöf et al, 2017).

However, despite the elevated risk, not all individuals with LDs encounter problems in psychosocial wellbeing later in life. Thus, it remains to be determined which factors besides childhood LDs per se are critical when predicting adult psychosocial wellbeing. Such factors may resemble those affecting the educational attainment and employment of individuals with LDs: that is, the extent to which the LD continues and its subtype. Some earlier findings suggest that the subtype of LD might be significant. For example, a stronger relationship with depression has been found for childhood MD than RD (Parsons & Bynner, 2005). Earlier research on whether the lack of postsecondary education, or whether psychosocial problems in childhood and adolescence further increase the risk for psychosocial problems in adulthood among individuals with LDs also seems to be scarce. In the general population, an association has been established between mental health problems in adolescence and mental problems in adulthood (Fergusson, Horwood, Ridder, & Beautrais, 2005; McLeod, Horwood, & Fergusson, 2016), prompting the notion that a similar link must also exist among individuals with LDs. However, deeper knowledge about the factors mediating the associations of LDs with psychosocial wellbeing would be of value in finding ways to anticipate and prevent mental health problems among individuals with LDs. Furthermore, the earlier research examining the longitudinal effect of LDs on psychosocial wellbeing has mostly been confined to self-rated problems (e.g., Ghisi, Bottesi, Re, Cerea & Mammarella, 2016), or, in rare cases, to diagnosed mental health problems (Cederlöf et al., 2017; Wilson et al., 2009). Thus, by enabling the examination of both aspects, that is, self-rated problems in psychosocial wellbeing and diagnosis-based mental health problems, this study aims to extend the existing knowledge of the associations between LDs and psychosocial wellbeing.

1.6 Aims of the research

This study focused on the long-term associations of LDs with adult-age outcomes, following up a sample of individuals with LDs assessed and documented in childhood and comparing their adult-age information with that of a control group without documented childhood LDs. With comprehensive data from childhood clinical assessment and follow-up data based on large registers and on adult-age individual assessments and interviews, the study aimed at gaining a more profound picture of LDs in the life course, concentrating not only on the disability itself but also on other factors the individual with LDs may encounter.

The aim of the study was three-fold: the first aim was to determine the extent to which a specific LD, namely RD, continues into adult-age and how this relates to adult-age outcomes in the contexts of education, employment, and psychosocial wellbeing. This aim was investigated with a sample of individuals with RD but with no other LDs or psychosocial problems in childhood. The second aim was to examine the associations of different types of LD in childhood (RD, MD and both RD and MD) with adult-age outcomes, that is, depression, anxiety, and unemployment by utilizing large, life-long data drawn from national registers with information on medical diagnoses, educational attainment, and amount of unemployment benefit received annually. The third aim was to study the extent to which other factors in childhood and in adolescence, aside from either RD as the only childhood LD or different types of LDs (RD, MD and both RD and MD), impact or shape the relation between LD in childhood and adult-age outcomes. This aim was investigated by 1) examining the possible factors predicting the continuance of RD, such as cognitive skills (RAN, phonological skills, and IQ), the amount of special educational support or self-experienced support received in childhood and in adolescence, in addition to reading skills, and by 2) examining the possible factors mediating or moderating the associations of childhood LDs (RD, MD, or RD+MD) with adult-age depression, anxiety and unemployment, such as psychosocial problems in childhood, psychiatric problems in adolescence, lack of post-secondary education, gender, and mother's educational level.

The three main aims of the research, the studies addressing the research questions related to each aim, and the statistical analyses used to answer the questions are shown in Table 1.

TABLE 1 Main research aims, specific research questions and statistical analyses related to the aims by the separate studies.

Aim	Study	Specific research questions	Statistical analyses
1. to examine the continuance of RD and the associations of the continuance of RD with adult-age outcomes	I	To what extent does childhood RD continue from childhood into adulthood?	Descriptive statistics Percentages
	I, II	How do individuals with childhood RD (with and without adult-age RD) and controls differ in a) reading skills, b) cognitive skills, c) education and employment outcomes, or d) psychosocial wellbeing?	Multivariate Analysis of Variance (MANOVA); continuous variables Crosstabulation, chi-square test and Fisher's exact test; categorical variables
	II	Is adult-age reading fluency associated with psychosocial wellbeing in the group of individuals with childhood RD?	Analysis of Variance (ANOVA)
2. to study the associations of different types of LDs with adult-age depression, anxiety, and unemployment	III	To what extent do childhood LDs predict the presence of adult-age depression, anxiety and unemployment?	Structural Equation Modeling (SEM)
	III	To what extent does the subtype of childhood LD (RD, MD, RD+MD) predict adult-age depression, anxiety and unemployment?	SEM
3. to explore the factors in childhood and adolescence that influence adult-age outcomes	I	In the RD group, are adult-age reading skills predicted by childhood a) reading skills, b) cognitive skills, or c) the amount of special education and experienced support received?	Linear regression analysis
	II	In the RD group, is the severity of childhood RD associated with adult-age psychosocial wellbeing?	ANOVA
	III	Is the association between childhood LDs and adult-age depression, anxiety and unemployment mediated by having post-comprehensive education (yes/no) or psychiatric problems in adolescence?	SEM
	III	Do gender and mother's educational level moderate this mediation?	
		Are the associations between the subtypes of childhood LD (RD, MD, RD+MD) and adult-age depression, anxiety and unemployment mediated by childhood psychological problems, post-comprehensive school (yes/no) or psychiatric problems at adolescence, in a group of adults with documented childhood LD?	SEM

2 METHOD

2.1 Participants

The participants of the present study were adults aged 20 to 39 who had been referred in childhood to the Clinic for Learning Disabilities (CLD) in Jyväskylä, Finland for neuropsychological assessment. The CLD, which is run by the Niilo Mäki Institute, a foundation-based research unit for LDs, and the Family Counseling Center of the City of Jyväskylä, offers neuropsychological assessment and interventions for children with LDs or with problems in attention and executive functions and counseling for families and teachers. The CLD is a public service for children in the area of Central Finland. The average age of assessment is 8 to 12 years. Typically, LDs or attention problems are first identified at school and assessed by a school psychologist. This is followed by special educational support. If this support is not deemed to be sufficient, the child is then referred by the school psychologist to the CLD for an assessment. Children with socioemotional or psychiatric problems or with global developmental delay are primarily referred elsewhere than to the CLD.

Since its foundation in 1985, the aim at the CLD has been to combine clinical work and research by collecting a comprehensive database of neuropsychological assessments for research purposes. By the beginning of the present study, neuropsychological assessment data had been collected on approximately 1 400 children. The participants of the present follow-up study (n = 430) represent a subset of this database, the selection criterion being at least 20 years of age in the year 2014 when the follow-up data collection started, and having assessment data on reading and mathematics performance available. In addition, only children with a z-score below -1.5 standard deviations in the reading or mathematics test or both were included in the present sample.

A matched control group for this sample was requested from the Population Register Centre of Finland, with the aim of gaining five controls for each individual in the clinical data, matched for age, gender, and place of

residence at age 7, that is, the year when the children enter compulsory education in Finland. The final size of the control group for the 430 individuals with LD was 2 149, as one control individual, who could not be identified from the registers, was missing.

Two datasets, both derived from the follow-up sample of 430 individuals, were used: (1) individual assessment and interview data for a sub-sample of adults with RD and without comorbid LDs or psychosocial problems in childhood (n = 48) and their matched controls (n = 37), and (2) large register-based data for all the 430 RD individuals and their 2 149 control adults. The individual assessment and interview data were used in addressing the first aim of the study on the continuance of RD and its adult-age outcomes (Studies I and II) and the third aim of the study on childhood predictors of the continuance of RD into adulthood (Study I). The register-based data were used to address the second aim of the study on the associations of different types of LDs with adult-age anxiety, depression and unemployment and the third aim of the study on the factors in childhood and adolescence impacting or shaping these associations (Study III). Figure 1 shows the design of the study and descriptive information on the samples.

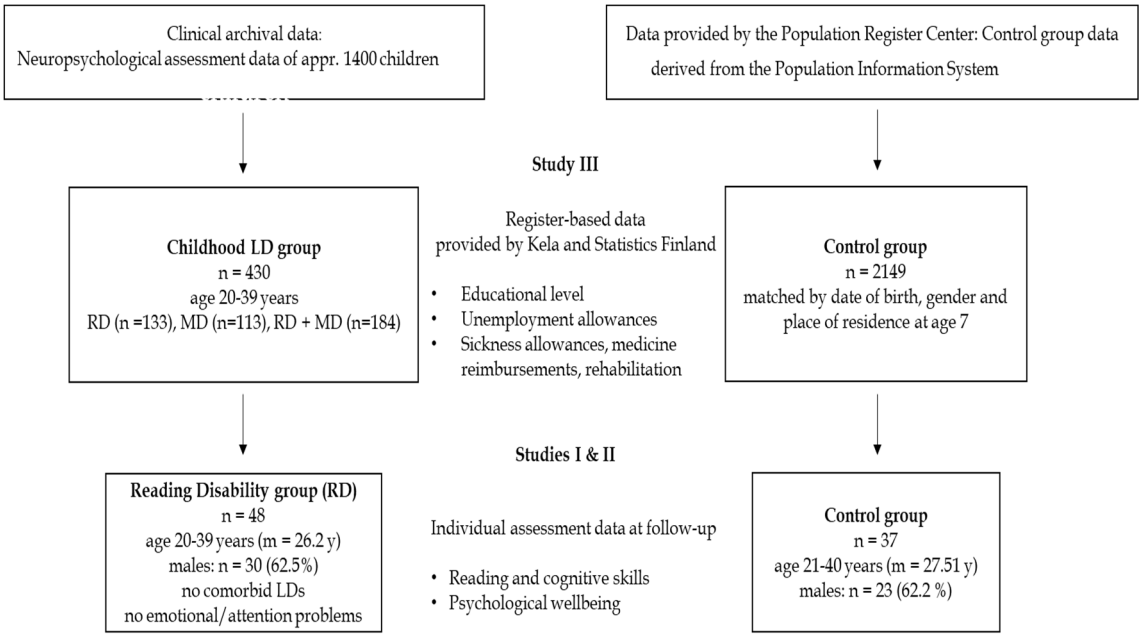

FIGURE 1 The design and participants of the study

2.2 Procedure

2.2.1 Individual assessments and interviews (Studies I and II)

The participants in the Studies I and II were 48 adults with childhood RD and their 37 matched controls, derived from the register-based data on 2 579 individuals, that is, the data on the 430 individuals with LDs and their 2 149 controls. Individuals with a z-score below or at -1.5 standard deviations in the childhood reading test but with a mathematics test performance above -1.5 standard deviations and with no psychosocial problems in childhood (teacher/mother rated internalizing, externalizing, and attention problem scores not below 1 standard deviation) were selected for this subsample with the aim of forming as homogeneous a group of individuals with RD as possible. Applying these selection criteria, the initial number of individuals identified was 76, of whom 10 were not contacted due to missing contact information for nine individuals and the death of one individual. Of the 66 individuals reached, 49 (74.2 %) agreed to participate in the one-on-one assessments. After one of the participants had been omitted from the sample because of a markedly low IQ score, the final sample size in the RD group was 48.

For the follow-up assessment, it had been planned to recruit one matched control group member for each RD group participant, and hence, all five controls matched for each of the RD participant were contacted in random order. No control participant was obtained for 11 RD participants either because all five control individuals declined or cancelled their appointment, or because none of them were reached. In addition, one potential control participant was not included in the sample owing to a low IQ, and thus the final control group comprised 37 individuals. In the RD group, no differences were found in the gender distribution between the individuals with matched controls (n=37) and those without a control individual (n=11). However, the two groups differed in age: the individuals with RD and with a matched control were older on average (M=27.05 years) than the individuals without a control (M = 23.5 years). The results were replicated in additional analyses run only for the individuals with RD and a control (n=37), and hence, the original sample size (48+37) was used to increase the power of the analyses.

After initial contact had been made by telephone, participants were interviewed on their education, employment, marital status and family situation, and on special educational support received during their school years. This was followed by a one-on-one assessment lasting four-and-a-half to five hours, conducted by licensed psychologists on the premises of the Niilo Mäki Institute. The follow-up appointments included standardized cognitive and neuropsychological tests, self-ratings and interviews (see the Measures section below and the original papers for detailed descriptions of the measures).

Follow-up appointments were primarily arranged in the daytime on workdays. Each participant was compensated for travelling expenses, paid a daily allowance, and offered lunch or a snack during the appointment.

Participants received oral feedback at the end of the appointment and an optional written summary on their test performance by mail.

2.2.2 Register-based data (Study III)

For the initial sample meeting the minimum age criterion of 20 in the year 2014 (n = 517), register information pertaining to education, employment, and mental health services was requested from the Social Insurance Institution of Finland (Kansaneläkelaitos, Kela; see http://www.kela.fi/web/en) and Statistics Finland (www.tilastokeskus.fi). Kela is a national institution administered by the state that provides Finland's residents with basic social security services, such as health insurance, unemployment allowances, pensions, and family benefits.

Due to privacy protection, the adult-age register data remained anonymous: no information that could enable identification of a participant was accessible from the national registers without a written informed consent from that individual. Before combining the original childhood assessment data with the register data, variables of interest in the former were converted into the categorical variables of gender, age group, presence of psychosocial problems, and LD subgroup (RD, MD, RD+MD), to enable the use of group-level information without information that could identify the participants. The grouping variables are detailed later in this section.

2.2.3 Ethical considerations

The Ethical Committee of the University of Jyväskylä approved the research. The study also followed the ethical standards of the Declaration of Helsinki. The participants in the childhood RD group (n = 48) and their controls gave their written informed consent and participated voluntarily in the follow-up. On admission to the clinic in childhood, the participants' parents had given their informed consent for the children's test data to be used for subsequent research purposes. Due to the current privacy protection legislation and the absence of written informed consents to access it, the register-based data was kept anonymous. In addition, according to the archiving obligations of the Finnish Psychological Association and its professional ethical guidelines, the quantitative data were saved in digital mode in the NMI server, and the original test and questionnaire papers stored securely in the NMI archives.

2.3 Measures

The measures used in childhood, adolescence and at the adult-age follow-up and the studies addressing these are described below and shown in Table 2. More detailed descriptions of the measures are available in the original papers.

2.3.1 Individual assessments and interviews (Studies I and II)

Measures in childhood and in adolescence

Reading. One of two standardized reading tasks, depending on which one was in use at the time the child was assessed at the CLD, was used to define the cut-off criterion and the level of difficulty of childhood RD. Reading speed performance was used as a measure in both of the tasks, as in a consistent orthography like Finnish where accurate reading is typically learned early (Aro & Wimmer, 2003), reading fluency (i.e., speed) is a better marker of reading problems.

Misku (Niilo Mäki Institute, 1985-2004, unpublished) is a text-reading task in which the child reads aloud a one-page narrative as quickly and correctly as possible. The time taken to complete the text is measured. The task is normed for Finnish 8- to 12-year-old children.

In the text reading task that forms part of the ÄRPS reading skill test battery normed for the grades 2 to 4 (Niilo Mäki Institute, 1992-2004, unpublished), the child also reads aloud a narrative, and the number of words read per time unit, that is, 1 minute for grade 2 and 2 minutes for grades 3 to 4, is measured.

In each of the two reading tasks, RD in childhood was defined as a z-score for reading speed performance of at least -1.5 SDs below the reference group mean. Moreover, the level of severity of childhood RD was classified as "very severe" when the z-score was below -2.5 SDs, and "severe" when it was between -2.5 and -1.5 SDs

Full Scale IQ, Verbal IQ and Perceptual IQ. Full Scale IQ (FSIQ), Verbal IQ (VIQ) and Perceptual IQ (PIQ) were estimated with the Wechsler Intelligence Scale for Children –Revised edition (WISC-R; Wechsler, 1974).

RAN. Automatized naming skills were evaluated with the Rapid naming test (Ahonen, Tuovinen & Leppäsaari, 1999; Denckla & Rudel, 1974), standardized for 6- to 12-year-old Finnish children. The child is requested to name an array of 50 symbols on six boards as quickly and correctly as possible. In this study, the rate of naming the items on each of two alphanumeric item boards, Letters and Numbers, was used. A composite score for RAN was formed of the mean of z-scores for rate in the two boards.

Phonological skills. Two tests were used as measures of phonological skills, depending on which one was used at the time the child was assessed at the clinic.

TABLE 2 Measures in childhood, adolescence and at adult-age follow-up by the separate studies

Phase	Variable	Measure	Study		
			I	II	III
Childhood	RD, severity level of RD	Misku text reading; Ärps text reading and wordlists	x	x	x
		Markkinat wordlist; Lukilasse wordlist			x
	IQ	WISC-R	x	x	
	RAN	Rapid Naming Test	x	x	
	Phonological skills	Phoneme Blending Task; NEPSY – Phonological processing task	x		
	Parental educational level	Highest educational attainment of mother (Statistics Finland)			
	Psychosocial problems	Teacher's Report Form; Child Behavior Checklist			x
	MD	RMAT; K-ABC – Arithmetic Subtest; Lukilasse – Arithmetic Subtest			x
Adolescence	Special educational support: self-report	Special education received during comprehensive school	x		
	Received support in general: self-report	Number of support providers	x		
	Psychiatric problems	Allowances received for diagnosed psychiatric problems (Kela)			x
	Educational degree after comprehensive school	Highest educational attainment (Statistics Finland)			x
Adulthood	Reading: fluency, accuracy, comprehension	Test battery on reading and spelling skills for adolescents and adults	x	x	
	Self-evaluation of reading	Self-rate questionnaire on the importance of academic skills (in part)	x		
	IQ	WAIS-IV, abbreviated version	x	x	
	Short-term and working memory	Digit span (WAIS-IV)	x		
	Phonological skills	Syllable blending task	x		
	RAN	Rapid Naming Test – letters board	x		
	Educational attainment	Postsecondary education and higher education (interview)	x		
	Unemployment: current	Employment status: employed – unemployed (interview)	x		
	Unemployment during adulthood	Mean of annual number of days of unemployment allowance (Kela)			x
	Depression: self-report	Beck Depression Inventory - II		x	
	Self-satisfaction: self-report	CORE-OM - Wellbeing domain		x	
	Social functioning: self-report	CORE-OM - Life Functioning domain		x	
	Self-esteem: self-report	Rosenberg Self-esteem scale		x	
	Persistence: self-report	Connor-Davidson Resilience scale -10		x	
	Depression: diagnosis	Allowances received for diagnosed depression (Kela)			x
	Anxiety: diagnosis	Allowances received for diagnosed anxiety (Kela)			x

Because the two tests were not comparable, a dichotomous variable for phonological deficit was formed using a separate cut-off for each of the tests.

The phoneme blending task, the Finnish version of the Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, & Kirk, 1968; Finnish adaptation Kuusinen & Blåfield, 1972), comprises three subtests where the child is presented with sounds and asked to voice the words the sounds form together. The child's performance is compared to the psycholinguistic age that corresponds to the child's chronological age. In the present study, a psycholinguistic age 12 months younger than the child's chronological age was used as the cut-off for a phonological deficit.

The phonological processing task is a two-part subtest of the NEPSY neuropsychological test battery (Korkman, Kirk, & Kemp, 1998), standardized for 9- to 12-year-old children in Finland. In the word segment recognition part, the child is presented with the sound of a phoneme or a syllable and an array of pictures of phonologically similar words and asked to link the sound to the picture of a word that contains the identical sound. In the phonological segmentation task, the child is asked to reformulate a word presented by removing a sound, syllable, or a part of a compound word, thereby forming a new word. A scale score of 7 in the phonological processing task, based on the test reference data, was used as the cut-off for a phonological deficit.

Special educational support. Special education received during comprehensive school and during upper secondary education (vocational school or high school) was obtained retrospectively from the participants during the adult follow-up interview. Owing to the lack of more specific, objective data on the quality and quantity of special education and to the considerable variation in special educational resources and practices between schools and communities over the years, only dichotomous variables ("received special educational support" – "did not receive special education") were used, one for comprehensive school and another for upper secondary education. The variable for special education received during comprehensive school was primarily used in this study.

Number of support providers. Support received for RD during adolescence, obtained retrospectively at the adult follow-up during a structured interview, was measured as the number of persons the participant referred to as support providers. The sum scores of the number of support providers were further converted into a dichotomous variable with the values "support from two or fewer persons" and "support from more than two persons".

Measures in adulthood

Reading. A standardized Finnish test battery on reading and spelling skills for adolescents and adults (Nevala, Kairaluoma, Ahonen, Aro, & Holopainen, 2006), comprising a word list reading task, a pseudoword list reading task, a text reading task, and a reading comprehension task, was used to measure reading in adulthood.

Reading fluency , that is, reading rate, was defined as the mean of the z scores of the time used to complete the 30-item word list and the 30-item pseudoword list, and the number of correctly read words in 3 minutes in the text reading task. The reading fluency mean score was used as a measure of the continuance of RD in adulthood, with a z-score of -1.5 or lower indicating continuing reading problems.

Reading accuracy was determined as the z-score of the number of correctly read words in the pseudoword list reading task. The measure of *reading comprehension* was the *z*-score of the correct answers in the 11-item questionnaire related to the reading comprehension text.

Self-evaluation of reading skills. The participants were asked to evaluate their reading skills in comparison to peers on a Likert scale ranging from "below average" to "above average", using a question adopted from a self-rated questionnaire on the importance and utility of academic skills based on earlier similar questionnaires (Eccles & Wigfield, 1995). Self-ratings were transformed into a three-category variable of "below average", "average", and "above average".

Full Scale IQ, and the indices of verbal comprehension, perceptual reasoning, processing speed and short-term memory. The abbreviated version of the Wechsler Adult Intelligence Scale–IV (WAIS-IV; Wechsler, 2008, 2013) was used to estimate FSIQ in adulthood. An estimate of the Verbal Comprehension Index (VCI) was produced with the subtests Vocabulary and Similarities, and an estimate of the Perceptual Reasoning Index (PRI) with the subtests Block Design and Matrix Reasoning, using partition in computing according to the WAIS-IV test manual (Wechsler, 2013). In addition, the complete Working Memory Index (WMI) and complete Processing Speed Index (PSI) were computed. The estimates of FSIQ in abbreviated versions of the WAIS-IV are reported to be reliable with test-retest reliability above .90 (Irby & Floyd, 2013). In addition, The Digit Span subtest of the WMI in the WAIS-IV (Wechsler, 2008, 2013) was used as a measure of short-term and working memory.

Phonological skills. Phonological skills were measured with an unpublished syllable blending task, standardized with a Finnish reference group. The task comprises lengthening strings of syllables which participants are asked to put together, thereby voicing pseudowords. Correctly voiced pseudowords were counted, and the raw scores for the task used as a measure.

RAN. Rapid naming in adulthood was evaluated with the letters board in the rapid naming test (Ahonen et al., 1999; Denckla & Rudel, 1974), standardized with a sample of comprehensive school ninth-graders. Raw scores of the time taken to complete the items on the board were used as measures of RAN.

Educational attainment. Post-secondary education, obtained during the interview was categorized into the classes of "no post-secondary educational attainment",

"vocational school diploma" and "high school diploma". In addition, higher educational attainment was measured with the categories "vocational school degree", "university of applied sciences degree" and "university degree".

