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# Profiles of reading and fluency and spelling skills: stability and change across the early school years

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## ABSTRACT

In this longitudinal study, we examined what kind of profiles of reading fluency and spelling skills could be identified among pupils ( $N = 467$ ) and how stable these profiles were during the first three years of school. We also investigated how monolingual (Swedish) and simultaneously bilingual (Finnish-Swedish) pupils and gender were distributed within the profiles. Three profiles of reading fluency and spelling skills were found among the pupils through latent profile analysis: low, average, and high performing. Latent transition analysis confirmed stable and identical profiles throughout the first school years. The distributions of monolingual and bilingual pupils and gender were equal in all profiles throughout the grades. These findings have implications on a pragmatic level in school, confirming the importance of early identification and support for low performing pupils.

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## KEYWORDS


Latent profile analysis; latent transition analysis; longitudinal; reading fluency; spelling skills; stability and change

## Introduction

The first years of school are important for pupils' reading and spelling development (e.g., Fuchs et al., 2014). Learning to read and spell effortlessly is key to mastering the demands of learning in school and for life (e.g., Duncan et al., 2007). Previous studies have emphasised the importance of early identification of pupils at risk for reading and spelling deficits (RSD) to ensure that every pupil receives appropriate support in this phase of development, preventing or reducing the risk for later failure in the learning process (Fuchs et al., 2014).

Although previous research has suggested that the gap between low and high performing pupils tends to remain over time (e.g., Eklund et al., 2015; Landerl & Wimmer, 2008), there are also contradictory research findings, showing instability in reading and spelling skills (Etmanskies et al., 2016; Torppa et al., 2015). In this longitudinal study, we aimed to complement previous research by using a longitudinal person-centred approach to examine reading fluency and spelling profiles, as well as their stability and change during the first three school years. Moreover, of interest was whether there were differences between monolingual and simultaneously<sup>1</sup> bilingual pupils and gender within the profiles. To our knowledge, no longitudinal study of this kind has been accomplished among monolingual and simultaneously bilingual

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<sup>1</sup>A pupil has learned two languages in a family with native speakers of both languages or has used two languages simultaneously from birth. See Vataja et al. (2022).

pupils in early school years. From a pragmatic perspective, it is important to bring more knowledge about identification of reading fluency and spelling deficits among these language groups. When it comes to L2 learners, previous research (e.g. Geva & Wiener, 2015) show that teachers in the early grades tend to misinterpret L2 pupils with (or with risk of) reading deficits, believing that the pupils' word reading problems are mainly due to lack of sufficient competence in the second language.

Previous studies on reading and spelling have focused on skills in the first two years in school (Lerkkanen et al., 2004), predictors of early reading and spelling skills (e.g., Furnes & Samuelsson, 2010), effects of familial risk for dyslexia on reading development (e.g., Eklund et al., 2015), or late-emerging and resolving difficulties (Catts et al., 2012; Torppa et al., 2015). However, to our knowledge, no study has used a person-centred approach to investigate co-occurring stability and change in both reading fluency and spelling during Grades 1–3. There is also evidence that reading fluency and spelling dissociate at some point in development (e.g., Moll et al., 2020; Moll & Landerl, 2009) or that some pupils show deficits in either reading fluency or spelling only (e.g., Eklund et al., 2015; Wimmer & Mayringer, 2002). This research aimed further to investigate whether these skills are associated within the profiles among pupils in the early school years.

Person-centred analytical approaches (i.e., latent profile analysis and latent transition analysis) go beyond predefined cut-off points to bring forward more knowledge about reading fluency and spelling skills on an individual level, particularly concerning pupils at risk for deficits in this area.

### ***Early reading fluency and spelling skills***

Reading fluency is usually defined as accurate, fast and automatic decoding with prosody in oral reading (Kuhn et al., 2010). Reading fluency is a necessary prerequisite for reading comprehension and future success in learning (Catts et al., 2012). Therefore, early identification of pupils struggling with decoding and reading fluency is of great importance in order to offer appropriate interventions at an early stage (Grimm et al., 2018; Virinkoski et al., 2018).