Unemployment. Owing to the lack of objective data on employment history, current employment status (employed/unemployed), also obtained during the interview, was used to define employment in the sample of individuals with RD. Current unemployment was defined as being a job seeker or laid off, not working part-time or full-time, not studying, not doing military service, and not on maternity or sickness leave or on a disability pension.

Psychosocial well-being

Symptoms of depression were measured with the Beck Depression Inventory-II (Beck, Steer, & Brown, 1996). In the 21-item self-rating questionnaire, participants are asked to respond to statements describing the intensity of typical symptoms of depression, such as sadness or self-dislike, on a 4-point Likert scale, higher scores indicating more intense symptoms. The sum score of all the items was used as a measure of depression.

Self-satisfaction was measured with the domain Wellbeing in the Clinical Outcomes of Routine Evaluation-Outcome Measure (CORE-OM; Evans et al., 2002), a 34-item self-report questionnaire evaluating the level of current psychological global distress in four domains: Life functioning, Symptoms, Risk, and Wellbeing. The domain Wellbeing consists of four statements describing aspects of self-satisfaction and hopefulness which the participants respond to on a 5-point Likert scale according to the intensity with which they feel these emotions or states. Two of the statements are positive and therefore reverse-coded, with higher scores indicating more problems in wellbeing. The sum score of the four items was used as a measure of wellbeing in the present study.

Social functioning was measured with the 12-item domain of Life functioning in the CORE-OM questionnaire, the statements describing functioning primarily in social encounters. As in the Wellbeing domain, the participants respond to the statements on a 5-point scale, those statements that are positive being reverse-coded. In this study, the sum score of the 12 items was used as a measure of social functioning.

Self-esteem was estimated with the sum score of the five statements in the abbreviated version of the Rosenberg Self-esteem Scale (Rosenberg, 1965), to each of which the participants responded on a 5-point scale. Higher scores indicated fewer self-esteem problems.

Persistence in overcoming difficulties was assessed with the Connor-Davidson Resilience Scale -10 (Campbell-Sills & Stein, 2007). The 10 statements describe the capacity to cope with adverse circumstances. Participants respond to each

statement on a 5-point scale. The sum score of the 10 items was used as a measure, higher scores indicating greater persistence.

2.3.2 Register-based data (Study III)

Age. Participant age was classified into four groups according to the individual's birth year, that is, the individual's age in the year 2014 when the register-data were obtained: 1) 20 to 23 years (born 1991-1994), 2) 24 to 28 years (b. 1986-1990), 3) 29 to 33 years (b. 1981-1985), and 4) 34 to 39 years (b. 1975-1980). The measures for psychiatric problems in adolescence and in adulthood described later in this section were constructed using the age groups as estimates of age.

Measures in childhood

LD subgroup. Three subgroups of LD based on test performance at childhood assessment were formed: 1) RD (n = 133), 2) MD (n = 113), and 3) comorbid RD and MD (RD+MD; n = 184). A z-score of at least -1.5 SDs below the reference group mean in the reading or mathematics test was defined as RD, MD, or RD+MD. Several different reading and arithmetic tests had been used at the CLD over the years. Therefore, the test used in defining RD and MD varied depending on the time each child was assessed at the CLD. The alternative tests used in defining the LD subgroups are described below.

Reading measures. As in the sample of individuals with RD (n = 48), reading fluency, that is, reading rate, was primarily used to define the cut-off criterion and the difficulty level of childhood RD. In addition to reading rate performance in the two text-reading tasks Misku (Niilo Mäki Institute, 1985-2004) and Ärps (Niilo Mäki Institute, 1992-2004), described in detail above, three word list reading tasks, each developed and normed in Finland, were also used as alternative measures to define RD. In the word- and pseudoword reading tasks of the Ärps battery (Niilo Mäki Institute, 1992-2004), both comprising 20 words to read aloud, as well as in the Markkinat Word List (Niilo Mäki Institute, 1985-2004), with 13 words to read aloud, the time taken to complete the word list was measured. In the word reading subtest of the Lukilasse test battery (Häyrinen, Serenius-Sirve, & Korkman, 1999), normed for grades one to six, reading fluency was measured with the number of correctly read words in two minutes.

Mathematics measures. Three arithmetic tests were used alternatively to define MD. In the Kaufman Assessment Battery for Children – Arithmetic Subtest (K-ABC; Kaufman & Kaufman, 1983), Finnish norms for grades 2 to 5 (Niilo Mäki Institute, 1985-2004) for correct answers in 38 basic tasks comprising evaluating counting, computing, and identifying numbers and concepts, were used. In the RMAT (Räsänen, 1992), normed in Finland for grades 3 to 6, the number of correct answers in basic arithmetical operations performed in ten minutes was measured in relation to the reference group mean. In the Lukilasse arithmetic subtest

(Häyrinen et al., 1999), the number of correct answers in arithmetic operation tasks was compared to the Finnish norms for grades 1 to 6.

Mother's educational level. Statistics Finland provided register-based information on the highest educational attainment of the participants' mothers, which was further recoded into the categories (1) comprehensive school, (2) post-secondary education (vocational or high school), and (3) higher education (polytechnic, university or doctoral education).

Psychosocial problems in childhood. Psychosocial problems in childhood were obtained from questionnaires given to each client's teacher and parents to be filled in at the time of the clinical assessment. Teachers were given the Teacher´s Report Form (TRF; Achenbach, 1991a) and parents the Child Behavior Checklist (CBCL; Achenbach, 1991b). Each questionnaire contained 113 items describing problem behavior to be rated on a 3-step scale. Of the eight syndrome scales and three larger sum scores that can be formed from the items, the attention problems scale and sum scores for internalizing problems and externalizing problems were used to measure psychosocial problems, primarily using the teacher's responses. The child was defined as having psychosocial problems if at least one of the three scores exceeded the cut-off of 1 SD.

Measures in adolescence

Psychiatric problems in adolescence. Annual disability and rehabilitation allowances, disability pensions, sickness allowances, and reimbursements for medicines received between 12 to 19 years of age, obtained from the register information provided by Kela, were used to define psychiatric problems in adolescence. Individuals were defined as having had psychiatric problems in adolescence if they had received at least one form of the allowances or reimbursements available for either depression (ICD-10 codes F30-39), anxiety and stress-related mental disorders (ICD-10 codes F40-48), adult-age personality and behavioral disorders (F60-69), behavioral and emotional disorders with onset in childhood and adolescence (F90-98), mental and behavioral disorders due to psychoactive substance use (F10-19), an eating disorder (F50), schizophrenic, delusional, or other non-mood psychotic disorders (F20-29) or if they had received medication reimbursement either for antidepressants, anxiolytics, antipsychotics, sedatives, psychostimulants or for psycholeptics or psychoanaleptics between ages 12 and 19.

Post-comprehensive education. Based on register information provided by Statistics Finland on participants' highest educational attainment, level of education was classified into two categories: (1) comprehensive school only and (2) post-secondary education or higher education.

Measures in adulthood

Adult-age depression. Individuals were defined as having had depression during adulthood if they had received at least one of the allowances available for depression (F30-39) or reimbursements for antidepressants after age 20.
Adult-age anxiety. Individuals were defined as having had anxiety in adulthood if they had received at least one of the allowances available for anxiety and stress-related mental disorders (F40-48) or reimbursements for anxiolytics after age 20.

Unemployment. Length of unemployment was defined as the mean annual number of days during adulthood for which the individual received the basic unemployment allowance from Kela. Using a dichotomous variable, individuals were defined as unemployed if they had received the unemployment allowance for a mean of at least 63 days, that is, three months, per year. Years spent in formal education or on a disability pension or subsidized rehabilitation were excluded. Owing to lack of information on payments from job-related unemployment funds, which in Finland are responsible for paying fund members unemployment allowances for the first 300 to 500 days of unemployment, the estimate of unemployment was rather conservative in this sample.

2.4 Statistical analyses

In Studies I and II, IBM SPSS Statistics 24 was used in the analyses. In Study I, descriptive statistics and percentages were used to examine the proportion of individuals with childhood RD who had reading problems continuing into adulthood (see Table 1). To examine the group differences between individuals with childhood RD who had continuing reading problems, those with childhood RD who did not have continuing reading problems and controls, Multivariate Analysis of Variance (MANOVA) was used for continuous variables and crosstabulation (chi-square test or Fisher's exact test) for categorical variables. Moreover, linear regression analysis was used to explore childhood predictors of adult-age reading fluency. In Study II, Analysis of Variance (ANOVA) was used to examine differences in psychosocial wellbeing between individuals with childhood RD and controls, and to study the associations between adult-age psychosocial wellbeing and reading skills in childhood and in adulthood in adults with childhood RD.

In Study III, structural equation modeling (SEM) in Mplus statistical package 8 (Muthén & Muthén, 1998-2017) was used to perform two mediation analyses. The mediation models were examined to answer the research questions on the extent to which childhood LDs predicted the presence of depression, anxiety and unemployment and the extent to which factors in childhood and adolescence mediated this association.

3 OVERVIEW OF THE ORIGINAL STUDIES

The three main aims of the research and the studies addressing the specific research questions are presented in Table 1.

3.1 Study I: Resolving reading disability – childhood predictors and adult-age outcomes

To answer the first and the third main research aims, Study I examined the continuance of RD and its childhood predictors among the 48 adults with documented childhood RD. The first specific research question was whether RD that has been resolved by adult age is associated with other adult-age cognitive skills or with education or employment. This question was answered by comparing three groups: one with RD continuing into adult-age (criterion was an adult-age reading speed score below -1.5 standard deviations), one without RD in adult-age, and a control group, matched by age, gender and home town in the beginning of compulsory education (n = 37), without documented childhood RD. The second research question was whether the adults with and those without adult-age RD differed in their childhood measures, that is, reading and cognitive skills, special educational or social support in childhood and adolescence, and whether these factors predicted the continuance of RD into adulthood in the childhood RD group.

Twenty-nine (60.4%) of the 48 adults with childhood RD were found to have resolved their RD when a reading speed (fluency) score below -1.5 in the follow-up assessment was set as the criterion for adult-age RD. Comparison of the two groups with childhood RD, one with adult-age RD (RD+; n = 19) and the other with resolved RD (RD- ; n =29), and the control adults (n = 37), revealed that both the childhood RD groups continued to show weaker performance than controls in all three reading skills (fluency, accuracy, and comprehension). The two RD groups did not differ in reading accuracy or comprehension.

Of the other cognitive skills, adult-age RAN alone differentiated the two groups with childhood RD, the RD group being significantly more fluent in rapid naming than the RD+ group. Individuals in both the childhood RD groups were weaker than controls in the adult-age measures of verbal comprehension, working memory, processing speed, and phonological skills when compared on the level of statistical significance or on the effect sizes in the group comparisons.

Educational level was lower in both the childhood RD groups than in the control group: the proportion of individuals completing upper secondary education was smaller and the proportion of vocational school graduates larger in the RD group. Higher education (degree from a university or university of applied sciences) was more frequent in the control group than in the childhood RD group, regardless of adult-age RD status.

Employment differentiated the RD+ group from both the RD- and control groups: unemployment at the time of data collection was more common in the RD+ group than in the other two groups.

In the childhood measures, the two childhood RD groups had only differed in RAN, where the performance of the RD+ group had been significantly slower. No group differences were observed in the VIQ or PIQ, or in the proportions of individuals with severe childhood RD or with phonological deficits or who had received special educational support or support provided by significant others. However, RAN performance, level of childhood RD, and number of support providers in adolescence together explained 18 percent of the variance in adult-age reading fluency, whereas phonological deficit in childhood alone explained 19 percent of the variance in adult-age accuracy. Adult-age reading comprehension was predicted by childhood VIQ and PIQ, which together explained 18 percent of the variance.

The results of this study showed that over half of the individuals with childhood RD had resolved their fluency deficit by adulthood when the z-score criterion of < -1.5 was applied, although not to the level of the control group, that is, the general population. Moreover, the results showed that the group of individuals with childhood RD had weaker reading-related cognitive skills and lower educational level in average than the controls in adult-age. These results also point to the importance of improved reading fluency in adulthood for the employment of individuals with childhood RD: individuals without adult-age RD were more likely to have found employment than those with adult-age RD. The results also showed that rapid naming skills and experienced support received in childhood and adolescence predicted RD later in life, a finding that should be taken into account when planning long-term support for children with RD. Moreover, the relatively high percentage of individuals who had resolved their childhood RD by adult-age may be related to the fact that the present study group was drawn from a clinical sample, that is, from adults who had been assessed at a child neuropsychological unit and who, along with the clinical assessment, had also received counseling and support as children. Moreover, these findings reflect the adult outcomes of individuals with pure RD, that is, RD without comorbid MD or psychosocial problems. Overall, the findings of the

study question the usefulness of using reading and cognitive skills as the only measures in determining whether childhood RD has been resolved: RD was associated with somewhat lower skills in adult age regardless of whether reading fluency had improved. Moreover, some differences in adult life among individuals with childhood RD compared to peers, such as lower educational level, seemed to be independent of reading skills in adulthood. These findings on the factors besides adult-age reading skills that contribute to how adults with childhood RD cope in their lives merit more in-depth examination.

3.2 Study II: Does childhood reading disability or its continuance into adulthood underlie problems in adult-age psychosocial well-being? A follow-up study

This study focused on adult-age psychosocial well-being (symptoms of depression, self-satisfaction, self-esteem, persistence in overcoming difficulties, and social functioning) among the 48 individuals with childhood RD and their 37 controls, and thus addressed the first and the third main aims of the research. The first research question was whether differences in psychosocial well-being exist between adults with childhood RD and controls, and whether these differences are associated with gender or adult-age IQ. The second question was whether adult-age psychosocial well-being in the childhood RD group is associated with childhood or adult-age reading skills, that is, the level of childhood RD or adult-age reading fluency, when controlling for IQ, gender, and unemployment. No differences in psychosocial well-being were found between individuals with childhood RD and their controls. Both groups reported relatively good psychosocial wellbeing in general, with fairly high self-esteem and persistence (resilience), few symptoms of depression and no substantial problems in self-satisfaction or social functioning. An association was observed between IQ and self-reported persistence, indicating that lower IQ was related to lower persistence. No gender-related differences were found.

However, bivariate correlations, conducted as preliminary analyses, revealed that the psychosocial well-being measures correlated with adult-age reading fluency and with unemployment only among individuals with childhood RD, suggesting that the association of psychosocial well-being and reading skills was specific to the group with the history of reading problems. Hence, the further analyses were run only for the group with childhood RD. The GLM analyses showed that better reading speed (fluency) was associated with higher self-esteem and social functioning and with fewer self-reported symptoms of depression, whereas no associations with self-satisfaction or persistence were found. The level of childhood RD was not associated with the psychosocial well-being measures. Psychosocial well-being, in turn, showed no associations with gender or unemployment, whereas IQ was related to higher persistence. The findings of this study indicated that the continuance of childhood RD into

adulthood, not RD in childhood as such, underlay problems in adult-age psychosocial well-being in the group of individuals with RD but with no other substantial disabilities or problems in childhood. Based on these findings it can be assumed that for children with RD, early assessment and interventions to improve their skills and emotional support to boost their psychosocial well-being are of importance, as both may contribute to favorable adult-age outcomes. The findings also emphasize that to better understand which factors besides RD influence adult-age outcomes requires a more holistic approach to studying RD in the life-course, one that includes cognitive, social, emotional, educational and environmental aspects.

3.3 Study III: Psychiatric problems in adolescence mediate the association between childhood LDs and later wellbeing

This study, pertained to the second and the third main research aims, investigated adult-age mental health and unemployment in 430 individuals with documented childhood LDs (either RD, MD, or RD+MD) and their 2 149 control adults using the life-long register-based data. The childhood assessment data on the adults with childhood LDs was also utilized. The first research question, on the extent to which childhood LDs predict adult-age depression, anxiety and unemployment and the extent to which not having post-secondary education or the presence of psychiatric problems in adolescence mediate these associations, was examined using both the data on the individuals with a history of LDs and the data on their controls. In addition, gender and mother's educational level were examined as possible moderators of these mediators. The second research question concerned the extent to which, in the group of adults with documented childhood LD, different subtypes of childhood LD (RD, MD, RD+MD) predict adult-age depression, anxiety and unemployment and the extent to which this association is mediated by childhood psychosocial problems, lack of post-secondary education or psychiatric problems in adolescence.

Investigation of the first research question showed that childhood LDs were found to predict adult-age anxiety via psychiatric diagnoses in adolescence. Moreover, psychiatric problems in adolescence almost fully explained adult-age depression. Childhood LDs predicted adult-age unemployment both directly and via having psychiatric problems in adolescence. Unexpectedly, childhood LD was also found to predict later unemployment indirectly via having post-secondary education and not via lack of it. Neither gender nor maternal educational level affected the associations of childhood LD with adult-age outcomes. These findings indicated that individuals with LDs were more likely than their peers to have psychiatric problems as adolescents, which in turn rendered them more prone to anxiety and depression and to being unemployed as adults. Childhood LDs also directly predicted adult-age unemployment.

Investigation of the second research question showed that the type of childhood LD (RD, MD, or RD+MD) was not a major factor in predicting adult-age outcomes. Individuals with MD were found to be more prone than individuals with RD to adult-age anxiety if they had had psychosocial problems in childhood and psychiatric diagnoses in adolescence. However, no other differences between the LD subtypes were found, even when psychiatric diagnoses in adolescence were included as mediating factors.

In conclusion, the findings indicated that childhood LDs are associated with the presence of psychiatric problems in adolescence, via which they present a risk for mental health problems and unemployment in adulthood. Moreover, these findings based on comprehensive longitudinal data extend the results of Studies I and II, confirming that childhood LDs per se do not necessarily have direct consequences in adulthood; instead some negative outcomes in adulthood may stem from secondary problems. In the present study, psychiatric diagnoses in adolescence were mediators between LDs and adult-age outcomes. Nevertheless, childhood LDs were found to be directly predictive of adult-age unemployment. The increased risk for unemployment in adulthood of children with LDs remained even in cases where the individual had a post-secondary educational qualification. In addition, as this study utilized register-based data with information on medical diagnoses, the analyses showed that individuals with LDs were more likely to have diagnosed mental health problems as well as self-reported problems in psychosocial wellbeing. Hence, by demonstrating that LDs present a serious risk for various wellbeing problems in adulthood, these findings further underline the importance of providing comprehensive support to individuals with LDs, not only in academic skills, but also in psychosocial domains throughout their school years and adolescence.

4 DISCUSSION

The aim of the present research was to gain a better understanding of the associations between childhood LDs and various adult-age outcomes by following up Finnish individuals with documented LDs in childhood. The main aims were, first, to determine the extent to which the continuance of a specific childhood LD, namely RD, is related to reading-related and cognitive skills, education, employment and psychosocial well-being in adulthood. The second aim was to investigate the associations of different types of childhood LDs (RD, MD, and RD+MD) with mental health and employment in adulthood. The third aim was to explore which factors, other than LDs, in childhood or adolescence shape mental health and employment in adulthood. A large dataset with lifelong register-based information on education, employment, and diagnosis-based disability and unemployment allowances and reimbursements for medications was used along with individual assessments and interviews conducted with a smaller sample of adults with RD as their only childhood LD and with their matched controls. The main results pertaining to the three aims are shown in Table 3.

The findings show that while childhood LDs have linkages to different adult-age outcomes, these linkages are for the most part indirect. First, the continuance of childhood reading problems, not childhood RD per se, was associated with employment status and psychosocial wellbeing in adulthood. Around 40 percent of individuals with childhood RD continued to struggle with fluent reading as adults. Unemployment was higher among these individuals than among individuals with childhood RD who no longer had marked reading fluency problems as adults, despite the fact that the group of individuals with childhood RD had a lower mean level of education than controls. Lower reading skills in adulthood were also associated with lower psychosocial wellbeing with respect to self-esteem, social functioning, and number of self-reported symptoms of depression, and with slower performance in RAN. Second, examination of the associations of the different subtypes of LDs with adult-age outcomes showed that childhood LDs, regardless of their subtype, increased the risk for depression, anxiety, and unemployment in adulthood, mainly via psychiatric problems in adolescence.

Finally, the findings revealed that adolescence may be a pivotal period when predicting adult-age wellbeing among individuals with childhood LDs. First, psychiatric problems in adolescence were strongly predictive of depression, anxiety, and unemployment in adulthood. Childhood LDs were indirectly associated with unfavorable adult-age outcomes, as they slightly increased the risk for psychiatric problems in adolescence which then were strongly associated with adult-age depression and anxiety. Second, along with RAN and the level of RD in childhood, self-experienced support from several support givers in adolescence was associated with resolving RD by adult-age.

On the whole, the findings underline that, besides childhood LD *per se*, there are other factors related to LD, that is, the continuance of RD, RAN, psychiatric problems in adolescence, and experienced support, that may contribute to the overall adult-age wellbeing of an individual with developmental LD. The results call for a holistic approach in research, that is, focus should be on cognitive, psychosocial, and environmental factors. The findings also suggest that there is a need of long-term support for individuals with LDs that includes giving consideration to both cognitive and psychosocial aspects.

TABLE 3 Main results by the separate studies.

Aim	Study	Main results
1. Continuance of RD and the associations of the continuance of RD with adult-age outcomes	I	RD was found to be persistent: 39.6 percent of the individuals with childhood RD were found to have continuing reading fluency problems (<-1.5 SDs or lower) as adults. Although 60.4 percent had reached a level in reading fluency above the criterion set for RD (<-1.5 SDs), the group of adults with childhood RD performed weaker on average than the control group in reading fluency, accuracy and comprehension. Individuals with childhood RD and with continuing reading problems as adults (adult-age RD) performed slower in adult-age RAN than individuals without adult-age RD and controls. No other cognitive differences were observed. The group of individuals with childhood RD attained lower educational level than controls. However, unemployment was more common among individuals with adult-age RD than among individuals without adult-age RD.
	II	In the group of individuals with childhood RD, reading fluency in adulthood was associated with psychosocial wellbeing (i.e., self-esteem, social functioning, symptoms of depression): the lower the reading skills, the more problems in psychosocial wellbeing.
2. Associations of different types of LDs with adult-age depression, anxiety, and unemployment	III	Childhood LDs were found to be predictive of diagnosed depression and anxiety and of unemployment in adulthood.
	III	The subtype of childhood LD (RD, MD, RD+MD) was not found to be pertinent when predicting adult-age depression, anxiety, and unemployment. The only significant difference was found between MD and RD: individuals with MD were more prone than individuals with RD to have anxiety as adults if they had had psychosocial problems in childhood and psychiatric diagnoses as adolescents.
3. Factors in childhood and adolescence influencing adult-age outcomes		Adolescence was found to be a key period in predicting adult-age outcomes of individuals with LDs.
	I	In the RD group, level of RD and performance in RAN in childhood, and self-experienced support from several support givers in adolescence were significant predictors of adult-age reading fluency predicting 18 percent of its variance.
	II	In the RD group, neither childhood RD *per se* nor the severity of childhood RD was associated with adult-age psychosocial wellbeing.
	III	Psychiatric problems in adolescence mediated the associations between childhood LDs and adult-age depression, anxiety, and unemployment: LDs slightly increased the risk for psychiatric problems in adolescence, and psychiatric problems in adolescence strongly predicted each adult-age outcome. Depression and anxiety in adulthood were fully mediated by psychiatric problems in adolescence. Unemployment in adulthood was directly associated with childhood LD, and an indirect association of LD with unemployment was found via having, not lacking, post-secondary education. Gender and mother's educational level did not moderate these mediators.

4.1 Continuance of RD and the associations of the continuance of RD with adult-age outcomes

Studies I and II addressed the issue of the continuance of childhood RD and its impact on adulthood. A sample of 48 adults with childhood RD documented during clinical neuropsychological assessments and their 37 matched control adults was studied by assessing their reading skills and cognitive skills (IQ, RAN, short-term and working memory, and phonological skills) in relation to their educational attainment, employment and psychosocial wellbeing. Reading rate was used as the measure of adult-age RD, that is, the continuance of childhood reading problems.

4.1.1 Continuance of RD

The findings showed, in line with the previous research on RD in adulthood (e.g., Maughan et al., 2009; Undheim, 2009), that problems in reading persist into adulthood in a considerable proportion of individuals with childhood RD. However, the proportion of those whose childhood RD had been resolved, that is, of those whose reading problems no longer met the criterion set for adult-age RD (<-1.5 SDs in reading rate performance), was more than half (60.4 %) in this study. The proportion is high compared to the proportions of between 7 and 30 percent generally reported in previous studies (Maughan et al., 2009; Parrila et al., 2007; Undheim, 2009). The higher proportion of improved reading skills in this study might be explained by orthographic differences: earlier research reporting lower proportions of improved reading has mostly been conducted in English-speaking language environments or in other orthographies with low consistency in letter-sound connections (e.g., Maughan et al., 2009; Parrila et al., 2007) in contrast to the high consistency of letter-sound connections in the Finnish orthography. This indicates that differences may exist between orthographies in the continuance of reading problems. Moreover, orthographic differences may also affect the ways in which reading is measured: reading (or spelling) accuracy may be an adequate indicator of reading in orthographies with less consistent letter-sound connections, whereas in more consistent orthographies, in which high accuracy in reading is typically achieved rather quickly (Aro & Wimmer, 2003), fluency, or speed of reading may be a more useful measure. Hence, differences in the proportions of "continuing RD" between studies conducted among readers in languages with more or less consistent orthographies are likely to reflect differences in the extent to which problems in the different skill domains of reading (i.e., fluency, accuracy, comprehension) typically persist into adulthood. Indeed, the skills used to define adult-age RD in earlier research have generally differed from those used in the present study: Maughan and colleagues (2009) measured spelling skills (accuracy), Undheim (2009) measured speed, spelling and decoding skills together, and Parrila and colleagues (2007) included reading comprehension and phonological skills.

However, owing to methodological differences between studies, findings on the proportion of continuing reading problems may not be comparable between orthographies with a similar level of consistency either. For example, in a study conducted in German, another language environment, like Finnish, with a consistent orthography, a rather favorable adult reading outcome was also reported (Schulte-Körne et al., 2003). However, the authors used spelling, not reading rate, as an indicator of reading skills, and compared adult spelling skills primarily to the initial skills in childhood, whereas in the present study, a control group was used at the adult follow-up. Moreover, in a Finnish sample of adolescents (Torppa et al., 2015), in which reading rate (i.e., fluency), with a cut-off close to the present criterion, was used as a measure of reading, the proportion of participants who had resolved their childhood RD was lower (40 %). This difference may, however, be due to differences in participant age and/or samples: in the present study, the participants had had several more years to develop their reading skills than the participants in the study by Torppa and colleagues (2015). Torppa and colleagues also used a sample with known familial risk for RD, which may have affected the proportion of participants with resolved RD. To conclude, the differences between findings on the continuance of RD illustrate the problem caused by the absence of comparable definitions of LDs or a definition that could be generally applied.

Another explanation for the rather high proportion of resolved RD in the present sample may be that comorbid LDs and comorbid psychosocial problems in childhood were deliberately excluded, the aim being to determine the associations on adult outcomes of childhood RD alone. In other words, the aim was to examine whether RD as single deficit has an influence on later life. Although comorbidity is known to be common between different LDs (Kovas et al., 2007; Landerl & Moll, 2010) as well as between LDs and attention or psychosocial problems (e.g., Willcutt et al., 2010), comorbid disabilities have rarely been controlled for in previous longitudinal research on LDs. In two exceptions, emotional problems were controlled for (Esser et al., 2002; Undheim, 2003). In the present study, exclusion of the possible combined effect of various comorbid disabilities that may further complicate the resolution of RD may have resulted in a more positive long-term outcome than expected. Furthermore, the present sample was drawn from a clinical data base, which may also have contributed to a more favorable outcome than expected. The use of clinical rather than non-clinical data is discussed in detail later in this section.

Overall, in spite of the discrepancies between this and earlier studies, the present findings strongly confirm that childhood RD is a persistent deficit. Although 60 percent of the sample reached a level in reading skills that no longer met the criterion for adult-age RD, the individuals with childhood RD, as a group, continued to show lower mean performance in reading than their non-childhood RD controls in reading speed as well as in reading accuracy and comprehension. Hence, the findings clearly indicate that more research on RD in adulthood is needed, especially on identifying which domains of reading are most typically problematic in adult-age, and which domains may be the most pivotal in enhancing coping in adult life.

4.1.2 Associations of childhood RD and its continuance with adult-age outcomes

As part of the first aim, Studies I and II also explored the extent to which the group with childhood RD differed from their matched controls in the adult-age outcomes of interest, and the extent to which the continuance of RD was associated with these outcomes.

In the case of cognitive skills, performance in adult-age was related to the continuance of RD: individuals with adult-age RD were slower in the rapid naming of letters than their controls or counterparts with childhood RD but without continuing reading problems. This finding further confirms that RAN, which is well established in earlier research (e.g., Heikkilä et al., 2015; Landerl et al., 2019) is one of the key factors underpinning reading fluency. Although in-depth elaboration of the possible factors underlying the relation between RAN and reading fluency was beyond the scope of the present study, the role of general processing speed as a possible common denominator of reading fluency and RAN, which has been suggested in earlier research (e.g., Georgiou et al., 2018), was minor in the present sample according to the post hoc analyses conducted in Study I. This may indicate that, instead of just one factor, the cognitive processes explaining or mediating the association of RAN with reading fluency are multiple, including orthographic processing or attention (Papadopoulos et al., 2016) in addition to the strong direct effect of RAN on reading speed (e.g., Papadopoulos et al., 2016). However, RAN was not the only adult-age cognitive difference observed between the groups: working memory, processing speed, and verbal skills, in addition to both reading accuracy and comprehension, were lower in the individuals with childhood RD than in the control group, regardless of whether they were classified as having adult-age RD or not. This suggests that childhood RD might have associations with lower performance in some cognitive skill domains in adulthood despite the possible improvement in reading fluency.

With respect to educational attainment, the group of individuals with childhood RD, with and without adult-age RD, had attained a lower mean educational level than their matched controls. A vocational qualification was more common and a higher education degree less common among the individuals with childhood RD than among controls, regardless of the continuance of childhood RD, that is, regardless of adult-age fluency problems. This is in line with several previous findings on the association of childhood LDs with low educational qualifications (e.g., McLaughlin et al., 2014; Undheim, 2003, 2009; Werner, 1993). However, unlike in Maughan and colleagues' (2009) study, no association was found between the continuance of RD and education in the present sample. It should be noted that this association was examined from somewhat different aspects in the two studies: in Maughan and colleagues (2009), educational qualification and age of completed education were found to predict later reading skills among poor readers, whereas in the present study, in which differences between groups with and without reading fluency problems were studied, no between-group differences

in educational qualifications were found. The present findings may indicate that the experience of struggling with learning in childhood may result in a reluctance to continue on an academic track after compulsory education, even if reading skills improve over the years. The findings of Maughan and colleagues (2009), in turn, suggest that if one continues academically demanding studies, reading skills will be practiced and may improve. Thus, the discrepancies in the findings of the two studies suggest that the relation between the continuance of RD and educational qualification may be reciprocal.

Despite the absence of differences in their educational qualifications, employment status differentiated the two groups with childhood RD: being currently unemployed was more common in the group with continuing problems in reading fluency than in the group without adult-age RD. Moreover, the group without adult-age RD did not differ from their controls in current employment status. This finding, which confirms the earlier rather few and varying results on unemployment among individuals with childhood RD (e.g., Caspi et al., 1998; Madaus, 2006; Parsons & Bynner, 2002; Schulte-Körne et al., 2003), indicates that continuing childhood RD, not childhood RD per se, may be a hindrance in finding or remaining in employment, regardless of previous educational attainment.

The extent to which reading fluency problems continued was also associated with psychosocial wellbeing in adulthood. Although subjective psychosocial wellbeing reported by the individuals with childhood RD did not differ from that of controls at the group level, it was related to reading fluency in adulthood among the former: the lower the level of adult reading fluency, the more self-reported problems in self-esteem and social functioning and the more self-reported symptoms of depression. This finding shows one example of the factors via which childhood LDs are linked with adult psychosocial wellbeing, and, again, underlines the consequences of the persistence of the initial deficit in skills for later life. Hence, as the continuance of RD, not childhood RD as such, seems to be related to problems in at least unemployment and psychosocial wellbeing in adulthood, individuals with childhood RD should not be studied as a homogeneous group. Instead, further research should aim at enhancing understanding of the factors underlying the continuance of RD, that is, of why some of these individuals have resolved their reading problems by adulthood and others have not. Moreover, as this study examined the continuance or resolution of reading fluency problems in particular, the question of whether a different definition of RD would yield different results in terms of adult outcomes remains to be answered: does the continuance or resolution of problems in reading accuracy or comprehension make a difference in adult life and, if so, in what way? In addition, as the present focus was on RD, further research is also needed on the continuance of MD and its possible associations with adult-age outcomes. Further research is also needed to ascertain why some individuals with childhood LD cope well in adult life and others do not. Therefore, large, representative, longitudinal data enabling study of the accumulation of different factors are needed.

4.2 Associations of different types of LDs with adult-age depression, anxiety, and unemployment

The second aim, the focus of Study III, was to investigate the associations of different types of LDs (RD, MD and RD+MD) with depression, anxiety and unemployment in adulthood. A lifelong register-based dataset of 430 individuals with childhood LDs and 2 149 control individuals enabled mental health and employment to be studied more objectively than in Studies I and II, as depression and anxiety were defined on the basis of reimbursements and allowances granted for diagnosed disorders, and unemployment was defined on the basis of unemployment allowances received. Childhood LDs were categorized into RD, MD, and comorbid RD and MD. First, when childhood LDs were studied in general, that is, with each of the three subtypes of LDs, the results showed that LDs were clearly associated with both adult depression and anxiety and unemployment: LDs strongly predicted depression and anxiety via psychiatric diagnoses in adolescence, and strongly predicted unemployment both directly and via psychiatric diagnoses in adolescence. These findings extend earlier results on the associations of LDs with anxiety and depression (e.g., Klassen et al., 2013; Wilson et al., 2009) by showing that LDs increase not only the risk for problems in subjective wellbeing but also the probability to be diagnosed with mental health disorders. Moreover, the association of LDs with unemployment, which has shown inconsistencies in earlier research (Caspi et al., 1998; Parsons & Bynner, 2005) was clearly detected in the present large sample of individuals with LDs and their matched control group, and utilizing long-term data on employment.

Comparisons of results on the effects of different subtypes of LDs on adult outcomes showed only a minor difference between subtypes. As expected on the basis of some earlier findings (Hakkarainen et al., 2013 & 2015; Parsons & Bynner, 2005), childhood MD affected adult life differently from RD in some respects. MD was more strongly related to psychosocial problems in childhood and psychiatric diagnoses in adolescence than RD, via which it was also more strongly associated with anxiety in adulthood than RD. This finding suggests that MD may have more detrimental consequences in adulthood than RD. The finding also confirms and extends the results of an earlier study on the same register-based dataset (Aro et al., 2019) which revealed MD to be more strongly associated with antidepressant use and unemployment and to pose a higher risk than RD, especially for females. However, the above-mentioned difference between MD and RD aside, the findings show that, regardless of subtype, childhood LDs are associated with mental health problems and unemployment in adulthood. Interestingly, however, LDs seemed to predict these outcomes mostly via psychiatric diagnoses in adolescence. Alternatively, it is possible that LDs and psychiatric problems are both caused by a third variable such as a shared genetic base and that psychiatric problems do not tend to escalate until adolescence. Nevertheless, this finding indicates that identifying mental health problems in adolescence is critical in seeking to ameliorate psychiatric and

social problems in adulthood among individuals with LDs. Moreover, the finding calls for further research to explore and better understand the factors that may protect children with LDs from developing psychiatric problems in adolescence.

4.3 Factors in childhood and adolescence influencing adult-age outcomes

The third main research aim, which was partly answered in each of the three studies, was to explore factors, other than LD, in childhood and in adolescence that may have had a bearing on the adult outcomes of individuals with a history of LDs. The persistence of childhood LD into adulthood, educational attainment, employment, and psychosocial wellbeing were examined as outcomes in adulthood. Factors with a possible influence on adult outcomes, such as childhood cognitive skills, special educational and experienced social support, psychosocial and psychiatric problems in childhood and in adolescence, and education after comprehensive school were also explored.

4.3.1 Predictors of adult-age RD

As part of the third aim, factors influencing the continuance of reading problems into adulthood among individuals with childhood RD were explored in Study I. Reading fluency was the primary focus, as it was the measure adopted to define adult-age RD. An additional aim was to identify predictors of the variance in reading accuracy and comprehension in adulthood. First, childhood RAN, severity of childhood RD, and number of support providers were found to be predictive of reading fluency in adulthood, accounting for almost a fifth of the variance in fluency. Second, childhood phonological deficit and RAN explained almost a fifth of the variance in reading accuracy. Moreover, a fifth of the variance in reading comprehension in adulthood was predicted by childhood verbal and perceptual reasoning skills. In line with previous research results, these findings demonstrate the predictive power of the initial cognitive factors underlying the development of reading skills. As assumed on the basis of earlier studies, RAN was one of the predictors of the variance in reading skills (see Araújo et al., 2015, and Georgiou & Parrila, 2013, for reviews; Landerl et al., 2019), in both fluency and accuracy, in adulthood. Moreover, phonological skills in childhood showed an association with reading accuracy, as also found earlier (Kairaluoma et al., 2013). Intriguingly, besides cognitive predictors, the number of significant support providers during adolescence, reported by the participants and based on their own experience, was also found to be predictive of adult-age reading fluency. This small but relevant finding suggests that, along with the more obvious linkages to later well-being among individuals with LDs (Carawan et al., 2016; Stack-Cutler et al., 2015), social support may also be associated with the development of the

skill itself. However, as the nature of the support received was not categorized, that is, both professional, educational and other support were included in the measure, the relative importance of each support provider in comparison to the others remains to be examined. Moreover, it is possible that the individuals whose reading problems had eased over time had experienced support more positively than those whose reading problems continued. That is, it may be that the resolution of RD induced positive memories and experiences of the support received that overestimated the actual contribution of that support to the favorable development of reading skills. More in-depth research is needed on the association between the continuance of RD and the support received in childhood and in adolescence. All in all, the findings indicate that both cognitive and social factors are of importance in predicting whether RD is persistent or whether it resolves by adulthood.

4.3.2 Factors in childhood and adolescence influencing the association of LDs with adult-age psychosocial well-being, diagnosed depression and anxiety, and unemployment

Study II examined the influence of the severity of the initial reading problem on self-reported psychosocial well-being in adulthood among individuals with childhood RD but found no significant association. Study III utilized the larger register-based sample to examine the mediators of the association of childhood LDs with adult mental health and employment outcomes. Psychiatric diagnoses in adolescence were found to have a markedly strong association with adulthood: they almost fully explained depression in adulthood and strongly predicted anxiety and unemployment. Childhood LDs predicted depression, anxiety and unemployment in adulthood via psychiatric diagnoses in adolescence, in addition to being directly related to unemployment. The association of LDs with diagnosed psychiatric problems in adolescence showed that LDs influence psychosocial well-being as early as in adolescence, and that problems in psychosocial well-being related to LDs may exceed clinical thresholds already at this stage. Moreover, the finding indicates that the association between mental health problems in adolescence and those in adulthood, established in the general population (Fergusson et al., 2005; McLeod et al., 2016), is also found among individuals with LDs.

Unlike psychiatric problems in adolescence, psychosocial problems reported by parents or teachers in childhood were not of importance for the association of LDs with adult-age outcomes. Since earlier research has found an association between LDs and problems in psychosocial well-being both in childhood (for reviews, see Nelson & Harwood, 2011a&b) and in adulthood (for reviews, see Klassen et al., 2013; Livingston et al., 2018), it would be reasonable to assume that association of psychosocial problems in childhood with those in adulthood would also hold in the long term. However, childhood psychosocial problems in the present sample were relatively mild in general, as children with severe psychiatric symptoms were primarily not referred to the CLD. The problems reported by parents and teachers may have been rather

temporary in nature and may even have eased with the support provided during the clinical assessment process. Therefore, future longitudinal research should extend the current knowledge on the association of LDs with mental health problems by investigating diagnosed psychiatric disorders in childhood as well. This is emphasized by a viewpoint that the overlap of LDs with psychiatric disorders is familial and may reflect a shared genetic base, suggested by recent findings on RD (Cederlöf et al., 2017).

Unexpectedly, the lack of postsecondary education had no impact on the association of childhood LDs with depression, anxiety, and unemployment in adulthood. In contrast, the presence of postsecondary education, not the lack of it, mediated the association between childhood LD and unemployment in adulthood. The effect of this finding was weak, although it was confirmed by post-hoc group comparisons indicating that among the individuals with LDs, but not controls, the proportion of those with postsecondary education who were nevertheless unemployed was higher than expected. The potential factors underlying this finding are various and it may indicate that postsecondary education is not necessarily a protective factor for individuals with LDs. These individuals may need continuing support in finding employment after graduation. However, the findings for educational attainment are in line with earlier, rather inconsistent, findings on the associations of educational attainment with adult outcomes among individuals with LD. Some of these findings suggest, for example, that mental health problems in adulthood are linked to uncompleted secondary education (Wilson et al., 2009) whereas other findings report no association between postsecondary education and later mental health (see Klassen et al., 2013). The importance of educational attainment for the long-term outcomes of LDs thus remains to be clarified and provides a challenge for further research.

Mother's education as a possible moderator of the relation between childhood LDs and adult-age outcomes was also found to have no impact. This is in contrast with earlier findings indicating that parental education is predictive of children's educational attainment (OECD, 2018), and that low parental education is related to children's learning difficulties (Hakkarainen et al., 2015) and, further, to psychosocial wellbeing (Dubow et al., 2009). The present finding may reflect the characteristics of the clinical sample that was examined: owing to possible referral bias, parental educational level among the clients of the CLD was somewhat higher than average. Well-educated parents may place a high value on their children's education and on supporting them at school, and thus, be more agreeable to clinical assessments than parents with a lower educational level.

It is noteworthy that the findings of Studies II and III on the association of childhood LDs with psychosocial well-being in adulthood were somewhat contradictory: in Study II, childhood RD *per se* was not related to self-reported psychosocial wellbeing in adulthood, whereas in Study III, a strong association of LDs with diagnosed depression and anxiety was found, yet mostly indirectly via psychiatric problems in adolescence. This difference in the results may be explained by differences between the samples. In Study II, the sample

comprised of individuals with childhood RD that had participated voluntarily in one-on-one assessments. As only 63 percent (48 individuals) of the original sample volunteered, it is possible that adults with major problems in psychosocial well-being did not participate in the follow-up, which may have induced a positive bias in the sample. This reflects a typical limitation in longitudinal research: individuals participating in follow-up assessments are not necessarily representative of the initial sample and may show better outcomes than drop-outs. However, this bias was avoided in the register-based sample in Study III where there was practically no attrition. Moreover, as the aim in Study II was to focus on "pure" RD, comorbid LDs and psychosocial problems in childhood were initially excluded from the sample, which may also have contributed to the rather positive adult-age outcomes. In addition, the sample in Study II was small and thus, the statistical power of the tests was rather low. Therefore, to enhance understanding of the association of LDs with adult-age outcomes, further longitudinal research on LDs may need more large-scale register-based studies.

Another possible explanation for the difference between the results of Study II and Study III is that the measures were different: in Study II, self-report questionnaires were used to measure psychosocial well-being whereas psychiatric diagnoses were used in Study III. Self-rating questionnaires provide subjective information of the individual's psychosocial well-being and, unlike medical diagnoses, are prone to personal and situational influences. In their self-ratings, the participants may have given responds that they thought to be socially more acceptable, aiming to provide a "better" or "healthier" picture of themselves than in reality. On the other hand, as they may provide information of more subtle subthreshold problems in well-being, self-rating questionnaires might have been a good indicator of the risk of possible later psychiatric problems. Thus, self-rating questionnaires can, at their best, be a useful adjunct to diagnoses with strict cut-off criteria. By evaluating psychosocial well-being from different perspectives, self-ratings and diagnose-based evaluation may together provide a richer picture of the individual's state than either of them alone.

4.4 Practical implications

The findings of this study contribute to both policymaking and the work of practitioners seeking to help individuals with LDs in several ways. First, the findings on the continuance of childhood RD and its further influences on adult life indicate the importance of early assessment, special education and interventions for children and adolescents with RD. The findings suggest that improved reading skills are not only an advantage during school years but may also contribute to employment prospects and psychosocial well-being later in life. Thus, the provision of special education resources for individuals with RD is of importance not only on the individual but also on the societal level. The

present findings also support earlier findings on RAN as a key predictor of reading fluency (e.g., Landerl et al., 2019), and suggest that in the evaluation of children with RD, severe problems in RAN should be considered as an indicator of persistent RD and hence need of long-term support.

Moreover, the findings underline the need to provide long-term psychosocial support for individuals with LDs to buffer them against problems in psychosocial wellbeing later in life. Identification of psychosocial problems, even minor, and the provision of social and emotional support may be at least as important as the practising of cognitive or academic skills. Hence, along with academic skill training, interventions for children with LDs should systematically include built-in elements of psychosocial support.

Greater attention should be paid to adolescence as a key period in terms both of psychosocial well-being and the choice of further education and career. It is of utmost importance that support for adolescents with a history of LDs is not withdrawn at this stage, as they are at higher risk than peers for struggling with or even dropping out of postsecondary education and for encountering psychosocial or psychiatric problems. Sadly, at the end of comprehensive education, the amount of support is often substantially withdrawn. As the findings on the association of LDs with unemployment, for instance, indicated, individuals with LDs may need diverse support, extending as far as early adulthood. Such support could include special education and student counselling as well as therapeutic and neuropsychological support. In Finland, a promising initiative in the recently released new government program is to extend compulsory education to the two years of postsecondary education. This involves, for instance, providing complimentary learning materials for students in high schools and vocational schools. Along with this reform, it would be advisable to develop special education and student counselling services in the postsecondary education to better serve students with LDs, and their well-being.