Reading accuracy is usually reached at an early stage of development in transparent languages like Finnish, and also in Swedish, despite Swedish being a more complex language than Finnish (Aro & Wimmer, 2003; Furnes & Samuelsson, 2011). In transparent languages, most poor readers reach reading accuracy already during Grade 1, but reading fluency often remains slow (Aro & Wimmer, 2003). Development of spelling seems to some extent to follow the same pattern: in transparent languages, it is easier and faster to master spelling accuracy than it is in more complex languages, such as English (Caravolas, 2004).

Reading fluency and spelling seem closely related, especially at the beginning of the reading and spelling development (Ehri, 2000; Treiman et al., 2019). Early reading development predicts later spelling skills (Frith, 1985), and Georgiou et al. (2020) also found evidence of such relations when examining reading fluency and spelling in their cross-linguistic study among pupils during first and second grade. In addition, a Finnish longitudinal study (Leppänen et al., 2006) revealed that preschool reading skills predicted spelling at the beginning of second grade. Spelling and reading fluency seem to rely on different lexical processes and cognitive underlying factors respectively (Furnes et al., 2019; Furnes & Samuelsson, 2011). Still, phonological awareness and rapid naming skills (RAN) are related to both spelling and reading fluency, but poor skills in RAN are more strongly associated with reading fluency deficits, whereas poor phonological awareness is more strongly related to deficits in spelling. RSD on the other hand relates to weaknesses in several areas, such as RAN, letter knowledge and phonological awareness (Furnes et al., 2019; Furnes & Samuelsson, 2010; Torppa et al., 2013). These findings support the assumption that reading and spelling skills seem to dissociate at some point with respect to the underlying cognitive factors (e.g., Furnes & Samuelsson, 2010; Torppa et al., 2016).

### ***Early reading fluency and spelling profiles and their stability and change***

Studies examining profiles of reading fluency and spelling skills have mainly focused on poor and typical performance in reading and spelling (e.g., Compton et al., 2008; Landerl & Wimmer, 2008). Others have focused on what profiles can be found when investigating different aspects of reading (e.g., Lerkkanen et al., 2004; Torppa et al., 2007; Wolff, 2010).

A few studies have used latent profile analysis to examine subgroups of readers and/or stability of profiles (e.g., Lerkkanen et al., 2004; Wolff, 2010) using measures on word reading and reading comprehension. Several subgroups of poor readers have emerged, which indicates poor readers as a heterogeneous group, such as poor decoders, poor comprehenders, and poor in both decoding and comprehension (Wolff, 2010). Focus in some studies has been on performance related to predictors of literacy skills, such as letter knowledge and phonological awareness, but with no investigation of stability (e.g., Torppa et al., 2007).

The stability of reading and spelling skills has been investigated in earlier studies differentiating between poor and typical performance, mostly by using predefined cut-off points (Eklund et al., 2015; Moll et al., 2020; Torppa et al., 2007). However, these findings have not been completely consistent. Some have found high stability of reading and spelling skills (Eklund et al., 2015; Landerl & Wimmer, 2008), whereas others suggest instability of such skills (Lerkkanen et al., 2004; Psyridou et al., 2020), especially when focusing on late-emerging and resolving deficits (Catts et al., 2012; Etmanskies et al., 2016; Torppa et al., 2015).

Previous studies (Eklund et al., 2015; Landerl & Wimmer, 2008) investigated the stability of spelling accuracy and reading fluency from Grades 1 and 2 to Grade 8 and found high stability of reading fluency, whereas the stability of spelling accuracy was moderate. Another study (Moll et al., 2020) focusing on the stability of different subtypes, including reading deficits (RD) only, spelling deficits (SD) only, RSD, and typical development (TD) in Grades 3–5 showed instability of spelling deficits, while RSD and RD among pupils were stable over time. Pupils with SD only improved their skills and moved to the TD-group. Most individuals with TD were stable over time (Moll et al., 2020).