Above all, the findings of the present study call for a notable shift in LD research and practice away from a focus on primarily training the child's skills towards a focus on the whole individual in interaction with his or her environment, or, as Waber (2011) succinctly puts it, "from skill focus to child focus" (p. 211). The present findings support the stance taken by Waber (2011) that instead of solely training the skill in question, LD interventions should be implemented in collaboration with each of the individual's support providers and thus involve the whole environment while simultaneously maintaining a lifespan perspective, that is, bearing the long-term influence of the LD in mind.

4.5 Strengths and limitations

The two-fold data in the present longitudinal research made it possible to approach LDs during the life course from different perspectives, that is, examining their implications at the societal and more general level through the

use of comprehensive register-based data and at the more individual and specific level by studying 48 individuals with RD and their matched controls. Moreover, as earlier longitudinal studies extending beyond adolescence and emerging adulthood are rare, this study offered new insights on the long-term effects of LDs. The study design was genuinely longitudinal, that is, the initial childhood LD assessment data was accessible at follow-up. This was an obvious advantage, as the challenges presented by longitudinal research mean that in studies on adults with an LD history, LDs have often been defined on the basis of self-reports or measurements conducted in adulthood. Moreover, the data and design in the present study also enabled the examination of RD free from comorbid disabilities. This study yielded valuable knowledge on the impacts of the continuance of pure RD on adult-age outcomes both regarding the important domains of education, employment and psychosocial wellbeing. Corresponding longitudinal research, controlling for comorbidities, is also needed on other LDs.

Another asset of the present study was that the comprehensive register-based data included annual data on reimbursements for medications used to treat psychiatric problems. Previous studies focusing on LDs and mental health have mainly identified mental health problems using self-ratings and have only examined mean-level differences between individuals with and without LDs. Thus, knowledge of mental health disorders exceeding clinical thresholds among adults with LDs is largely absent in earlier research. Two recent exceptions are the large-scale study on mental health among adults with LDs by Wilson with colleagues (2009), who used the World Mental Health Composite Diagnostic Interview Schedule (WHO, 1990) as a measure, and the register-based cohort study on the co-occurrence of documented RD and psychiatric diagnoses by Cederlöf and colleagues (2017). Nevertheless, the study of Wilson and colleagues (2009) was cross-sectional and based on self-reported information on mental illnesses, and the study of Cederlöf and colleagues (2017) focused only on RD. Hence, the present study, along with a previous study using the same register data (Aro et al., 2019), likely represents the most comprehensive recent longitudinal study on LDs with information about diagnosed mental health disorders in adulthood.

The sample used in the present study was originally clinical. Hence, besides the long-term outcomes of childhood LDs, the findings of the study may also shed light on the possible long-term contribution of clinical assessment and intervention. This was especially evident in the subsample of adults with childhood RD, as the long-term outcomes regarding the resolution of reading problems and psychosocial wellbeing were both relatively positive. These findings resemble those of earlier longitudinal studies on clinical samples, which have also reported rather positive long-term outcomes regarding the resolution of RD (Schulte-Körne et al., 2003) and psychosocial wellbeing (Schulte-Körne et al., 2003; Strehlow et al., 1992; Undheim, 2003). The clinical assessment process, for which each individual with childhood LDs in the present sample had been referred, can arguably be considered a short-term intervention, as it included three to five appointments for a family interview,

neuropsychological assessments, feedback and counselling for family members and school personnel. Besides the clinical assessment, each child received special educational support, which in Finland can be provided on the recommendation of the child's teacher (see Björn, Aro, Koponen, Fuchs, & Fuchs, 2015). Thus, the clinical assessment and the related active participation of the family and school might be reflected in the rather positive long-term outcomes of the present individuals with RD. However, despite the history of clinical assessment in childhood, the findings of the larger register-based sample of LDs clearly indicated that LDs were associated with psychiatric problems and unemployment. This suggests that support received in childhood alone, although beneficial in many ways, may not necessarily make a long-term contribution to outcomes in adulthood.

This study has limitations that should be borne in mind when interpreting the results. Owing to the use of clinical data, the results cannot be directly generalized to the wider population of individuals with LDs. While clinical samples have clear advantages in that they typically provide systematically collected assessment data for use in research, they also have limitations, one of which is referral bias. Children are referred for clinical assessment by their teachers or by school psychologists, and hence the rationale for the referral may vary according to, for example, personal preferences or school practices. Hence, clinical samples are not representative of the whole population of individuals with LDs as a whole. Findings on the long-term outcomes of childhood LDs based on a representative population-based sample of LDs could differ markedly from the present findings. However, for practical and ethical reasons, such a sample could not be formed: given that the prevalence of LDs in the general population is estimated to be around 10 percent, a representative sample of 4 000 individuals would be required to obtain a sample of 400 individuals with LDs. However, bearing its limitations in mind, the present investigation with a clinical sample yielded valuable knowledge on the long-term outcomes of LDs that can be applied both in future research and in practice.

Another consideration of the present study is that the register-based data provided by the Social Insurance Institution of Finland (Kela) and Statistics Finland were limited. For example, only Kela-funded unemployment allowances were available for the present research and not those awarded by other organizations. This may have led to somewhat biased results, despite the comprehensiveness of the register-based data. It is also noteworthy that the data in the present study were correlational. Hence, causality between variables that are associated with each other cannot be assumed. Thus, as an alternative explanation for, for example, the relation between childhood LDs and later psychiatric diagnoses, instead of the interpretation that LDs precede or predict psychiatric problems, it is possible that both are caused by a third variable such as a shared genetic base or even childhood adversity. Nevertheless, the present findings underline adolescence as a critical period in the lives of individuals with LDs as problems, no matter whether they are

caused by LDs or an unmeasured third variable, typically escalate or are maybe best prevented during that developmental period.

4.6 General conclusions

By investigating a large sample of adults with a documented childhood LD, this longitudinal study extends the existing research by shedding light on the long-term outcomes of LDs from a wider perspective than that of the deficits alone. The overall message of the findings is that childhood LDs per se do not necessarily have associations with negative outcomes in adult life, but the relationship between LDs and adulthood is mediated by various other factors. Some of these factors, such as psychiatric problems in adolescence, were identified while others were beyond the scope of this study and remain to be explored.

Overall, the findings of this study support Waber's (2010) view that LDs should not be thought of merely as distinct skill deficits in need of rehabilitation. Instead, the focus should be on the whole individual who lives not just with a learning deficit but also with many other problems, strengths and experiences. These may not differ substantially from the problems, strengths and experiences that individuals in general encounter. However, to support the individual comprehensively, or, in the field of research, to enhance understanding of LDs in the life course, requires knowledge of these personal factors and of the role of the environment in which the individual lives. Waber (2010) takes this viewpoint even further by stating that the focus should not be the child either, but "rather the interaction between the child and the world within which that child must function".

However, our results on the specific problems caused by the LD should not be underestimated. Among individuals with RD, the extent to which reading fluency problems continue to manifest in adulthood is relevant to their general well-being, which should be taken into account when planning interventions to improve the skill itself. As McNulty (2003) showed in a qualitative study examining the emotional experiences of adults with dyslexia, both functional (referring to the cognitive deficit) and emotional compensation are essential in adapting to living with an LD. McNulty (2003) also emphasized the importance of support received from significant others and professionals in promoting the both functional and emotional compensation in adult life. This corresponds with the finding on received support in the present study: the self-experienced number of supportive significant others during adolescence was relevant to the extent to which childhood RD continued into adulthood. On this issue, it has been suggested that interventions combining both academic skill training and emotional support could best benefit individuals with RD (for a review, see Livingston et al., 2018). This can be assumed to apply to other LDs as well.

In sum, by confining examination of the long-term outcomes of LDs to skill deficits related to the disability, we may be misled and lose something of essential importance to the phenomenon in the larger context. On the other hand, by dismissing the deficit at the cognitive level, which continues to occur at some level in adulthood, we may also lose out. Therefore, a holistic approach including cognitive, social, emotional, educational, and environmental aspects in the lifespan perspective should be applied when examining LDs, both in research and practice.

Despite its aim of investigating LDs in a wider context, this study was unable to comprehensively disentangle the factors that contribute to a successful adult life in some individuals with LDs. An important challenge for further research that was beyond the scope of this study would be to explore the emotional and personal qualities and characteristics that may be related to how the individual copes in life despite the hampering effect of the LD. This calls for a more individual and qualitative approach. A few well-known initiatives have been made to elucidate these personal factors. One of these is the longitudinal study conducted by the Frostig Center, which explored the "success attributes" of adults with childhood LDs (Goldberg, Higgins, Raskind, & Herman, 2003; Raskind, Goldberg, Higgins, & Herman, 1999; Spekman, Goldberg, & Herman, 1992). Combining both quantitative and qualitative approaches, the authors found that self-awareness of, and a realistic adaptation to, the LD, perseverance and the ability to set appropriate goals, and emotional stability and appropriate use of support systems contributed to success in educational, employment and social outcomes among individuals with LDs, both in young adulthood (Spekman et al., 1992) and later (Goldberg et al., 2003; Raskind et al, 1999). Corresponding findings were reported in the the Island of Kauai longitudinal study: protective and resilience factors related to unexpectedly positive adult outcomes in the employment, mental health and social relationships of individuals with LDs included a favorable temperament and emotional support at home and outside the family, as these boost self-esteem and help the individual to find a suitable path in life (Werner, 1993; Werner & Smith, 2001). Moreover, a common finding in the earlier studies on LDs that have explored personal protective factors is the importance of discovering a niche: finding environments and activities that are well-suited to one's skills and that feel meaningful enhances success and balance in life (Goldberg et al., 2003; McNulty, 2003; Werner & Smith, 2001). All in all, according to these earlier findings, the factors that are related to success in education or employment or to high well-being in individuals with LDs seem to be much the same as those among individuals in general.

As this line of research remains rather narrow, more in-depth study is needed on the personal qualities related to success in life among individuals with LD. Earlier findings on protective personal qualities suggest that these factors may be pivotal in overcoming the risk presented by the LD, and therefore furthering knowledge about them would be of great importance in finding ways to better support individuals with LDs. If we could help individuals with LDs to load their backpacks with personal characteristics such

as high self-esteem and perseverance instead of negative experiences, the long-term outcomes might be more positive. Exploring the impact of personal characteristics in the present sample would therefore be an important next step in this research. The results might even contribute to finding means to protect individuals with LDs from psychiatric problems in adolescence, which were shown here to have further consequences in life. In the present sample, the clinical referral and assessment process may have strengthened the positive personal characteristics of some individuals, such as self-awareness and adaptation to the LD, and thus provided protective factors that they could carry in their backpack. However, more research is needed to better understand the possible impact of personal qualities of these kinds on the long-term outcomes of LDs. In sum, the findings on personal characteristics show that each individual with LDs is different and has a unique combination of skills, deficits, and personal characteristics, however a specific LD is classified. The uniqueness of each pathway to adulthood means that research on the group-level can never fully portray the diverse associations of LDs with adult-age outcomes.

YHTEENVETO (FINNISH SUMMARY)

**Seurantatutkimus lapsuudessa todetuista oppimisvaikeuksista:
Polut koulutukseen, työllistymiseen ja psyykkiseen hyvinvointiin.**

Tämän seurantatutkimuksen tavoitteena oli tarkastella lapsuudessa todettujen oppimisvaikeuksien jatkuvuutta ja yhteyksiä aikuisiän kouluttautumiseen, työllistymiseen ja psyykkiseen hyvinvointiin. Oppimisvaikeudet ovat kapea-alaisia neurologisia häiriöitä, jotka aiheuttavat hitautta esimerkiksi lukemisen tai matematiikan taitojen oppimisessa riippumatta yleisestä taitotasosta tai opetuksesta. Oppimisvaikeuksia arvioidaan esiintyvän noin 5-15 prosentilla lapsista (American Psychiatric Association, 2013). Koska oppimisvaikeudet liittyvät tiiviisti koulunkäyntiin, tutkimus on suurelta osin keskittynyt kouluikäisiin lapsiin, oppimisvaikeuksien kognitiivisiin taustataitoihin ja siihen, miten ne heijastuvat oppimiseen (ks. Araújo, Reis, Petersson, & Faísca, 2015; Georgiou & Parrila, 2013). Oppimisvaikeuksien tiedetään kuitenkin olevan sitkeitä ja jatkuvan usein yli nuoruuden aikuisuuteen asti (mm. Gerber, 2012; Maughan, ym., 2009). Kapea-alaisen koulunkäyntiin vaikuttavan haitan lisäksi oppimisvaikeudet voivat siis heijastua elämään monella tapaa myös aikuisiässä, esimerkiksi kouluttautumisen (McLaughlin, Speirs, & Shenassa, 2014), työllistymisen (Caspi, Wright, Moffitt, & Silva, 1998; Parsons & Bynner, 2002; Undheim, 2003), itsetunnon (Carawan, Nalavany, & Jenkins, 2015) ja mielenterveyden ongelmina (Wilson, Armstrong, Furrie & Walcot, 2009). Vuosien myötä oppimisvaikeuteen liittyvät muut hankaluudet voivat muodostua ihmiselle itselleen olennaisemmiksi kuin oppimisvaikeus sinänsä. Tämän vuoksi oppimisvaikeuksien pitkittäistutkimus koulunkäyntiä ja oppimista laajemmassa yhteydessä on erityisen tärkeää. Pitkittäistutkimuksia, joissa hyödynnettäisiin sekä lapsuuden oppimisvaikeuteen liittyviä tietoja, että aikuisiän tietoja, on kuitenkin edelleen vähän.

Harvat olemassa olevat oppimisvaikeuksia koskevat pitkittäistutkimukset osoittavat, että vaikka oppimisvaikeus muodostaa riskin aikuiselämän ongelmille, huomattava osa oppimisvaikeustaustaisista aikuisista pärjää hyvin elämässään. Aiemmat pitkittäistutkimukset ovat tyypillisesti keskittyneet tarkastelemaan lukemisen ja kirjoittamisen erityisvaikeutta eli lukivaikeutta, joka on yleisin oppimisvaikeus (ks. Shaywitz, Morris, & Shaywitz, 2008). Lukivaikeuden jatkuvuutta tutkittaessa sen on todettu lieventyvän aikuisuuteen mennessä osalla lukivaikeustaustaisista henkilöistä (mm. Schulte-Körne ym., 2003; Torppa ym., 2015). Tieto siitä, mitkä tekijät itse lukivaikeuden ohella vaikuttavat siihen, kuinka sitkeästi vaikeus jatkuu ja miten se on yhteydessä kouluttautumiseen, työllistymiseen ja psyykkiseen hyvinvointiin aikuisena, on kuitenkin vielä puutteellista. Nämä tekijät voivat liittyä niin kognitiivisiin taustataitoihin kuin psyykkisiin, sosiaalisiin tai yhteiskunnallisiin seikkoihin.

Aiemmissa pitkittäistutkimuksissa on harvoin tutkittu oppimisvaikeuksien välillä olevia mahdollisia eroja, vaikeuksien samanaikaista esiintymistä tai samanaikaisia psyykkisiä ongelmia. On kuitenkin viitteitä siitä, että erityyppi-

sillä oppimisvaikeuksilla olisi erilainen yhteys aikuisiän sopeutumiseen ja hyvinvointiin: erityisesti matematiikan oppimisen vaikeuden tai sekä matematiikan että lukemisen heikkojen taitojen on todettu ennustavan muun muassa työttömyyttä ja masennusta aikuisena pelkkää lukivaikeutta vahvemmin (mm. Parsons & Bynner, 2005). Tämän tutkimuksen tarkoituksena oli laajentaa aiempaa tutkimustietoa oppimisvaikeuksien yhteyksistä aikuisuuteen. Tutkimuksessa tarkasteltiin sekä puhtaan lukivaikeuden ja sen jatkumisen yhteyttä että usean erityyppisen oppimisvaikeuden yhteyksiä koulutukseen, työllistymiseen ja psyykkiseen hyvinvointiin aikuisena. Tutkimuksen keskiössä oli tarkastella oppimisvaikeuden ohella myös muita aikuisikään mahdollisesti heijastuvia kognitiivisia, psyykkisiä tai nuoruuden elämäntapahtumiin liittyviä tekijöitä.

Tutkimuksessa hyödynnettiin aineistoa 20-39-vuotiaista aikuisista, jotka olivat lapsena käyneet laajoissa neuropsykologisissa oppimisvaikeustutkimuksissa Niilo Mäki Instituutin ja Jyväskylän Perheneuvolan ylläpitämällä Lastentutkimusklinikalla. Lastentutkimusklinikka on kouluikäisten lasten oppimisvaikeuksien tutkimiseen ja kuntouttamiseen erikoistunut yksikkö, joka toimii osana kunnallisia palveluita Keski-Suomen alueella. Lapset tulevat tutkimuksiin useimmiten erityisopettajan tai koulupsykologin lähetteellä. Oppimisvaikeuksien arviointien ohella lasten testituloksista ja taustatiedoista kerätään perheiden luvalla aineistoa myös tieteelliseen käyttöön. Tähän tutkimukseen valittiin aineistosta kaikki ne henkilöt, jotka olivat seurantatutkimusaineiston keruun alkaessa vuonna 2014 vähintään 20-vuotiaita ja joiden osalta aineistosta löytyi tutkimukseen tarvittavat testitulokset. Seuranta-aineisto sisälsi näin ollen yhteensä 430 oppimisvaikeustaustaisesta henkilöä sekä heidän 2149 verrokkiaan. Tutkimus koostui kolmesta osatutkimuksesta. Osatutkimukset I ja II perustuivat 48 aineistosta valitun lukivaikeustaustaisen aikuisen ja heidän 37 verrokkinsa seurantatapaamisten testi- ja haastattelumateriaaleihin. Osatutkimuksessa III hyödynnettiin koko seuranta-aineiston lapsuuden tietoja sekä nuoruuden ja aikuisuuden rekisteripohjaisia tietoja.

Tutkimuksessa oli kolme päätavoitetta. Ensimmäinen tavoite oli tutkia, missä määrin lapsuudessa todettu lukivaikeus jatkuu aikuisuuteen asti ja millaisia yhteyksiä lukivaikeudella ja sen jatkuvuudella on aikuisiän koulutukseen, työllistymiseen ja psyykkiseen hyvinvointiin. Osatutkimukset I ja II osoittivat, että 60 prosentilla (29 henkilöllä) lukivaikeustaustaisista aikuisista (n = 48) lukivaikeus oli lieventynyt aikuisuuteen mennessä, kun vaikeuden mittarina käytettiin lukemisen sujuvuutta eli lukunopeutta. Kaikilla lukivaikeustaustaisilla aikuisilla lukutaito oli silti vielä merkitsevästi heikompi kuin verrokkiaikuisilla (n = 37) sekä sujuvuuden, tarkkuuden että ymmärtämisen osalta. Lukivaikeustaustaisten aikuisten koulutustaso oli verrokkeja alempi riippumatta siitä, oliko lukivaikeus jatkunut aikuisuuteen. Lukivaikeuden jatkuminen oli kuitenkin yhteydessä työllistymisen ongelmiin: ne lukivaikeustaustaiset, joilla oli myös aikuisena selviä lukusujuvuuden ongelmia, olivat muita useammin työttöminä. Tulokset osoittivat myös, että lukivaikeuden jatkumisella oli lukivaikeustaustaisten aikuisten joukossa yhteyttä psyykkiseen hyvinvointiin aikuisena: mitä sujuvampi lukutaito aikuisena, sitä vahvempi itsetunto, sitä

parempi sosiaalinen toimintakyky ja sitä vähemmän masennusoireita. Verrokkiryhmässä, jossa aikuisilla ei ollut lukivaikeustaustaa, lukusujuvuudella ei ollut samanlaista yhteyttä hyvinvointiin.

Toinen päätavoite oli selvittää, miten eri tyyppiset oppimisvaikeudet lapsuudessa (lukivaikeus, matematiikan oppimisen vaikeus ja näiden yhtäaikainen esiintyminen) ovat yhteydessä aikuisiän työttömyyteen ja diagnosoituihin mielialahäiriöihin. Osatutkimuksessa III havaittiin, että lapsuuden oppimisvaikeudet ennustivat sekä masennus- ja ahdistusdiagnoosia että työttömyyttä aikuisena. Oppimisvaikeustyypillä (lukivaikeus, matematiikan vaikeus tai molemmat) ei kuitenkaan havaittu olevan suurta merkitystä oppimisvaikeuden ja aikuisiän mielenterveysongelmien ja työttömyyden väliselle yhteydelle. Henkilöt, joilla oli matematiikan vaikeus, olivat lukivaikeustaustaisia alttiimpia ahdistukselle, jos heillä oli ollut psykososiaalisia ongelmia lapsena ja mielenterveysongelmia nuorena. Muita ryhmäeroja ei tullut esiin.

Kolmantena päätavoitteena oli tarkastella, miten eri tekijät lapsuudessa ja nuoruudessa muokkaavat oppimisvaikeuksien yhteyksiä aikuisikään. Tähän tavoitteeseen liittyen tutkittiin, ovatko lapsuuden lukutaito ja kognitiiviset taidot, erityisopetus tai ympäristöltä nuorena saatu tuki yhteydessä siihen, jatkuuko vai lieventyykö oppimisvaikeus aikuisena, ja ennustavatko nämä tekijät vaikeuden jatkumista tai lieventymistä. Osatutkimuksessa I havaittiin, että ne lukivaikeustaustaiset aikuiset, joiden lukemisvaikeus oli jatkunut, olivat olleet lapsena hitaampia sarjallisen nimeämisen tehtävässä. Lisäksi havaittiin, että sarjallinen nimeäminen, lapsuuden lukivaikeuden vaikeustaso sekä oma kokemus siitä, kuinka paljon on saanut tukea ympäristöltä nuoruusiässä, ennustivat aikuisiän lukusujuvuuden tasoa. Yhdessä nämä tekijät selittivät kuitenkin vain 18 prosenttia lukusujuvuuden vaihtelusta aikuisena. Osatutkimus II taas osoitti, että lapsuuden lukivaikeudella sinänsä tai sen vaikeustasolla ei ollut yhteyttä psyykkiseen hyvinvointiin aikuisiässä. Lisäksi tutkittiin, missä määrin lapsuuden taustatekijät, koulutuksen puute ja nuoruuden mielenterveysongelmat muokkaavat tai välittävät oppimisvaikeuksien yhteyttä aikuisiän masennukseen, ahdistukseen ja työttömyyteen. Osatutkimus III osoitti, että oppimisvaikeudet eivät suoraan ennustaneet aikuisiän masennus- tai ahdistusdiagnoosia, vaan oppimisvaikeuden ja aikuisiän masennuksen ja ahdistuksen yhteys kulki sen kautta, oliko henkilöllä ollut nuoruudessa mielenterveysongelmia. Oppimisvaikeus lapsena lisäsi riskiä nuoruuden mielenterveysongelmille, jotka ennustivat aikuisiän masennusta ja ahdistusta vahvasti. Lisäksi oppimisvaikeudet olivat yhteydessä työttömyyteen sekä suoraan että nuoruuden mielenterveysongelmien kautta. Sukupuoli tai äidin koulutustaso eivät vaikuttaneet oppimisvaikeuksien ja aikuisiän välisiin yhteyksiin.

Tämän seurantatutkimuksen tulokset osoittavat, että lapsuuden oppimisvaikeus sinänsä ei ole suoraan yhteydessä kouluttautumisen, työllistymisen tai psyykkisen hyvinvoinnin ongelmiin aikuisena. Myöskään oppimisvaikeuden tyypillä tai sillä, onko henkilöllä yksittäinen oppimisvaikeus vai useampi samanaikainen vaikeus ei tämän tutkimuksen mukaan ole huomattavaa merkitystä aikuisiässä. Oppimisvaikeus lapsena on kuitenkin riski nuoruuden mie-

lenterveysongelmille; mikäli riski toteutuu, työttömyys ja mielialaongelmat aikuisena ovat todennäköisempiä. Lisäksi se, miten sitkeästi lukivaikeus jatkuu, eli miten selvästi vaikeus näkyy vielä aikuisena, on yhteydessä sekä työllistymiseen että itse koettuun psyykkiseen hyvinvointiin. Oma kokemus nuoruudessa saadusta tuesta lähiympäristöltä taas on yhteydessä siihen, missä määrin oppimisvaikeus jatkuu aikuisuuteen. Nuoruusikä siis näyttää olevan erityisen merkityksellinen oppimisvaikeustaustaisten ihmisten elämässä.

Tutkimustulosten perusteella voidaan päätellä, että lapset ja nuoret, joilla on oppimisvaikeuksia, tarvitsevat monipuolista, pitkäaikaista tukea, joka jatkuu myös peruskouluajan jälkeen. Oppimisvaikeuden kuntouttaminen ja taitojen harjoittaminen kannattaa, koska oppimisvaikeuden lieventymisellä voi olla pitkäaikaisia myönteisiä vaikutuksia aikuisikään asti, koulunkäynnin ja opiskelun lisäksi myös työllistymiseen ja psyykkiseen hyvinvointiin. Erityisopetukseen käytetyt resurssit ovat siksi tärkeitä sekä yksilöllisellä että yhteiskunnallisella tasolla. Tukimuodot eivät kuitenkaan saisi rajoittua erityisopetukseen tai kuntoutukseen: monipuolinen psyykkinen tukeminen, kuten kannustaminen, hyväksyvä ilmapiiri ja itsetunnon vahvistaminen, voivat olla vähintään yhtä merkityksellisiä aikuisiän kannalta. Kaikki aikuiset nuoren ympärillä, niin koulun henkilökunta, sosiaalitoimen henkilöstö, harrastustoiminnan vetäjät kuin perhe, voivat yhdessä vaikuttaa kannustavan ja hyväksyvän ilmapiirin luomiseen. Jo lieviin ongelmiin koulunkäynnissä ja mielenterveydessä pitäisi tarttua, jotta suuremmat vaikeudet voitaisiin ennaltaehkäistä. Seuraukset näkyvät aikuisena sekä yleisemmin yhteiskuntaan sijoittumisessa että yksilön omana kokemuksena.

Näihin tuloksiin peilaten on valitettavaa, että erityisopetuksellinen tuki usein vähenee huomattavasti juuri yläkoulun aikana ja toiselle asteelle siirryttäessä. Monipuolisen tuen jatkuminen nuoruusiässä ja aikuisiän kynnyksellä olisi olennaista, jotta opintojen sujuminen ja loppuunsaattaminen olisi mahdollista oppimisvaikeudesta huolimatta ja jotta psyykkisen hyvinvoinnin ongelmia voitaisiin ennalta ehkäistä. Uuden hallitusohjelman linjaus oppivelvollisuuden pidentämisestä toiselle asteelle voi tuoda mukanaan mahdollisuuksia erityisopetukselle: oppivelvollisuuden jatkuessa myös tehostettua ja erityistä tukea niitä tarvitseville opiskeilijoille on mahdollista jatkaa järjestelmällisesti. Samalla erityisopetuksellista ja psykososiaalista tukea toisella asteella voidaan kehittää vastaamaan paremmin oppimisvaikeustaustaisten opiskelijoiden tarpeita.

Tämän seurantatutkimuksen mukaan lapsuuden oppimisvaikeuden yhteys aikuisikään muovautuu elämän varrella monien eri tekijöiden myötävaikutuksesta. Siksi se, miten aikuiselämä oppimisvaikeuden kanssa sujuu, voi olla varsin yksilöllistä, vaikka taustalla olisi alun perin sama vaikeus. Tässä tutkimuksessa pystyttiin tarkastelemaan vain osaa niistä tekijöistä, jotka mahdollisesti vaikuttavat oppimisvaikeuksien kehityskulkuun. Oppimisvaikeuksien kehityskulun ja siihen liittyvien tekijöiden ymmärtämiseksi tarvitaankin lisää pitkittäistutkimusta, jossa seurataan oppimisvaikeustaustaisten ihmisten elämää useissa eri mittapisteissä ja jossa pystytään löytämään erilaisia yksilöllisiä kehityspolkuja lapsuudesta aikuisuuteen. Tätä kautta myös tukijärjestelmiä

sekä perusopetuksessa että toisen asteen opetuksessa pystyttäisiin muokkaamaan toimivammiksi oppimisvaikeustaustaisille henkilöille. Koska oppimisvaikeuden vaikutukset eivät rajoitu ainoastaan oppimiseen, on tuen muotojen syytä olla monialaisia.

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ORIGINAL PAPERS

I

RESOLVING READING DISABILITY – CHILDHOOD PREDICTORS AND ADULT-AGE OUTCOMES

by

Anna-Kaija Eloranta, Vesa Närhi, Kenneth Eklund, Timo Ahonen & Tuija Aro, 2019

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Authors: Anna-Kaija Eloranta, MA, Vesa M. Närhi, PhD, Kenneth M. Eklund, PhD, Timo P. S. Ahonen, PhD, and Tuija I. Aro, PhD

Affiliations:

Anna-Kaija Eloranta, Niilo Mäki Institute & University of Jyväskylä

Vesa M. Närhi, Niilo Mäki Institute & University of Jyväskylä

Kenneth M. Eklund, University of Jyväskylä

Timo P.S. Ahonen, Niilo Mäki Institute & University of Jyväskylä

Tuija I. Aro, Niilo Mäki Institute & University of Jyväskylä

Corresponding author: Anna-Kaija Eloranta, Department of Psychology, PO Box 35, FI-40014 University of Jyväskylä, Finland. Email: akeloranta@nmi.fi Telephone: +35850 377 3906.

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Abstract

We examined frequency of adult-age reading disability (RD) and its childhood predictors among 48 adults (20 to 39 years) with documented childhood RD, and contrasted their cognitive skills, education, and employment with 37 matched controls. Among individuals with childhood RD, more than half had improved in their reading fluency to the level where the set criterion for adult-age RD was not met anymore. More fluent rapid naming, less severe childhood RD, and multiple support providers in childhood together predicted improvement of reading fluency. More fluent naming differentiated the childhood RD participants whose reading fluency had improved by adult-age from those participants whose RD persisted to adult-age. All the individuals with childhood RD performed weaker than the controls in adult-age working memory, processing speed, and verbal skills. Educational level among both RD groups was lower than that among the controls. Unemployment of individuals with persistent adult-age RD (31.6%) was higher than that of individuals with improved adult-age RD (13.8%) or that of the controls (8.1%). According to our findings, rapid naming is one evident factor differentiating individuals with persisted RD from those with ameliorated reading fluency. Also, better adult-age reading fluency has significance for adult-age employment among individuals with childhood RD.

Longitudinal research has shown that developmental reading disability (RD) is a persistent deficit that impacts adult life (for reviews see Gerber, 2012; Swanson, 2012). However, follow-up studies have continued mostly up to adolescence or the early twenties (e.g., Landerl & Wimmer, 2008; Torppa, Eklund, van Bergen, & Lyytinen, 2015), with few studies extending beyond emerging adulthood (e.g., McLaughlin, Spears, & Shenassa, 2009; Maughan et al., 2009). Furthermore, although studies have shown continuity of RD on a group level, developmentally distinguishable subtypes of RD have also been detected, such as a group of individuals with RD who improve in their reading skill over time to the level where RD criteria are no longer fulfilled (e.g., Ferrer, Shaywitz, Holahan, Marchione, & Shaywitz, 2010; Torppa et al., 2015). However, factors contributing to whether RD persists or not are not yet known. In the present study, we aimed to provide more insight into RD continuing to adult-age (adult-age RD) and into the factors related to it using follow-up data of individuals with documented childhood RD.

Earlier longitudinal research indicates that childhood RD is associated with weaker reading skills at adult-age, yet still, wide variance in adult reading skills have been reported (e.g., Bruck, 1993; Maughan et al., 2009; Undheim, 2009). The proportion of adults with the history of RD that have been found to have improved in their reading and spelling skills varies from 7 to 60 percent (e.g., Maughan et al., 2009; Parrila, Georgiou, & Corkett, 2007; Schulte-Körne, Deimel, Jungemann, & Remschmidt, 2003; Undheim, 2009), depending on the definition, cut-off, sample used, and orthography. Most of the studies continuing beyond adolescence and young adulthood have been conducted in English-speaking countries (e.g., Maughan et al., 2009). To our knowledge, only a few exceptions exist in German (Schulte-Körne, Deimel, Jungemann, & Remschmidt, 2003; Strehlow et al., 1992), in Norwegian (Undheim, 2009), and in Finnish (Korhonen, 1995). However, as orthographies vary in the

consistency of letter-sound correspondences (Seymour, Aro, & Erskine, 2003), which has implications on how different domains of reading skills (fluency and accuracy) develop (e.g., Landerl & Wimmer, 2008), more longitudinal research of the persistence of RD is needed in different language environments.

There is limited knowledge on the mechanisms related to cognitive skills that are associated with persistence of RD and on childhood RD's associations with adult-age cognitive skills. Among the cognitive predictors of reading, phonological skills and rapid automatized naming (RAN) have been the most extensively studied. Phonological skills are known to predict reading acquisition at early stages (see Papadopoulos, Spanoudis, & Georgiou, 2016) and early deficits in phonological awareness to predict later RD at school-years (e.g., Carroll, Solity, & Shapiro, 2016; Puolakanaho et al., 2007; Torppa et al., 2015). Phonological deficits also tend to be persistent (e.g., Svensson & Jacobson, 2006; Wilson & Lesaux, 2001), and associated especially with reading accuracy (Kairaluoma, Torppa, Westerholm, Ahonen, & Aro, 2013). RAN has been found to be closely related to reading fluency in childhood (e.g., Georgiou, Parrila, & Kirby, 2009; Heikkilä et al., 2015; Moll, Fussenegger, Willburger, & Landerl, 2009; Papadopoulos et al., 2016) and in adulthood (e.g., Vukovic, Wilson, & Nash, 2004). Childhood RAN skills have also been found to predict developmental dyslexia (Landerl et al., 2013). Torppa and colleagues (2015) found that early problems in RAN differentiated a group of children that had persistent dyslexia in adolescence from children with no later dyslexia. Despite these findings, knowledge of the association between the childhood RAN and adult-age reading, and of the association between adult-age RAN and persistence of RD is still insufficient.

Processing speed and working memory have also been linked to reading skills and RD. General processing speed has been found to reflect in problems of RAN, to predict reading fluency and to mediate the RAN–reading association among children (Papadopoulos

et al., 2016). Moreover, earlier studies indicate working memory problems to be related to reading difficulties and to RAN–reading relationship among children (Cowan et al., 2017; Gathercole, Alloway, Willis, & Adams, 2005; Majerus & Cowan, 2016; Papadopoulos et al., 2016). However, knowledge of how adult-age processing speed and working memory are related to adult-age reading skills or to persistence of childhood RD is insufficient. Similarly, association between general intelligence (IQ) and RD is unclear. Although IQ is considered independent from development of RD per se (e.g., Ferrer et al., 2010; Fletcher, 2009; Kortteinen, Närhi, & Ahonen, 2009), there are some long-term associations between IQ and persistence of RD: individuals with higher childhood IQ have been found to have better adult-age spelling skills relative to childhood skills than their peers with lower IQ (Strehlow, 1992). RD and verbal intelligence in particular are known to have reciprocal long-term relationship (e.g., Ingesson, 2015; Stanovich, 1986; Swanson, 2012). Reading comprehension problems, which are commonly seen as secondary deficits due to compromised reading fluency and accuracy (Lyon et al., 2003), but also as the common product of problems in decoding and language comprehension (Simple View of Reading; Gough & Tunmer, 1986), have been found to be especially related to components of verbal intelligence, vocabulary in particular (e.g., Swanson, Barnes, Fall, & Roberts, 2018).

Besides cognitive predictors, other factors during development can affect later RD outcome. At primary school age and in adolescence, various factors buffering the negative implications of reading problems have been identified, including early entry to special education (Ehrhardt, Huntington, Molino, & Barbaresi, 2013), as well as supportive and motivational interaction with peers, teachers, and parents (Al-Yagon, 2016; Sideridis, Stamovlasis, & Antoniou, 2016). Likewise later in life, support experienced from significant others has been found to be important for social and emotional well-being of individuals with RD (e.g., Carawan, Nalavany, & Jenkins, 2016; Stack-Cutler, Parrila, & Torppa, 2015).

However, the association of individual experience of received support at school-age with adult-age reading skills is less clear.

Besides affecting later reading skills, childhood RD is known to be a risk factor for lack of education beyond the school years: students with RD are more likely than their peers to leave school after compulsory education, to drop out, or to choose vocational education (see e.g., Hakkarainen, Holopainen, & Savolainen, 2015; McLaughlin, Speirs, & Shenassa, 2014). There is also evidence of higher unemployment rates among individuals with poor reading skills (Caspi, Entner Wright, Moffitt, & Silva, 1998) or with childhood RD (Undheim, 2003), and of lower qualifications or incomes compared to non-RD peers at group-level (Maughan et al., 2009; McLaughlin et al., 2014). It is of interest whether individuals, who in spite of childhood RD have good enough adult-age reading skills (i.e., *not* meeting the criteria for adult-age RD), are able to educate themselves more and be less probably unemployed than their counterparts with adult-age RD.

In sum, due to the scarcity of longitudinal research, more information is needed about the adult-age reading, cognitive skill, education and employment outcomes of individuals with childhood RD. Moreover, the predictive role of different cognitive and extrinsic factors for adult-age reading skills and for persistence of RD is still to be confirmed. To gain better understanding on these issues, we examined a group of Finnish adults who had been referred to a learning disability clinic at school age, and whose primary deficit in childhood had been RD, defined as a deficit to read with adequate speed. In childhood, they had no comorbid socio-emotional problems or difficulties in learning mathematics. To characterize the long-term outcomes of childhood RD we scrutinized the proportion of individuals not meeting the set criterion for adult-age RD. We also examined adult-age reading and cognitive skills, attained educational level, and employment, as well as childhood cognitive factors, special education attendance and the number of support providers as

possible predictors of adult-age reading skills. The following research questions were addressed:

1. Which proportion of individuals with documented childhood RD do not have RD continuing to adult-age, and how do they differ from individuals with adult-age RD and from control individuals in (a) reading skills (speed, accuracy and comprehension), (b) cognitive skills, or (c) education and employment outcome?
2. Do the two childhood RD groups (with or without adult-age RD) differ from each other in childhood (a) reading skill level, (b) cognitive skills, or (c) special education and experienced support?
3. Within the childhood RD group, are reading skills (speed, accuracy and comprehension) in adulthood predicted by childhood (a) reading skills, (b) cognitive skills, or (c) the amount of special education received and experienced support?

Method

Participants and procedure

Two groups of participants were studied: adults with RD documented in childhood (RD; n=48), and controls with no known history of RD (n=37). Participants for the childhood RD group were selected from the clinical archival data of former clients of the Clinic for Learning Disabilities (CLD) at the Niilo Mäki Institute (NMI) in Jyväskylä, Finland, and they were further divided into two groups (i.e., with and without adult-age RD) according to their adult-age reading skill. The CLD offers neuropsychological assessment and counseling for children with learning disabilities (LDs). Children with socio-emotional problems or global developmental delay were not referred to the clinic (for details see Närhi, 2002). The present participants were selected from the archives on two criteria: RD was their only childhood LD (i.e., z-score $\leq$-1.5) and they were over 20 years of age. Thus, children with comorbid mathematical difficulties (z-score $\leq$-1.5) or emotional and attention problems (z-score $\leq$-1.0

in teacher/parent ratings) were excluded to form as homogeneous group as possible. All subjects were Caucasian and spoke Finnish as their native language.

Of the 76 identified individuals 66 were contacted, as no contact information was found for 9 subjects, and one subject had died. Forty-nine individuals (74.2% of the 66 individuals that were reached) agreed to participate in the follow-up assessments. One participant with low scores on the childhood IQ measures (full scale IQ 60) was dropped from the sample. This produced the final sample size of 48 in the RD group.

A control group (n=37) was formed from a large sample provided by the Population Register Center, in which each participant from the clinical dataset was matched with 5 controls based on age, gender and home town at the age of seven, i.e., at the beginning of compulsory education. All five controls matched for each of the RD participants were contacted in random order, the aim being to provide one matched control participant for each RD participant. For 11 of the RD participants, none of the five control participants were reached, or all of them declined or cancelled their appointment, and one potential control participant with a low IQ was dropped from the sample, yielding the final control group of 37 individuals.

Within the RD group, the individuals who participated in the follow-up assessments in adulthood (n=48) and those who did not participate (n=27) did not differ significantly in age or gender distribution, although there were slightly more males among the non-participants (22/27, 81.5%) than participants (30/48; 62.5%). No significant differences were found in childhood RD level, RAN, VIQ or PIQ, emotional and attention problems, or in parental education level.

The RD group with matched controls (n = 37) and those without controls (n = 11) did not differ in terms of gender distribution, but there was a difference ($p < .05$) between the groups in age: the individuals with RD who did not have controls were younger (M = 23.5

years) than those with matched controls (M = 27.05 years). To find out whether the attrition of some of the controls creates a bias in the results, the analyses were also conducted including only the RD participants (n = 37) that had matched controls in this sample. As the results replicated in these additional analyses, the original sample size was used so that a substantial proportion of the data and power of the analyses would not be lost.

Ethical approval was given by the University Ethical Committee. Written informed consent was obtained from each participant. Parents had given informed consent to use their children's assessment data for research purposes when the participants had been assessed as children. The follow-up assessments (lasting 4.5-5 hours) were conducted by licensed psychologists. The participants were given oral feedback, and offered a written summary of the test results.

Measures in Childhood

Reading skills and definition of childhood RD. Reading speed, i.e., fluency, was used to measure reading skills both in childhood and at follow-up, because in orthographies with consistent letter-sound correspondences such as Finnish, reading accuracy is typically learned at early stage (Aro & Wimmer, 2003), and reading speed is therefore a better marker of reading difficulties than accuracy.

Since the tests used at the clinic to assess reading skills have varied along the years, childhood RD was defined by reading speed in one of the two text-reading tasks described below, depending on which one was used at the time the child visited the clinic. A z-score of reading speed was calculated in both tests based on Finnish reference group.

Misku (Niilo Mäki Institute, 1992, unpublished) is an age-normed text-reading task normed for 8- to 12-year-old children with a reference group (n = 211) collected in Central Finland. In the test, the child is asked to read aloud a one-page story as quickly and correctly as possible. The time taken to complete the text was used as the reading speed measure.

ÄRPS (Niilo Mäki Institute, 1994, unpublished) is a reading skill test battery developed for 2nd to 4th graders with a reference group of children from Central Finland. In the text reading task the child is asked to read aloud a one-page story as quickly and correctly as possible. The number of words read per time unit, one minute for 2nd graders and two minutes for 3rd and 4th graders was used as the reading speed measure.

Since the two tests used in the clinic were not corresponding, reading skill measure could not be used as continuous variable. A child was classified having RD if the performance was at least -1.5 SDs below the reference group mean in one of the two reading speed tasks. Childhood RD was further categorized into a dichotomous variable as follows: "very severe" (below -2.5 SDs) or "severe" RD (-2.5 to -1.5 SDs), and this was used in the statistical analysis as an indication of the childhood RD severity.

Intelligence quotients (IQs). IQs were evaluated using the Wechsler Intelligence Scale for Children-Revised edition (WISC-R; Wechsler, 1974). Verbal intelligence quotients (VIQ) and performance intelligence quotients (PIQ) were used in the present analyses.

Rapid automatized naming (RAN). Rapid Naming Test (Ahonen, Tuovinen, & Leppäsaari, 1999; Denckla & Rudel, 1974) was used to assess automatized naming. It is a standardised test for 6- to 12- year-old Finnish children, in which the child names an array of 50 pictures or symbols presented on six boards as fast as possible trying to avoid errors. In the present study, the mean of the norm-based z-scores for rate of naming all the items in two alphanumeric item boards, i.e., Letters and Numbers, was used as a composite score for RAN. Cronbach alpha reliability, calculated from the z-scores for rate of naming the items in each of the two item boards used was .84.

Phonological skills. Phonological skills were evaluated using either the Phoneme Blending task or the Phonological Processing test, depending on the time of assessment. The Phoneme Blending task is the Finnish version of the Illinois Test of Psycholinguistic Abilities

(ITPA, Kuusinen & Blåfield, 1972; Kirk, McCarthy, & Kirk, 1968) and consists of three subtests in which the examiner presents sounds and asks the participant to voice the words the sounds form when put together. Test performance is compared to the psycholinguistic age corresponding to the child's chronological age. The Phonological Processing subtest in the neuropsychological test battery Nepsy (Korkman, Kirk & Kemp, 1998), standardized for 9- to 12-year-old Finnish children, contains two parts. In Part 1, Word Segment Recognition, the child is presented with pictures of phonologically similar words and the sound of one phoneme or a phoneme combination composing a syllable, and asked to link the sound to the right picture. In Part 2, Phonological Segmentation, the child is presented with a word and asked to form a new word by removing a sound, a syllable, or a part of a compound word. Standard scores for test performance are formed on the basis of the test reference data. Cronbach's α for Phonological Processing in the standardization data was .97 (Korkman, 2000).

As the two phonological tests were not corresponding, we had to form a dichotomous variable for phonological deficit (1=deficit; 0=no deficit). As the cut-off, a psycholinguistic age twelve months younger than chronological age was used for children assessed with the Phoneme Blending task, and a scale score of seven for children assessed with the Phonological Processing test.

Special educational support. Special educational support received during a) primary and secondary school, and during b) upper secondary education (vocational school or high school, or other) was elicited retrospectively at adult follow-up interview. Because no objective data was available, the information were based on the participants' memory, which may have varied in specificity (i.e., some individuals had clear memories on received support while others were less sure on the exact amount of support). As the quality and quantity of special educational support in general has varied along the years depending on the school or

community, our participants, with the age range from 20 to 39 years, had also had different offsets for receiving special educational support. Thus, we formed two dichotomous variables, one for primary and secondary school and the other for upper secondary education: 0="did not receive special educational support"; 1="received special educational support".

Number of support providers. Support received for RD was elicited retrospectively at adult follow-up with questions on whether support had been received from parents, teachers, special education teachers, siblings, friends, and other people. The six dichotomous measures with the values 0="no support" and 1="some support" were summed to form a score for the number of support providers. To avoid small group sizes, the sum scores were further collapsed into a single dichotomous measure with the values "support from two or less persons" and "support from more than two persons", since only few individuals had more than 4 support providers.

Measures at Adult-age

Reading fluency, accuracy, and comprehension. Reading skills were measured using a Finnish test battery on reading and spelling skills for adolescents and adults (Nevala, Kairaluoma, Ahonen, Aro, & Holopainen, 2006) that is the only test for adult reading skills available. It is standardised with comprehensive school 9th graders (n = 208). In the Word Reading Task, the participants read aloud 30 words as quickly and accurately as possible. In the Pseudo-Word Reading Task, the participants read aloud 30 pseudo-words as quickly and accurately as possible. In the Text Reading Task, the participants read aloud a text for three minutes as quickly and accurately as possible. In all tests correctly read words and errors were counted. In the Reading Comprehension Task, a text was read silently and 11 multiple-choice questions were answered based on the text without any time constraints.

Reading fluency, i.e., reading rate was based on the test manual z-scores of time used in the Word Reading Task (reversed) and in the Pseudo-Word Reading Task (reversed),

and number of words read in three minutes in the Text Reading Task. In the present data, Cronbach's α for the z-scores of reading rate in the three reading tasks was .78. Accuracy score was based on the test manual z-score of number of correctly read words in the Pseudo-Word Reading Task. The performance in the pseudoword task was used as the only measure of accuracy because the ceiling of accuracy in reading words is typically reached already at school age in Finnish (see Torppa et al., 2015), and reading pseudowords can therefore be considered to be a more sensitive and reliable measure of accuracy. The Cronbach's α for the accuracy in Pseudoword reading task in the test manual was 0.74 (Nevala et al., 2006). Comprehension score was the test manual z-score of the correct answers in the Reading Comprehension Task. Cronbach's α for the right answers in the present sample was .59.

Self-evaluation of reading skills. Self-evaluation of reading skills was examined with a question adopted from a six-item self-rate questionnaire on the importance and utility of academic skills, based on earlier questionnaires on similar topics (Eccles & Wigfield, 1995). Participants were instructed to evaluate their reading skills in relation to peers on a Likert scale ranging from 1 = "below average" to 5 = "above average". To avoid small group sizes, the self-ratings were further collapsed into a three-category variable of 1 = "below average", 2 = "average", and 3 = "above average".

IQ. An abbreviated version of the Wechsler Adult Intelligence Scale – IV (WAIS IV, Wechsler, 2008) was used to evaluate adulthood IQ. As in the Wechsler Abbreviated Scale of Intelligence – II (WASI-II, Wechsler, 2011; see e.g., Irby & Floyd, 2013), the subtests Vocabulary and Similarities were used to produce a Verbal Comprehension Index (VCI), and Block Design and Matrix Reasoning to produce a Perceptual Reasoning Index (PRI). These indexes were computed using partition according to the WAIS IV test manual (Wechsler, 2008). Test-retest reliability above .90 for the VCI and a range from .86 to .87 for the PRI in the WASI-II is commonly reported (Irby & Floyd, 2013).

The Processing Speed Index (PSI) was produced from Symbol Search and Coding. In the Finnish standardization sample, the mean reliability for the PSI is .90 (Wechsler, 2008).

Digit Span. We also examined the group differences in the Digit Span subtest (i.e., forward and backward spans) of the Working Memory Index (WMI) in the WAIS IV, which can be considered as a combination measure of short-term memory and working memory. Total raw score of the Digit Span was used in the analyses.

Phonological skills. Adult-age phonological skills were measured with the Syllable Blending task, which is an unpublished test standardized with a sample of comprehensive school 9th graders (n = 208). In the Syllable Blending task, lengthening strings of syllables (three items with same number of syllables) were presented, and the participant was asked to voice the pseudowords formed by the syllables when put together. Correctly presented pseudowords were counted. In the present study, raw scores of the task were used as a measure.

RAN. Naming speed was examined with the Letters board of the Rapid Naming Test, also used in childhood and standardized with the same sample of comprehensive school 9th graders as the reading and phonological tasks. The raw score was used in the analysis.

Educational attainment. Educational attainment was elicited by interviewing. Upper secondary education was classified into three categories of 0="has not finished vocational or high school", 1="vocational school qualification", and 2="high school qualification". Highest level of further education was classified into categories 1="vocational school qualification", 2="university of applied sciences degree/attending university of applied sciences", 3="university degree/ attending university".

Employment. Employment status was also elicited by interviewing. The current employment status was used as a measure because the information of the participants' employment history, e.g., of the length of unemployment periods during lifetime, were based

on the participants' memories and were therefore not completely comprehensive. Furthermore, because of the small sample size, a specified classification of the current employment status (i.e., whether the participant works part-time or is on maternity leave) would have made the group sizes small and weaken the power in the analyses. Thus, a dichotomous variable was formed with categories 0="employed" and 1="unemployed". We classified the participants as unemployed if they were job seekers or laid off, and not studying, not working full-time or part-time, not in the military service, not on maternity or sickness leave, nor on disability pension.

Statistical Analyses

Descriptive statistics and percentages were used to study the proportion of adult-age RD among the childhood RD group. To test group differences in adult-age reading status and the other adulthood and childhood measures, we used multivariate analyses of variance (MANOVA) for continuous measures, and the χ^2 test for categorical variables. A Fisher's exact test instead of a chi squared test was used when more than 20 percent of the cells in the cross tabulation had expected values smaller than 5. To examine childhood predictors of adulthood reading fluency, accuracy and comprehension, we first examined bivariate correlations between the variables. We then ran linear regression analyses for each reading measure, including only those childhood variables in the models that had a correlation with a *p*-value of .10 or smaller with the adult-age reading measures.

One-tailed testing was adopted in group-comparisons, as we expected the control group and the group with childhood RD but without adult-age RD to have better adult-age reading (e.g., Maughan et al., 2009; Undheim, 2009) and cognitive skills (e.g., Kairaluoma et al., 2013; Torppa et al., 2015; Vukovic et al., 2014), higher educational level (e.g., Hakkarainen et al., 2015) and less unemployment (e.g., Caspi et al., 1998) than the

group with persistent adult-age RD. However, in the analyses concerning educational and social support we used two-tailed tests because of the lack of earlier research.

Results

Proportion of individuals with and without adult-age RD

We defined adult-age RD on the basis of adult-age reading fluency, i.e., speed as follows: a speed z-score below -1.5 indicated adult-age RD and a z-score above -1.5 as no adult-age RD. Using this criterion, 29 (60.4%) participants were classified as individuals without adult-age RD (RD-), and nineteen (39.6 %) participants as having adult-age RD (RD+). The mean ages of the RD+ and RD- groups were 27.4 (*SD* = 5.4) and 25.5 (*SD* = 4.2) years, respectively, and did not differ from each other. There was no statistically significant difference between the two RD groups in the proportion of men, despite the higher percentage (72.4%) in the RD- group than in the RD+ group (47.4%).

Adult-age reading and cognitive skills, education, and employment in the two RD groups and the control group

Table 1 shows the group comparisons of the control group and the two RD groups (i.e., RD+ and RD-) in reading and cognitive skills. Results of the MANOVA for reading measures showed statistically significant differences between the three groups in reading fluency, accuracy, and comprehension. Pairwise comparisons (Table 1) indicated that both RD groups were statistically significantly weaker than the control group in all reading skills, and that the RD- group had better reading fluency scores than the RD+ group, as expected because it was used as the criterion for adult-age RD-grouping. The two RD groups did not differ from each other in reading accuracy or comprehension, although the effect size in reading accuracy was moderate in favour of the RD- group. In their self-evaluations of reading, the three groups differed statistically significantly (Table 1) so that the RD+ group was overrepresented in the

rating “below average” (adjusted standardized residuals, Adj. Res. = 4.8), and the control group in the rating “above average” (Adj. Res. = 3.4).

Results of the MANOVA for the cognitive measures showed statistically significant differences between the three groups also in verbal comprehension, working memory, processing speed, phonological skills, and rapid naming but not in perceptual reasoning. In verbal comprehension, processing speed, working memory, and phonological skills, the two groups with childhood RD did not differ from each other. The phonological skills of the controls were statistically significantly better than in the two RD groups. Moreover, in verbal comprehension, working memory, and processing speed, the effect sizes in pairwise comparisons were moderate to high in favour of the controls in each measure, although the group differences failed to reach statistical significance (see Table 1). The RAN scores were statistically significantly better in the RD- group than in the RD+ group, and the RD- group did not differ from the control group (Table 1). However, the effect sizes indicated a considerable difference both between the RD+ and the control group as well as between the two RD groups (Table 1).

Table 1 shows the group comparisons in education and employment. The two RD groups and the control group differed significantly in upper secondary education: there were more individuals with high school degree within the control group (Adj. Res. = 3.5) than within the RD groups, and the proportion of control group members with vocational school degree was smaller (Adj. Res. = -3.1) than those of the two RD groups. Higher education (university of applied sciences or university degree) was more common within the control group (Table 1) than within either of the RD groups (Adj. Res. = 3.3). The proportion of unemployed (Table 1) was higher within the RD+ group (Adj. Res. = 2.2) than within the RD-, or within the control group.

Differences in childhood measures between the two RD groups

The MANOVA indicated that the RD- group had performed significantly faster in childhood RAN than the RD+ group, effect size being moderate between the groups (Table 2). The groups did not differ in childhood VIQ, PIQ, or RD severity level (RD and severe RD), or in the proportion of individuals with phonological deficits, individuals having received special educational support, or having had more than two support providers.

Predictors of adult-age reading fluency, accuracy and comprehension among the childhood RD group

As the bivariate correlations in Table 3 show, RAN was the only childhood variable that correlated with adult-age reading fluency at a statistically significant level in the RD group. As the correlations of both the severity of childhood RD and the number of support providers with reading fluency were also close to significant ($p \leq .10$), we included them in the regression model in addition to RAN. As Table 4 shows, none of the three variables alone predicted adult-age fluency, but the model was significant, indicating that the performance in childhood RAN, the level of childhood RD and number of support providers together explained 18 percent of the variance in adult-age reading fluency. Moreover, phonological deficit correlated at a statistically significant level with adult-age accuracy, and the correlation of RAN was close to significant ($p \leq .10$) (Table 3). In the regression model with phonological deficit and RAN as predictors, phonological deficit alone predicted accuracy at a statistically significant level, and the model explained 19 percent of the variance of adult-age accuracy. Childhood VIQ and PIQ correlated significantly with adult-age reading comprehension, and in the regression model, explained 18 percent of the variance in comprehension.

Discussion

The present study examined the proportion of adult-age RD in a group of Finnish individuals with documented childhood RD. Reading and cognitive skills as well as education and

employment of the two childhood RD groups, i.e., with or without adult-age RD (RD+ or RD-), were compared to that of their matched controls without known history of childhood RD. In addition, childhood cognitive factors, special education attendance and the number of support providers were examined as possible predictors of adult-age reading fluency, accuracy, and comprehension among individuals with childhood RD. We found that majority of the participants had improved in their reading fluency to the level where criterion set for the RD at adult-age was not met anymore. The group without adult-age RD (RD-) performed at the level of the controls in adult-age RAN, and these two groups performed faster than the group with adult-age RD (RD+). However, both RD groups showed poorer skills than controls in phonological skills, processing speed, and verbal comprehension. The RD- group was significantly less likely to be unemployed than the RD+ group or control group, although both RD groups had lower educational attainment than the controls. Moreover, fluency in childhood RAN distinguished the RD- group from the RD+ group. Childhood RAN, severity of childhood RD and number of support providers in childhood together predicted almost a fifth of the variance in adult-age reading fluency, and almost 20 percent of the variance in reading accuracy was predicted by childhood phonological deficit and RAN. Childhood verbal and perceptual intelligence together explained a fifth of the variance in adult-age comprehension.

Our results indicated that individuals with childhood RD as a group performed poorer in adult-age reading tasks than the control group confirming earlier findings that reading problems continue into adulthood (e.g., Maughan et al., 2009). On the other hand, as much as 60.4 percent of the participants did not any more meet our criterion for adult-age RD ($\leq$ -1.5 SDs). The proportion of individuals without adult-age RD was higher than that reported in earlier research on orthographies with less consistent letter-sound connections (7 to 30 %; e.g., Maughan et al., 2009; Parrila et al., 2007; Undheim, 2009), and also higher than

the proportion of resolved RD (40%) in a Finnish sample of adolescents (Torppa et al., 2015). However, it is in concordance with the findings on adult-age RD in other consistent orthographies (Schulte-Körne et al., 2003). This might reflect the fact that in consistent orthographies, fluent reading is generally reached quickly (Aro & Wimmer, 2003) and the proportion of individuals who resolve their childhood RD by adulthood may thus be higher than in orthographies with less consistent letter-sound connections.

It should also be noted that our sample comprised individuals with childhood RD without comorbid LDs or socioemotional problems. In previous longitudinal studies with follow-up at adult-age, few studies have controlled for comorbidity, and those that have, have focused on comorbidity of emotional problems (Esser, Wyschkon, & Schmidt, 2002; Undheim, 2003). As comorbidity of RD with other learning (e.g., Landerl & Moll, 2010) or developmental difficulties, such as ADHD (e.g., Willcutt et al., 2010) is known to be common, the lower proportion of resolved RD in earlier studies compared to our study may be due to possible other deficits besides RD that complicate resolving. Moreover, the high proportion of individuals with resolved RD may also reflect that we used a sample of a clinical population, who had their difficulties recognized early and received support for them already during school years.

It is also noteworthy that we used mean performance of 9th graders as reference data to evaluate reading skills and to define adult-age RD, as it is the only standardized test in Finland aimed at evaluating reading skills of adults. This might overestimate the proportion of adults with "adequate" reading skills, because it is possible that reading skills still develop after 9th grade, that is, there might still be individuals who struggle with their reading in our sample compared to their same-age peers, despite having reached the level of ninth graders. The mean of the reading speed scores of the 29 participants classified as "childhood RD but without adult-age RD" was still markedly lower than those of the 37 matched controls: the

mean level was 0.83 SD lower than that of the normative sample, and only three participants (10.3 %) with childhood RD scored at or above -0.25 SD. Moreover, in our additional analyses in which we normed reading speed against the adult-age control group of the present study (using the -1.5 SD as a criterion), three individuals moved from the resolved RD group (RD-) to the adult-age RD (RD+) group, resulting in the proportion of resolved RD being slightly smaller (54.3%, 26 individual) than in the original grouping (60.4%, 29 individuals). Hence, the individuals in the RD- group, despite better performance in reading speed than individuals in the RD+ group, had not fully caught up with the controls, which is in line with earlier research (e.g., Maughan et al., 2009; Torppa et al., 2015). In addition, their reading accuracy and comprehension as well as performances in phonological skills, verbal comprehension, and processing speed, were below the level of controls and did not differ from the RD+ group. Thus, our findings suggest that childhood RD is associated with lower cognitive performance in adulthood even when reading fluency has improved.

The only major difference in cognitive skills between the RD+ and RD- groups was on RAN. The RD+ group performed significantly slower in both childhood and adult-age RAN than the RD- group. As we defined RD on the basis of reading speed, the findings particularly reflect the strong relation of RAN with reading speed established in earlier studies (e.g., Georgiou et al., 2009; Heikkilä et al., 2015; Papadopoulos et al., 2016; Vukovic et al., 2004). These findings support the stance that RAN is an important factor in reading speed, i.e., fluency, in consistent orthographies, and is applicable also in predicting the long-term persistence of RD.

Since performance in RAN is highly associated with general processing speed (e.g., Catts et al., 2002; Georgiou et al., 2009; Papadopoulos et al., 2016) and since we defined both childhood and adult-age RD on the basis of speed, our finding could be a result of faster processing of words by those with higher general processing speed. However, no major

difference was found in adult-age processing speed (PSI) between the two childhood RD groups. In additional analyses, we found no differences between the two groups in the childhood Coding subtest of the WISC R, which is commonly used as a processing speed measure (see Närhi et al., 2005). Our post hoc analyses also revealed that the partial correlation between childhood RAN and adult-age reading fluency, when controlling for adult-age PSI, was only slightly weaker (r = .27) than the bivariate correlation (r = .29). Moreover, earlier research indicates that there are several other processes, such as phonological skills, orthographic processing, working memory, and attention, which explain or mediate the relation of RAN to reading speed (e.g., Papadopoulos et al., 2016), and that RAN also exerts strong direct effects on reading speed (Papadopoulos et al., 2016). There were other findings suggesting that reading problems in the RD+ group were not merely in reading speed. First, the RD+ group evaluated their functional reading skills in general lower than other groups. Second, despite no significant group difference, reading accuracy among the RD+ group was also lower than that of the RD- group evidenced by medium effect size.

When predicting adult-age reading fluency, RAN appeared not to be the only childhood factor that had predictive power: severity of childhood RD and the number of support providers in childhood together with RAN explained variance in fluency. In addition, although reading fluency was the focus of reading skills in the present study, we also examined the childhood predictors of adult-age accuracy and comprehension, and found that, in line with earlier research (Kairaluoma et al., 2013), phonological skills had an association with reading accuracy. Our finding of verbal and perceptual IQ explaining variance in reading comprehension were also in concordance with earlier research, which has suggested association between IQ and reading, and verbal IQ and reading comprehension in particular (Ingesson, 2015; Swanson, 2012; Swanson et al., 2018). However, it should still be noted that

a rather small proportion of the variance in adult-age reading skills could be explained by the childhood variables we used.

According to our findings, childhood RD has implications for education and employment. Low educational level as a high proportion of vocational upper secondary education was found among childhood RD group, which concords with earlier research (e.g., Hakkarainen et al., 2015; McLaughlin et al., 2014). The unemployment rate was, interestingly, much higher in the RD+ group than in the RD- group or within the controls, the overall unemployment rate being 9.4 percent at the follow-up time in Finland (Statistics Finland, 2016). This clarifies earlier conflicting findings on employment among individuals with RD (Caspi et al., 1998; Undheim, 2003), and suggests that it is not childhood RD per se, but continuing problems in reading at adult-age, which is related to difficulties in employment. Obviously, this result should be interpreted with caution because of small group sizes in the present analyses. However, it could be hypothesized that there are additional factors underlying the higher unemployment within the RD+ group. The two RD groups may have chosen different fields of education with different employment opportunities, which we were unable to examine in the present study. It also remains to be examined whether adult-age RD has wider associations with problems of psychosocial wellbeing leading to difficulties in labor market.

Our sample comprised RD individuals with no additional learning or socio-emotional problems in childhood. This enabled us to minimize sample heterogeneity and the effects of comorbid disabilities on the results. Thus, our findings concerning employment should also be interpreted as reflecting outcomes of pure RD with no comorbid problems. The findings indicate that it is of relevance to employment whether a pure RD like this eases with age.

We investigated a sample drawn from clinical archives, which provided a large, systematically collected and documented dataset on childhood RD. Despite the exceptionality of this comprehensive clinical data, it should be noted that clinical samples are typically biased due to referral procedures and exclusion criteria, and the present sample is therefore likely not to be fully representative of children with RD in Finland. Additionally, as discussed above, the childhood assessment and counseling process itself may have functioned as a short-term intervention, thus inducing a positive bias compared to population samples of RD. Also, our sample was relatively small, due to which we only had sufficient power to detect medium to large effect sizes in our analyses. However, there were no group comparisons with moderate or large effect sizes that failed to reach significance. Furthermore, despite the attrition in the follow-up, the follow-up participants did not differ from the non-participants in any of the childhood measures, and thus, our sample could be considered satisfactorily representative of the full sample. As 11 of the matched control group members could not be reached, only 37 of the RD participants had a matched control to compare results with. However, the results replicated in the additional analyses using only those RD participants that had matched controls, and the attrition of some of the controls was therefore not considered to create a bias in the results.

When interpreting the results, some limitations related to the measures used should also be taken into account. First, the Digit Span subtest that we used in the present study is not comprehensive as a working memory (WM) measure, although it is widely used and considered to tap both auditory short-term memory and working memory. As working memory is a complex construct with multiple components (see e.g., Baddeley, 2017; Cowan, 2017), more comprehensive measures should be used to catch the different facets of WM more thoroughly. Second, in terms of the childhood measures, the only reading skill tests available at the time our participants visited the clinic were unpublished and unfortunately

lacked reliability and validity information. However, both reading skill tests had unpublished norms based on comprehensive data (N=211) and had been used on a routine basis at the clinic. Moreover, the individuals in the present sample had been referred to the clinical assessment because of substantial problems particularly in reading and spelling at school, detected by teachers and school psychologists. This indicates that the initial reading problems among the participants were serious and noticed not only on the basis of a single reading test. Moreover, as tests used at the clinic had varied over the years, and as the age of our participants varied from 20 to 39 years, different tests had been used to measure their reading skills in childhood. The tests were not corresponding, and therefore, we could not use continuous variables for childhood reading skill level, but instead formed dichotomized variables. The same applied to childhood phonological skill variables. We also dichotomized the variables for special educational support, support provided by others, and employment, because we would have had small group sizes in the analyses if more detailed classifications had been used. To examine special educational support, support provided by others or employment of individuals with RD more thoroughly, objective data in addition to deep interview should be used for more nuanced information. Yet another limitation concerning the measures we used, internal reliability particularly in the adult-age reading comprehension task was rather low (.59) in our sample. Therefore, it cannot be ruled out that there may have been differences between the groups in reading comprehension that we could not detect partly because of the low reliability of the task. The low reliability in the comprehension task may be due to the structure of the task: the task comprises items tapping different aspects of comprehension (e.g., fact retrieval and interpretation). In the test manual, the published reliability (Cronbach's alpha) for the comprehension task (.57) is approximately the same as in the present sample. Thus, in the future, more research should be conducted analyzing different subskills required in reading comprehension.

Based on our findings it can be concluded that a little less than two thirds of individuals with childhood RD had improved in their reading fluency to the level where RD criterion at adult-age was not met anymore. Despite attaining a lower educational level than controls and despite having lower group level performance in cognitive tests (verbal comprehension, working memory, and processing speed), individuals without adult-age reading fluency problems had been able to find employment, suggesting that better reading fluency may have significance for adult-age employment. On the other hand, attention should be paid especially to problems in rapid naming as well as to how severe the childhood RD is as they may be predictive of persistent deficits in reading fluency. Together with these cognitive factors, our findings suggest that support provided by others during childhood and adolescence, regardless of whether it is professional or not, may be valuable. This should be emphasized when planning interventions for children with RD. Moreover, it should be noted that RD affects each individual differently, and the mechanisms behind why some resolve RD and others do not can be multifold. Besides cognitive factors affecting how the difficulties in RD manifest themselves, earlier research has identified personal characteristics that contribute to successful life with RD, such as emotional stability, strong self-esteem, proactivity, perseverance, and appropriate goal-setting (e.g., Goldberg et al., 2003; McNulty, 2003; Raskind, Goldberg, Higgins, & Herman, 1999). Further discussion on how persistence of childhood RD or coping with it should be considered in relation to other factors in adult life is needed. The questions to be considered in studies on adult-age RD include, for example, how relevant it is to examine reading skills per se, or should more focus be on the complexity of underlying cognitive and social-emotional skills contributing to functional reading skill, or rather, on how successfully one copes in adult life, e.g., attains education and employment or a satisfying level of psychosocial wellbeing.

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Table 1. Group Comparisons of Adult-age Reading, Cognitive Skills, Education, and Employment between Control Group and the two RD Groups.

	Control (n = 37)[a]		RD- (n = 29)		RD+ (n = 19)			*Cohen's d*		
	Mean	SD	Mean	SD	Mean	SD	*F(2, 81)*[b]	C vs RD-	C vs RD+	RD- vs RD+
Reading							31.48***			
Fluency	0.31[x]	0.87	-0.83[y]	0.46	-2.63[z]	0.60	106.22***	1.58	3.72	3.47
Accuracy	0.38[x]	0.57	-0.85[y]	1.22	-1.19[y]	1.18	20.90***	1.35	1.90	0.28
Comprehension	0.81[x]	0.59	-0.04[y]	0.87	0.03[y]	0.98	11.47***	1.17	1.05	0.08
Cognitive skills							4.20***			
VCI	95.37[x]	11.95	83.66[y]	14.69	84.26[x, y]	19.15	6.10**	0.89	0.75	0.04
PRI	98.63	15.57	99.83	13.59	97.58	22.07	0.11	0.08	0.06	0.12
Digit Span	24.91[x]	3.64	22.66[x, y]	5.06	21.16[y]	4.38	5.04***	0.52	0.96	0.31
PSI	101.06[x]	17.60	91.90[x, y]	12.83	90.32[y]	13.39	4.28*	0.58	0.66	0.19
Phonological skills	8.74[x]	1.80	6.00[y]	2.42	5.32[y]	2.31	20.41***	1.30	1.72	0.29
RAN	21.24[x]	6.05	22.07 [x]	4.37	27.43[y]	5.87	8.43***	0.15	1.03	1.07
							χ^2 (4)			
Self-evaluation of reading							31.49***			
Below average	1 (2.7%)		6 (21.4 %)		12 (63.2%)					
Average	19 (51.4%)		16 (57.1 %)		12 (36.8%)					
Above average	17 (45.9%)		6 (21.4 %)		0 (0%)					
Education										
High school degree	18 (56.3%)		6 (20.7%)		3 (15.8 %)		12.02**[c]			
Vocational school degree	21 (40.6%)		21 (72.4%)		15 (78.9 %)					
No upper secondary degrees	2 (3.1 %)		2 (6.9 %)		1 (5.3 %)					
University of applied sciences or University degree	17 (58.6%)		6 (23.1 %)		3 (16.7 %)		11.29**			
Unemployed	3 (8.1%)		4 (13.8 %)		6 (31.6 %)		4.92*[c]			

Note. VCI = Verbal Comprehension Index (WAIS IV). PRI = Perceptual Reasoning Index (WAIS IV). Digit Span = Raw score of the Digit Span subtest (WAIS-IV). PSI = Processing Speed Index (PSI). RD- = Childhood RD group without adult-age RD. RD+ = Childhood RD group with adult-age RD. Groups with different

superscript letter (x, y or z) differed significantly from each other in the post hoc pair wise comparisons of ANOVA F tests ($p < .05$). Bonferroni or Dunnett's T3 corrections were used depending on equality or inequality of the variances.
[a] n = 35 in group comparisons of cognitive measures due to two missing scores in RAN
[b]Degrees of freedom 2, 80 in cognitive skills.
[c] n = 18 in group comparisons of reading and cognitive measures due to a missing score in reading comprehension.
[d] Degrees of freedom 2, 71 in Age.
[e] Fisher's exact test.
*p <.05, **p < .01, ***p < .001.

Table 2. Group Comparisons of Childhood Measures between RD- and RD+ Groups.

	RD- (n = 29)[a]		RD+ (n = 19)[b]			
	Mean	SD	Mean	SD	*F(1, 4)*	*Cohen's d*
VIQ	91.52	7.86	91.89	12.09	0.02	0.04
PIQ	98.93	12.66	100.06	9.77	0.10	0.10
RAN	-1.49	1.67	-2.62	1.68	4.90*	0.68
					χ^2 (1)	
Severe childhood RD	12 (42.9 %)		12 (63.2 %)		1.87	
Phonological deficit	14 (48.3 %)		11 (64.7 %)		1.17	
Special education	23 (92 %)		17 (94.4 %)		0.10	
Experienced support > 2 support providers	19 (67.9 %)		10 (52.6 %)		1.11	

Note. [a] n = 27 in VIQ, PIQ, and RAN due to missing cases in RAN. [b]n = 18 in VIQ, PIQ, and RAN. Severe childhood RD = reading fluency z-score at or below -2.5 compared to the mean of the norm data.
*p <.05

Table 3. Pearson Correlations of Adult-age Reading Fluency, Accuracy, and Comprehension, Childhood Cognitive Measures (IQ, RAN, Phonological Deficit), Severity of Childhood RD, Special Education, and Number of Supportive Adults in Childhood within the RD Group.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Adult-age fluency	-	.22	-.07	-.08	-.05	**.29***	-.24	.28	-.08	.26
2. Adult-age accuracy		-	.14	-.02	.06	.26	**-.41****	.15	-.10	.20
3. Adult-age comprehension			-	**.33***	**.35***	.01	-.01	-.03	-.00	-.02
4. VIQ				-	.11	-.21	-.09	.01	.08	-.18
5. PIQ					-	**.36***	.12	-.26	-.01	-.04
6. RAN						-	-.27	.08	-.36*	.10
7. Phonological deficit							-	.11	.12	-.05
8. RD severity								-	-.13	.23
9. Special education									-	-.01
10. Support										-

Note. Group sizes in the correlations vary from 41 to 48 due to missing values in some items. VIQ = Verbal Intelligence Quotient (WISC-R). PIQ = Performance Intelligence Quotient (WISC-R). Phonological deficit = Phonological deficit in childhood, a dichotomous variable based on the performance in the ITPA Phoneme Blending task or the NEPSY Phonological Processing test: 1 – phonological deficit, 0 – no phonological deficit. RD severity = RD level in childhood, a dichotomous variable for RD level based on reading fluency z-score: 1 - "very severe RD" (z-score at or below -2.5), 0 - "severe RD" (z-score -2.5 to -1.5). Special education = Special education received at comprehensive school, 0 = did not receive SE, 1 = received SE. Support = Number of support providers in childhood, 1= more than 2 support providers, 0 = 2 or less support providers.

*$p < .05$.

Table 4. Regression Coefficients for Childhood Predictors of Adult-age Fluency, Accuracy and Comprehension.

	Fluency		Accuracy		Comprehension	
Predictors	*β*	*SE*	*β*	*SE*	*β*	*SE*
VIQ					.30*	.01
PIQ					.32*	.01
RAN	.26	.09	.16	.11		
Phonological deficit			-.37*	-.89		
RD severity	.22	.30				
Special education						
Support	.18	.31				
R^2	.18		.19		.21	
F	3.15*		5.09*		5.56**	

*$p < .05$.

** p <.01.

II

DOES CHILDHOOD READING DISABILITY OR ITS CONTINUANCE INTO ADULTHOOD UNDERLIE PROBLEMS IN ADULT-AGE PSYCHOSOCIAL WELL-BEING? A FOLLOW-UP STUDY

by

Anna-Kaija Eloranta, Vesa Närhi, Timo Ahonen & Tuija Aro, 2019

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Does childhood reading disability or its continuance into adulthood underlie problems in adult-age psychosocial well-being? A follow-up study

Eloranta, A-K., Närhi, V. M., Ahonen, T. P. S., & Aro, T. I.

Abstract

This follow-up study aimed at a better understanding of the associations of reading disability (RD) with adult-age psychosocial wellbeing. We compared adult-age psychosocial wellbeing in 48 individuals (20-39 years) with documented childhood RD but without comorbid disabilities to 37 matched controls. The associations of psychosocial wellbeing with childhood and adult-age reading fluency were studied in the RD group, controlling for IQ, gender and unemployment. Psychosocial wellbeing was assessed with commonly used self-report questionnaires. No group differences were found in psychosocial wellbeing. In the RD group, lower adult-age reading fluency was associated with symptoms of depression, lower self-esteem and social functioning. Severity of childhood RD was not associated with psychosocial wellbeing. Thus, reading fluency problems continuing into adulthood appear to be related to adult-age psychosocial wellbeing. A more holistic approach to studying how RD impacts adult-age wellbeing is needed, including both the individual's developmental history and current functioning in various domains.

Keywords: adults, longitudinal, psychosocial wellbeing, reading disability.

Reading disability (RD) shows high persistence from childhood across adolescence (e.g., Eklund, Torppa, Aro, Leppänen, & Lyytinen, 2015) and has also been reported to be highly persistent into adulthood (Maughan et al., 2009). RD is also associated with psychosocial wellbeing problems in childhood and adolescence (for a review see Livingston, Siegel, & Ribary, 2018). However, research on the impact of RD on individuals' psychosocial wellbeing beyond adolescence is scarce. This study aimed at furthering understanding of the association between RD and adult-age psychosocial wellbeing (i.e., symptoms of depression, self-satisfaction, self-esteem, persistence, and social functioning) in adults with a known childhood history of RD.

High proportions of problems in psychosocial wellbeing have been found among adult-age individuals with RD (e.g., Carawan, Nalavany, & Jenkins, 2016; Ghisi, Bottesi, Re, Cerea, & Mammarella 2016; for a review see Livingston et al., 2018). However, adults with RD and with good self-evaluated persistence to overcome difficulties have been found to report lower levels of psychiatric symptoms (Campbell-Sills, Cohan, & Stein, 2006), and higher life satisfaction (Stack-Cutler, Parrila, & Torppa, 2015). Yet, follow-up studies from childhood into adulthood of individuals with documented childhood RD are rare. Among the few such studies, findings on the impact of RD on the adult-age psychosocial wellbeing of these individuals vary from less favorable (e.g., Undheim, 2003) to more positive (e.g., Schulte-Körne, Deimel, Jungermann, & Remschmidt, 2003).

In their follow-up studies of population-based samples, Esser, Wyschkon, & Schmidt (2002), Maughan & Hagell (1996) and Undheim (2003) found more psychiatric, social and emotional problems amongst individuals with RD compared to controls. Esser and colleagues (2002) followed up 31 individuals at age 25 who had been diagnosed with RD at age eight in a population-based screening program, and compared them to a control group and to a group with other developmental disorders. Undheim (2003) followed up individuals

diagnosed with RD at age ten, derived from a cohort sample, and compared them to a control group and to a group of former child psychiatric clinic clients with RD. At age 23, the most severe problems were found in the cohort-based RD group. In the study of Maughan and Hagell (1996) on a population-based sample of 127 poor readers and 73 normal readers followed from age ten into adulthood (27-28 years), the participants with RD, especially women, had more problems in social relationships and more psychiatric disorders than controls.

In contrast to the studies mentioned above, in their follow-up studies of clinical samples, neither Strehlow, Kluge, Möller, and Haffner (1992) nor Schulte-Körne and colleagues (2003) found higher proportions of psychiatric or emotional symptoms in individuals with RD. Strehlow and colleagues (1992) followed up a sample of 59 former clients of a child psychiatric clinic twelve years after RD diagnosis at age ten. Schulte-Körne and colleagues (2003) in turn followed up 29 students at a boarding school for dyslexic children 20 years after RD diagnosis at age eleven.

In sum, despite their conflicting results, the few earlier longitudinal studies of RD suggest that RD could influence adult-age psychosocial wellbeing. However, these studies did not control either for the severity of childhood RD or adult-age reading skills, or they used the severity of childhood RD as a predictor of adult-age reading but not of wellbeing (Schulte-Körne et al., 2003). It therefore remains unclear whether childhood RD *per se* or its continuity into adult-age is associated with psychosocial wellbeing. Another confounding factor is comorbidity: RD is known to co-occur with other learning (e.g., Landerl & Moll, 2010) or developmental difficulties, such as ADHD (e.g., Margari et al., 2013; Willcutt et al., 2010). Nevertheless, few studies have analyzed the influence of comorbidity on psychosocial wellbeing. Exceptions include Esser and colleagues (2002) and Undheim (2003), who compared their RD groups with groups exhibiting other disorders: Esser and colleagues

(2002) with a group with other developmental disabilities, and Undheim (2003) with a comorbid RD and psychiatric problems group. Undheim (2003) concluded that problems in some aspects of psychosocial wellbeing may partially be explained by comorbid childhood psychiatric problems. Both studies, however, also reported elevated risk for psychosocial wellbeing problems in RD samples without comorbid disabilities. The results are thus unclear. Moreover, neither of the two studies report controlling for comorbid LDs in the groups with RD. Distinguishing the effect of comorbidity from that of RD *per se* on adult-age psychosocial wellbeing problems is thus problematic.

To better understand the influence of RD *per se* on adult-age psychosocial wellbeing, we report our findings for an adult-age sample of individuals who had been diagnosed with RD in childhood but without any comorbid learning or psychological disorders. Our clinical sample was thus highly homogeneous, with as few confounding factors as possible, enabling us to focus on RD and its possible later psychosocial correlates. The sample was compared to a population-based control group. We analyzed the effect of both severity of childhood RD and adult-age reading fluency on psychosocial wellbeing, and examined several aspects of the multifaceted concept of psychosocial wellbeing, from the individual's inner experiences of self (symptoms of depression, self-satisfaction, self-esteem) to the more social and functional aspects of wellbeing (social functioning, persistence to overcome difficulties).

Furthermore, we aimed to gain greater insight into differences in wellbeing in the RD group by controlling for the effect of IQ, gender, and unemployment. Individuals with higher IQ have been found to show better adult-age reading skills (Ferrer, Shaywitz, Holahan, Marchione, & Shaywitz, 2010), and individuals with RD combined with lower IQ to be at higher risk for unemployment (Caspi, Entner, Wright, Moffitt, & Silva, 1998). We assumed that IQ would also be related to psychosocial wellbeing in the present RD group. In addition,

women are known to be more prone to symptoms of depression than men (e.g., Kessler, 2003), and psychosocial problems have been found to be more common among women with RD than male counterparts (Maughan & Hagell, 1996), which is why we also expected more psychosocial wellbeing problems to be found among women than among men in the present RD sample. Moreover, some earlier studies have found higher unemployment rates among individuals with RD compared to their controls (e.g., Undheim, 2003). Therefore, we controlled unemployment in the analyses regarding the childhood RD group.

To address the aforementioned gaps in the earlier research, we sought answers to the following questions:

1. Are there differences in psychosocial wellbeing (experience of symptoms of depression, self-satisfaction, self-esteem, persistence to overcome difficulties, and social functioning) between adults with childhood RD and adults with no documented childhood RD, and, if so, are these differences associated with gender or IQ?

2. Is there an association (after controlling for IQ, gender and unemployment) in adults with childhood RD between adult-age psychosocial wellbeing and the severity of childhood RD or adult-age reading skill?

Method

Participants

Two groups of participants were recruited: Finnish adults who had been diagnosed with RD in childhood (RD group; n = 48) and controls (n = 37). Participants for the RD group were selected from the client archives of the [name deleted to maintain the integrity of the review process], which offers neuropsychological assessment for children with LDs or attention problems (for details see Närhi, 2002). Children were typically referred by school psychologists and had received special education services at school prior to clinical assessment. We selected participants for the RD group from a larger longitudinal register-

based data of former clients of the clinic, with a follow-up age of at least 20 years (n = 509), of which 317 (62.3%) had RD, with some of them also having comorbid other problems along with RD. Seventy-six, i.e., approximately a fourth (23.9%), of all the individuals with RD had RD as their only childhood LD (z-score $\leq$ -1.5), with no comorbid mathematical disability (z-score >-1.5) or psychological problems (z-score >-1.0 in teacher/parent ratings). Of the sample of these 76 individuals, 66 were reached. For nine individuals, no contact information was available, and one person had died. Forty-nine individuals (74.2% of those reached) agreed to participate in the follow-up; one was omitted from the sample owing to low childhood IQ (full scale IQ 60). Thus, the final RD group size was 48. The RD participants had attended the clinic at age eight to 13 years (M=10.7 years). All the participants were native speakers of Finnish.

The control group was assembled from the Population Register Center. Each RD group member was matched with five control individuals for age, gender and home town at the age of seven, i.e., at the beginning of compulsory education. We then contacted all five with the aim of recruiting one matched control for each study group member. No controls were available for eleven of the RD participants either because they were not reached or because they declined to participate or cancelled their participation. Thus, the final control group size was 37.

In the RD group, based on the available data, no differences were found between participants (n=48) and non-participants (n=27) in age, childhood RD level, VIQ or PIQ, psychological problems, or in parental level of education. There were slightly more males among the non-participants (81.5%) than participants (62.5%), but the difference was not significant.

Procedure

The primary method of contacting subjects was a telephone call, which included sharing basic information about the project, arranging one-on-one appointments (if the subject consented to participate), and a preliminary interview on, e.g., education, employment, and special education. The follow-up assessments for the RD group and the control participants were conducted by licensed psychologists on the premises of the [name deleted to maintain the integrity of the review process]. Each appointment lasted four and a half to five hours and was primarily arranged during the day time on workdays. The assessments included standardized tests evaluating cognitive and academic skills as well as interviews and self-rating questionnaires. In the self-rating questionnaires, the instructions were given orally and the participants were encouraged not to hesitate to ask if anything was unclear while completing the questionnaire, so as to ensure that the text would be understandable. The assessments were not blind to group status as some of the interview questions directly dealt with RD and were therefore omitted or reformulated for the control participants.

Each participant was paid daily allowance in compensation and received travelling expenses and lunch or a snack during the assessment break. The participants were given oral feedback on their test performance at the end of the appointment, and offered a short written summary of the main test results by mail.

Ethical Considerations

Ethical approval for the follow-up was given by the Ethical Committee of the University of Jyväskylä, and the study followed the ethical standards of the Declaration of Helsinki. All the participants participated voluntarily and gave their written informed consent. Parents of the RD group individuals had given their informed consent to use their children's test data for research purposes when the participants had been assessed as children.

Measures

Severity of childhood RD

Reading fluency, i.e., speed, was used to measure both childhood RD and adult-age reading skills: in a shallow orthography like Finnish, with consistent letter-sound relationships, reading accuracy is typically learned quickly (Aro & Wimmer, 2003), and hence reading speed is a better marker of reading difficulties than reading accuracy in Finnish, especially in adulthood. Moreover, oral reading fluency has been considered to reflect overall reading competence (see Fuchs, Fuchs, Hosp, & Jenkins, 2001) and is therefore an adequate measure of reading skills.

Childhood RD was assessed by oral reading speed in one of two text-reading tests commonly used at the clinic. Misku (Niilo Mäki Institute, 1992, unpublished) is an age-normed text-reading task for eight- to twelve-year-old children, while the ÄRPS text reading task (Niilo Mäki Institute, 1994, unpublished) is a test normed for second to fourth graders. In both tests, the child reads aloud a one-page story as quickly and accurately as possible. The time taken to complete the text was measured in the Misku and the number of words read per time unit was measured in the ÄRPS.

As the participants had attended the clinic in different times, different tests had been used to measure their reading skills in childhood. The two reading tests used were not fully commensurable, one measuring time taken to complete a text and the other the number of words read per time unit, and therefore, the variances of the z-scores in the tests differed substantially. Hence, we preferred not to use a continuous measure for childhood reading skill level, but instead formed a dichotomous variable on the basis of the z-score calculated based on either of the two tests. The z-scores were computed based on Finnish normative data separately for each test. A z-score of at least -1.5 SDs below the reference group mean was used as the cut-off criteria for RD. Childhood RD was further dichotomized as two RD subgroups as follows: “severe” (below -2.5 SDs) or “RD” (-2.5 to -1.5 SDs).”

Adult-age reading fluency

A Finnish test battery for reading and spelling for use with adolescents and adults (Nevala, Kairaluoma, Ahonen, Aro, & Holopainen, 2006), with a standardization sample of comprehensive school ninth graders (n=208), was used to assess reading skills in adulthood. In the subtests *Word Reading Task* and *Pseudo-Word Reading Task*, the participants read aloud 30 Finnish words or 30 pseudo-words as fast and accurately as possible; the time taken was recorded and the number of correctly read words counted. In the subtest *Text Reading Task,* participants read aloud a text for three minutes as fast and accurately as possible and the number of correctly read words and errors was counted.

Reading fluency was determined as the mean of the reference data based z-scores of the time used in (1) the *Word* and (2) the *Pseudo-Word Reading Task*, and the number of words read in three minutes in (3) the *Text Reading Task*. Cronbach's alpha was .78.

Psychosocial wellbeing measures

Symptoms of depression. Depression was measured with the Beck Depression Inventory -II (BDI-II; Beck, Steer, & Brown, 1996), a 21-item self-rating questionnaire. Participants respond to statements on a four-point Likert scale ranging from zero to three in the intensity of the symptom in question, such as sadness or self-dislike (e.g., 0 = I don't feel I am any worse than anybody else; 3 = I blame myself for everything bad that happens). Higher scores indicate more symptoms of depression. The sum score of all items was used in the present study, the highest possible value being 63. Cronbach's alpha was .66.

Self-satisfaction and social functioning. The sum scores of the domains Wellbeing and Functioning of the Clinical Outcomes of Routine Evaluation – Outcome Measure (CORE-OM; Evans et al., 2002) were used to measure self-satisfaction and social functioning, respectively. The CORE-OM is a 34-item self-report questionnaire including

domains of Wellbeing (four items measuring self-satisfaction and hopefulness), Functioning (twelve items measuring functioning mainly in social encounters), Symptoms (twelve items measuring e.g., anxiety, pain, and unpleasant emotions), and Risk (six items measuring risk of harming self or others). Participants respond to statements on a five-point Likert scale ranging from zero ("not at all") to four ("most of the time") in the intensity of the emotion or function being described. In the domain Wellbeing, the statements describe emotions or states such as "I have felt like crying" or "I have felt optimistic about my future". In the domain Functioning, the individual responds to statements like "I have felt I have someone to turn to for support when needed", or "Talking to people has felt too much for me". The statements indicating positive states in the both domains are on reversed scales, so that higher scores indicate more problems in wellbeing or in social functioning. The sum scores of all items for both domains were used as measures in the present study, the highest possible sum score in the Wellbeing being 16 and that in the Functioning 48. The domain Wellbeing had a Cronbach's alpha reliability of .48 and the domain Functioning a Cronbach's alpha of .65 in the present sample. Cronbach's alphas of .64 for Wellbeing and .79 for Functioning have been reported for the general population in a Finnish validation study (Juntunen, Piiparinen, Honkalampi, Inkinen, & Laitila, 2015).

Self-esteem. Self-esteem was measured with the abbreviated version of the Rosenberg Self-Esteem Scale (RGSE; Rosenberg, 1965), a self-report measure comprising five statements relating to self-esteem (e.g., "I feel that I have a number of good qualities.") to which individuals respond on a five-point Likert-scale (from "strongly disagree", to "strongly agree"). Higher scores indicate less self-esteem problems. The highest possible sum score of the five items is 20. Here, the sum score of all statements was used, and Cronbach´s alpha was .79.

Persistence to overcome difficulties. Self-evaluated persistence was estimated with the Connor-Davidson Resilience Scale -10 (CD-RISC-10; Campbell-Sills & Stein, 2007) which comprises ten statements measuring the capacity to cope with adversity, such as "I am not easily discouraged by failure" or "Coping with stress can strengthen me" to which individuals respond on a five-point Likert scale ranging from "not true at all" to "true nearly all the time". Higher scores indicate stronger persistence. The sum score of all items was used as a measure of persistence, the highest possible sum score being 40. The Cronbach's alpha in the present study was .89 as compared to the value of .85 reported in an earlier study (Campbell-Sills & Stein, 2007).

Unemployment. Current employment status was gained from the participants' pre-assessment telephone interviews. A dichotomous variable was formed with categories 0="employed" and 1="unemployed". The participants were classified as unemployed if they were job-seekers or laid off, and not studying, working full-time or part-time, doing military service, on maternity or sickness leave, or on a disability pension.

IQ. Full Scale IQ (FSIQ) was estimated using the abbreviated version of the Wechsler Adult Intelligence Scale – IV (WAIS IV, Wechsler, 2008; Finnish standardization). As in the Wechsler Abbreviated Scale of Intelligence – II (WASI-II, Wechsler, 2011; see e.g., Irby & Floyd, 2013), the subtests Vocabulary and Similarities were used to produce a Verbal Comprehension Index (VCI) and the subtests Block Design and Matrix Reasoning to produce a Perceptual Reasoning Index (PRI), and were computed using partition according to the WAIS IV test manual (Wechsler, 2008; Finnish standardization). Working Memory Index (WMI) and Processing Speed Index (PSI) were used as whole measures in computing the FSIQ. Test-retest reliability above .90 for FSIQ in abbreviated WAIS-IV versions is commonly reported (Irby & Floyd, 2013).

Statistical analyses

Correlations and univariate general linear model (GLM) analyses were used to answer the research questions. Because the distributions of the psychosocial wellbeing measures were not normal, the results of the GLM analyses were tested using bootstrapped (Boos & Stefanski, 2010) confidence intervals (95%) with 1 000 replications. To evaluate the statistical power of the group comparisons, we used partial eta squared (η^2) as an effect size. A partial eta squared of 0.01 to 0.06 is considered as small, that of 0.06 to 0.14 as medium, and a partial eta squared above 0.14 as large.

Results

Description of the groups

Descriptive statistics on gender, current employment status, age, IQ, and adult reading fluency of the RD and control group are presented in Table 1. The groups did not differ in the proportion of males or age at follow-up. Current unemployment was more common among the RD participants than among the controls.

Average reading fluency at adult-age was significantly lower in the RD group than in the control group. In the RD group, reading fluency of 29 participants (60.4%) was better than -1.5 SDs based on the test norm data, approaching an "adequate" level of reading skill. However, only three RD participants scored at or above the mean of the normative sample, and only one RD participant above the control group mean of reading fluency.

Average IQ was higher in the control than the RD group. In the RD group, seven individuals (14.5%) had an IQ below 70 in the follow-up assessment, and ten participants' IQ had declined more than ten standard points from the childhood. When comparing the RD group without the seven individuals with low IQs to the control group, the significant group difference in reading fluency remained.

The group difference regarding IQs was only found in the VCI (comprising subtests Vocabulary and Similarities), the RD group scoring averagely lower than the control group, while no difference was found in the PRI. The VCI of eleven RD participants had declined more than ten standard points from childhood, while only four PRI scores were more than ten points weaker than the childhood PIQ scores. Moreover, one participant in the present sample had particularly low IQ at adult follow-up, which was partially due to considerable test anxiety during the follow-up appointment. The possible effect of IQ on the results was taken into account by controlling adult-age IQ in the analyses, and by running post-hoc analyses in group comparisons without the one individual with low IQ at adult follow-up.

[Insert Table 1 here]

Differences in psychosocial wellbeing between the RD and the control group

Table 2 shows the results on the first research question. As can be seen, the scores indicating psychosocial wellbeing problems (depression, and problems in self-satisfaction and social functioning) were generally rather low, whereas the scores indicating good psychosocial wellbeing (self-esteem and persistence) were rather high in the groups. The RD and the control group did not differ in depression, self-satisfaction, self-esteem, persistence, or social functioning, and there were no gender-related differences. IQ had a significant effect only on the persistence score, and the observed power was .59.

[Insert Table 2 here]

Associations of psychosocial wellbeing with reading skills in the childhood RD group

To answer the second research question we first examined the bivariate correlations between the psychosocial wellbeing measures and adult-age reading fluency both in the RD and the control group. The correlations were examined in order to find out whether there is a possible

association between adult-age reading and psychosocial wellbeing in the both groups or whether this association is specific to the RD group. Hence, the aim was to find out whether current reading skills were more strongly related to psychosocial issues in adults with the history of struggling with reading compared to adults without such problems. As Table 3 shows, the psychosocial wellbeing measures correlated significantly with each other in both groups, apart from the persistence and the depression measures, which did not correlate in the controls. However, adult-age reading fluency correlated with the five psychosocial wellbeing measures and with unemployment only in the RD group. In addition, unemployment correlated with social functioning and self-satisfaction only in the RD group. When the one individual with particularly low IQ at adult follow-up was removed from the sample, the correlations between psychosocial wellbeing measures, reading skills, IQ and unemployment did not change substantially, still varying from .05 to .68. No significant correlations were found in the control group. Hence, only the RD group was included in the analyses pertaining to the second research question. In the RD group, a significant positive correlation was found between persistence and adult-age IQ. The severity level of childhood RD in the RD group did not correlate significantly with the psychosocial wellbeing measures or with adult-age fluency, IQ or unemployment.

[Insert Table 3 here]

Table 4 shows the results of the GLM analyses and bootstrapped confidence intervals pertaining to the associations between psychosocial wellbeing and the severity of childhood RD or adult-age reading skill, conducted in the RD group only. As can be seen, better adult-age reading fluency was associated with fewer depressive symptoms (observed power .69), with higher self-esteem (observed power .73), and better social functioning (observed power .64), but not with self-satisfaction or persistence in the RD group. The severity of childhood RD had no significant associations with any of the psychosocial

wellbeing measures. Of the control variables, higher adult-age IQ was related to higher self-reported persistence (observed power .86), whereas gender and unemployment showed no associations with psychosocial wellbeing.

[Insert Table 4 here]

Discussion

We compared the psychosocial wellbeing of adults with childhood RD but without childhood comorbidities with that of their matched controls. We also examined whether the severity of childhood RD or adult-age reading fluency were related to psychosocial wellbeing in the childhood RD group, after controlling for adult-age IQ, gender, and employment status. The RD group did not differ from controls in the psychosocial wellbeing measures (depression, self-satisfaction, self-esteem, persistence, and social functioning) and there were no gender-related differences. In the RD group, no associations were found between the severity of childhood RD and the psychosocial wellbeing measures. Adult-age reading skill, however, was associated with psychosocial wellbeing.

Our finding that adults with RD did not differ from controls in psychosocial wellbeing conflicts with many earlier studies reporting an association between RD and psychosocial wellbeing problems in adulthood (e.g., Carawan et al., 2016; Undheim, 2003, for a review see Livingston et al., 2018). However, most of the earlier adult-age findings lack a longitudinal perspective on RD. Our results, for a sample of adults with a documented history of childhood RD, showed that childhood RD itself is not necessarily related to adult-age psychosocial wellbeing problems, whereas reading fluency problems that continue into adulthood may have a negative impact on psychosocial wellbeing.

Esser and colleagues (2002), Maughan and Hagell (1996) and Undheim (2003) also examined follow-up samples of adults diagnosed with RD in childhood. Contrary to our

results, they found a higher proportion of psychiatric problems among the RD group compared to matched controls. Participant ages at childhood diagnosis and at follow-up resembled those in our study (8 and 25, 10 and 27-28, and 10 and 23 years, respectively). However, each study used population-based samples whereas we studied a sample of former clinical clients. Two other follow-up studies of RD examining a clinical (Strehlow et al., 1992) and a boarding school sample (Schulte-Körne et al., 2003) instead of a population-based sample found no differences in adult psychiatric symptoms compared to controls, as was the case in our study. This could indicate that a clinical assessment in childhood is related to more positive adult outcomes in psychosocial wellbeing. This speculation is in line with Undheim's (2003) finding that the population-based RD group reported more depressive symptoms than another RD sample drawn from a psychiatric clinic.

A thorough assessment process in childhood may function as a short-term intervention and induce a positive effect in psychosocial wellbeing. In our sample, the assessment process comprised three to five appointments, including the initial family interview, neuropsychological assessments, feedback, and a counseling appointment with family and teachers. Each child also received special educational support both before and after the assessment process. In Finland, no diagnosis is required for a child to be eligible for special education: instead, it is provided based on the teacher's evaluation (see Björn, Aro, Koponen, Fuchs, & Fuchs, 2015). These participants may also have originated from particularly supportive environments, as the clinical assessment process requires active participation of both the family and the referring school personnel. Such supportive factors may have boosted the development of psychosocial wellbeing among the children. The participants might have come from families that place a high value on education and are willing to support their children in studying. In addition, the participants in this sample did not have substantial comorbid disabilities (i.e., did not meet the criteria set for disability, a z-

score below -1.5 in mathematics or below – 1 in psychological problems) besides RD in childhood, which may also have contributed to the relatively positive adult-age outcomes. Thus, our findings are best generalizable to a population having received diagnosis of RD and support during childhood, and not having considerable comorbid disabilities.

Our longitudinal data enabled us to study both childhood and adult-age reading skills in relation to adult-age psychosocial wellbeing, associations that few earlier studies have examined (Schulte-Körne et al., 2003). Although we found no association between the severity of childhood RD and adult-age psychosocial wellbeing, our results showed that childhood RD matters when reading fluency problems continue into adulthood. It is plausible that improved reading skills enhance adult-age psychosocial wellbeing, or that psychosocial wellbeing helps improve reading.

Unexpectedly, gender did not explain variance in psychosocial wellbeing. This result conflicts with earlier observations that symptoms of depression are more common among women in general (Kessler, 2003) and psychosocial wellbeing problems more common among RD women (Maughan & Hagell, 1996) than RD men. The possible reason for their better-than-expected wellbeing may be that the women had received more support than women in general during their lives, beginning from the early clinical assessment process in childhood.

Hence, the clinical nature of our data needs to be considered when interpreting the results. In addition, while the attrition rate was reasonable (26%) for a longitudinal study and participants and non-participants did not differ in the childhood measures, attrition may have induced bias in the findings: adults with major issues in psychosocial wellbeing may not have participated in the follow-up. Moreover, as we excluded individuals meeting the criteria for mathematical disability or psychological problems and thus focused on rather pure RD, the sample size is small, owing to which the statistical power of most of the tests was rather low.

Psychosocial wellbeing should also be examined more thoroughly in relation to comorbid LDs or to different types of LD (e.g., Klassen, Tze, & Hannok, 2011). However, our study aimed to gain knowledge on the wellbeing of individuals without comorbidity in childhood. The present sample of "pure" RDs formed one fourth of the original sample with RD in childhood which indicates that comorbidity of reading, math disability and psychological problems is common. The present findings should be interpreted with the original aim and design of the study in mind.

To better understand the implications of childhood RD on psychosocial wellbeing, other childhood factors possibly related to RD would also have been interesting to look at. Due to excluding children with substantial psychological problems in childhood from this sample so as to make it as homogenous as possible, the variance in childhood psychosocial wellbeing was small and hence, we did not have the chance to examine its effect on RD or on adult-age wellbeing. Also, we could not examine the relation of, e.g., school career with adult-age outcome among the present sample, nor compare childhood reading skills between the RD group and the controls, as the control group lacked childhood reading data.

Despite the association between adult-age reading fluency and psychosocial wellbeing, it should be noted that the variance in psychosocial wellbeing measures was generally low: in the measures indicating good psychosocial wellbeing (self-esteem and persistence), the scores were generally rather high, and in the problem scores (depression and problems in self-satisfaction and social functioning), none of the participants reported mental health problems that would need, e.g., medical treatment. The measures of psychosocial wellbeing problems that we used in the present study are primarily targeted at clinical practice and at detecting substantial problems in mental health, and hence the threshold for scores indicating problems are high. Even minor problems in psychosocial wellbeing can still have a considerable effect on everyday life, which is why subtle differences are also worth

taking into account. However, the results pertaining to psychosocial wellbeing should also be interpreted carefully because of rather low reliability of some of the self-rating measures, which might indicate that among the present sample, some questions may have had wider variation than others. In addition, in some of the measures, the mean values and variances for the sum scores of all questions were considerably low. Still, higher reliabilities had been reported in the normative data of the measures. Further research is needed to find out which items or features best produce differences between groups. Also, it should be recognized that self-report measures are not equivalent to clinical diagnosis.

The descriptive statistics concerning unemployment should be interpreted with caution: we only examined current unemployment gained from the participants' interviews, because of the lack of reliable information on employment history, e.g., on the length of unemployment periods during lifetime. However, according to the results based on comprehensive register data on a larger sample of the clinical clients, a significantly higher share of the participants with RD than that of the control group had been unemployed for more than a year during lifetime (Aro et al., 2018). This confirms the figures of higher unemployment among the RD participants that we found in the present sample.

It should also be noted that a considerable proportion of our RD participants had rather low IQs at adult-age, and that the decline in the full scale IQs was mainly due to deteriorated verbal skills. Although the usage of different Wechsler test batteries must be taken into account when comparing the childhood and adult-age IQs, this finding may reflect the reciprocal long-term association of reading problems with verbal skills in particular which has been reported in earlier research (e.g., Ingesson, 2015; Stanovich, 1986; Swanson, 2012); weak reading skills and consequential minor exposure to text may diminish vocabulary and verbal skills in the long run. This is in line with our finding that adult-age reading fluency of the individuals with low IQs was also lower than that of the rest of the RD group. Finally, it

should be noted that the adult-age IQ estimate used in the present study was based on an abbreviated battery of the WAIS IV, with only two verbal and two perceptual subtests included, which is why the results concerning IQ should be considered cautiously.

The results of our follow-up study suggest that childhood RD per se does not necessarily impact adult-age psychosocial wellbeing. This partially clarifies the contrasting findings of earlier longitudinal studies reporting associations between childhood RD and adult-age psychosocial wellbeing but which have not controlled for adult-age reading skills. Our results suggest that the extent to which reading problems continue into adulthood might be critical for psychosocial wellbeing among individuals with RD. This finding supports a focus on early assessment, special educational support and interventions in childhood, the importance of which has also been emphasized in earlier research (e.g., Partanen & Siegel, 2014; for a review see Livingston et al., 2018), as improved reading fluency may be an advantage in life to individuals with RD. In addition, it is reasonable to argue that some RD children need emotional support, continuing into adolescence and adulthood, to buffer against later problems in psychosocial wellbeing. As earlier research has suggested, interventions that combine both academic skill training and emotional support would best benefit most individuals with RD (for a review see Livingston et al., 2018). However, to identify the children who mostly need help and to support them more adequately, more in-depth research on the factors that boost psychosocial wellbeing is needed. This means applying a more holistic approach that includes the individual's developmental history and present-day functioning in various domains (cognitive, social, emotional, educational and environmental). This is necessary to better understand the factors that along with RD influence and shape various individual pathways.

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Conflicts of interest

The authors have declared no conflicts of interest.

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Table 1. Descriptive statistics on gender, current employment status, age, IQ, and adult reading fluency of the RD and control group.

	RD (n=48)[a]			Control (n=37)/Population[b]				
	Range	Mean	SD	Range	Mean	SD	*F(1, 83)*	η^{2} [c]
Males (%)	62.5 %			62.2%				
Unemployed currently	20.8%			8.1%				
Age follow-up	20-39	26.23	4.75	21-40	27.51	4.79	1.52	.02
Age childhood	8-13	10.68	1.36	-	-	-		
IQ follow-up (WAIS)	49-112	86.08	15.29	70-120	95.95	12.63	10.09**	.11
Verbal Comprehension Index (VCI)	53-118	83.90	16.40	68-122	95.78	11.93	13.79**	.14
Perceptual Reasoning Index (PRI)	50-128	98.94	17.26	59-124	99.14	15.40	0.00	.00
Reading fluency follow-up	-3.49-0.44	-1.56	1.05	-2.36-1.95	0.31	0.88	75.99**	.48

Note. [a]n =31 in maternal education. [b] In maternal education, educational distribution in 30-54-year-old population in year 2000 (Official Statistics of Finland, 2018) serves as a control group. [c] η^2 = Effect size, partial eta squared. Reading fluency follow-up = Adult-age reading fluency; z-score mean of three reading fluency measures in the individual test battery on reading and spelling skills for adolescents and adults (Nevala, Kairaluoma, Ahonen, Aro, & Holopainen, 2006).

**$p < .01$.

Table 2. Group and gender comparisons between the RD and the control group in depressive symptoms, self-satisfaction, self-esteem, persistence and social functioning.

	Group				Gender				IQ		
	F (1; 81)[a]	M(SD) RD / Control	η^{2b}	95 % CI[c]	F(1; 81)[a]	M(SD) male/female	η^{2b}	95 % CI[c]	F(1; 81)[a]	η^{2b}	95 % CI[c]
Depression	.07	3.57(3.24) / 3.05(2.99)	.00	-1.22 – 1.69	.14	3.21(3.13) / 3.55(3.14)	.00	-1.55 - 0.92	1.90	.02	-.08 - .01
Self-satisfaction	.71	2.88(1.84) / 2.33(1.90)	.01	-.47 – 1.22	.20	2.56(2.05) / 2.78(1.56)	.00	-.99 - .68	1.61	.02	-.04 - .01
Self-esteem	2.78	14.66(2.61) / 13.49(4.03)	.03	-.37 – 3.16	.16	14.04(2.99) / 14.31(3.89)	.03	-1.80 – 1.20	.25	.00	-.03 - .06
Persistence	.91	29.73(5.59) / 29.43(5.87)	.01	-1.34 – 3.83	.04	29.79(5.43) / 29.28(6.14)	.00	-2.43 – 3.14	4.86*	.06	.01 - .18

Social functioning	1.24	8.90(4.52) / 7.54(4.51)	.02	-.97 – 3.34	.66	8.60(4.84) / 7.81(4.03)	.01	-.08 - .05	.26	.00	-.08 - .05

Note. Depression = Self-ratings in the BDI –II, total score (0-63). Self-satisfaction = the sum score of the 4 items in the Psychological wellbeing domain of the CORE-OM, reversed scale (0-16). Self-esteem = Rosenberg self-esteem scale, abbreviated, the sum score of all items (0-20). Persistence = Connor-Davidson Resilience Scale -10 (CD-RISC-10), the sum score of all items (0-40). Social functioning = the sum score of the 12 items in the Functioning domain of the CORE-OM, reversed scale (0-48).

[a] degrees of freedom 1; 79 in BDI, and 1; 80 in Self-satisfaction and Self-esteem

[b] η^2 = Effect size, partial eta squared.

[c] Bootstrapped confidence intervals with 1 000 samples.

*$p < .05$.

Table 3. Pearson correlations of psychosocial wellbeing measures with adult-age reading fluency, IQ, and unemployment in the RD group (above the diagonal) and the control group (below the diagonal), and with the severity level of childhood RD in the RD group.

	Control (n=37)	RD (n=48)							
Variable		1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Depression	_	.67**	-.37**	-.37*	.57**	-.47**	-.15	.28	.24
2.	Self-satisfaction	.33*	_	-.40**	-.34*	.76**	-.41**	-.13	.37*	.27
3.	Self-esteem	-.55**	-.48**	_	.53**	-.41**	.41**	.18	-.16	-.16
4.	Persistence	-.31	-.30	.54**	_	-.28	.34*	.41**	-.23	-.17
5.	Social	.40*	.54**	-.43**	-.39*	_	-.44**	-.13	.36*	.14
6.	RF (ad)	-.12	-.11	.03	.10	-.02	_	.07	-.33*	-.28
7.	IQ	-.24	-.19	-.07	-.02	.09	.28	_	-.09	.09
8.	Unemployment	-.21	-.27	.24	.16	-.37*	-.15	-.27	_	-.01
9.	RD (child)									_

Note. Depression = BDI –II total score. Wellbeing = CORE-OM Psychological wellbeing score. Social = CORE-OM Functioning score. Self-esteem = Rosenberg self-esteem scale, abbreviated. Persistence = Connor-Davidson Resilience Scale -10 (CD-RISC-10). RF(ad) = Adult-age reading fluency; z-score mean of three reading fluency measures. IQ = Full scale intelligence quotient (WAIS-IV, abbreviated, Wechsler, 2008; Finnish standardization). Unemployment: dichotomous variable for working situation: 1 – unemployed, 0 – not unemployed. RD (child) = severity level of childhood RD, based on the z-score of reading speed in either of two reading fluency tests commonly used at the clinic. As the two tests were not commensurable, a dichotomous measure for childhood reading skill was used. 1 “RD” (-2.5sd to -1.5sd), 2 “severe RD” (below -2.5sd).
$^{*}p < .05$; $^{**}p < .01$.

Table 4. GLM analyses and bootstrapped confidence intervals for the relations of each psychosocial wellbeing measure in the RD group with adult-age reading fluency and the level of severity of childhood RD, with IQ, gender, and unemployment as control variables.

	Depression			Self-satisfaction			Self-esteem			Persistence			Social functioning		
	F [a]	η^{2b}	CI[c]	F [a]	η^{2b}	CI[c]	F [a]	η^{2b}	CI[c]	F [a]	η^{2b}	CI[c]	F [a]	η^{2b}	CI[c]
RF (ad)	5.41*	.12	-2.07 - -.09	2.67	.06	-1.00 - .13	7.82**	.16	.30 – 1.90	3.22	.07	-.20 – 3.29	5.60*	.12	-3.08 - -.04
RD (ch)	1.18	.03	-2.73 - .86	2.24	.05	-1.81 - .37	.13	.00	-1.32 – 1.81	.97	.02	-1.58 – 4.54	.12	.00	-2.98 – 2.39
IQ	.79	.02	-.09 -.03	.59	.01	-.04 - .02	1.76	.04	-.02 - .08	9.80**	.19	.03 - .28	.56	.01	-.10 - .03
G	.25	.01	-2.24 – 1.38	.04	.00	-1.11 - .92	3.46	.08	-3.12 - .14	.95	.02	-4.60 – 1.63	.74	.02	-1.08 – 3.58
Ue	1.07	.03	-3.94 - 1.47	3.87	.09	-2.68 - .46	.00	.00	-1.84 – 2.03	.63	.02	-2.44 – 5.55	2.63	.11	-5.26 - .25

Note. Depression = BDI –II total score. Self-satisfaction = CORE-OM Psychological wellbeing sum score. Self-esteem = Rosenberg self-esteem scale, abbreviated, sum score. Persistence = Connor-Davidson Resilience Scale -10 (CD-RISC-10), sum score. Social functioning = CORE-OM Functioning sum score. RF (ad) = Adult-age reading fluency. RD (ch) = severity level of childhood RD. G = gender. Ue = unemployment.

[a] degrees of freedom 1; 41.

[b] η^2 = Effect size, partial eta squared.

[c] Bootstrapped 95 % confidence intervals with 1 000 samples.

*p<.05, **p < .01.

III

PSYCHIATRIC PROBLEMS IN ADOLESCENCE MEDIATE THE ASSOCIATION BETWEEN CHILDHOOD LEARNING DISABILITIES AND LATER WELLBEING

by

Anna-Kaija Eloranta, Vesa Närhi, Joona Muotka, Asko Tolvanen, Elisa Korhonen, Timo Ahonen & Tuija Aro, 2019

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