### ***Language and gender in reading and spelling profiles***

Quite often parents, teachers and health professionals fear that bilingualism could worsen difficulties connected to dyslexia (Vender & Melloni, 2021). Most of the studies about reading and spelling development for bilingual pupils are based on L2 learners (e.g., Bialystok, 2005; Durgonoğlu et al., 1993; Schaars et al., 2017), not simultaneously bilinguals as in this study. Some of these studies have revealed bilinguals to perform better in reading than monolinguals (Bialystok, 2005), while others found no differences between monolingual and bilingual readers (Durgonoğlu et al., 1993; Schaars et al., 2017). Research focusing on spelling of bilinguals has revealed similar results as for reading. Some suggest positive cross-language facilitation, while others propose negative literacy skills transfer across languages, for example depending on similarities or dissimilarities between L1 and L2 languages (Bialystok, 2017). A recent Finnish study (Vataja et al., 2022) investigating reading and spelling skills of monolingual and simultaneously bilingual first graders showed, in line with some previous research on L2 learners, no significant differences between the language groups.

Looking at gender proportions, especially among low performing pupils, previous studies reveal in general no differences in the first grade. A study by Limbrick et al. (2012) among pupils in Grades 1 and 2 found no gender differences in reading fluency and spelling in the first grade, whereas in the second grade there was a difference in favour of girls. A study on late-emerging and resolving dyslexia from Grade 2 to Grade 8 among Finnish-speaking pupils found an equal number of boys and girls in the dyslexia group in Grade 2, but more boys in the late-emergent group (Torppa et al., 2015). Wolff (2010) examined reader subgroups among a large sample of 9-year-old Swedish children in a cross-sectional study. Eight subgroups were identified, from very good readers to dyslexic readers. Gender distribution showed that there were significantly more girls in the high performing

profiles, and contrarily, more boys in the low performing groups (Wolff, 2010). Results from other previous studies show similar findings with an overrepresentation of boys when it comes to poor performance in especially spelling, whereas girls mostly are found in the highest performing groups (Moll et al., 2014).

### ***The present study***

The aim of this study was to investigate what kind of reading fluency and spelling profiles can be found in Grades 1–3 and how stable these profiles were among Finnish-Swedish pupils. Furthermore, we examined how reading fluency and spelling were associated in the profiles. Of further interest was to explore if there were differences between monolingual and simultaneously bilingual pupils and gender groups within the profiles. The use of LPA without predefined cut-off scores offered the possibility to explore what kind of profiles in reading fluency and spelling can be found at an individual level in the early school years.

The specific research questions were as follows:

1. What kind of reading fluency and spelling profiles can be found among pupils in the first three grades?

Based on previous research, we expected to find at least two groups of pupils—a group with low performance (Hypothesis 1; H1) and a profile with typical performance (H2; e.g., Eklund et al., 2015; Landerl & Wimmer, 2008; Moll et al., 2020). In line with previous research, we also expected dissociation between reading fluency and spelling (H3; e.g., Moll et al., 2020)

2. How stable are reading fluency and spelling profiles from Grade 1 to Grade 3?

We expected that most of the pupils would be stable in their profiles over time (H4; e.g., Landerl & Wimmer, 2008) but that some transitions would occur as well (H5) due to the development of literacy skills in early school years (e.g., Lerkkanen et al., 2004; Moll et al., 2020).

3. How are monolingual and simultaneously bilingual pupils and gender groups distributed within the profiles?

We expected monolingual and simultaneously bilingual pupils to be equally distributed within the profiles (H6; e.g., Vataja et al., 2022), whereas boys would be overrepresented in the low performing group (H7; e.g., Wolff, 2010).

## **Method**

### ***Context of the study***

This study was conducted in Swedish-speaking schools in Finland. In these schools, about 50% of the pupils are monolingual Swedish, whereas bilingual Finnish-Swedish pupils comprise around 40%. Pupils with other language backgrounds (Finnish language, multilingual, or bilingual other than Finnish-Swedish) are 10% (Statistics Finland, 2019). Finland has two official languages—Finnish and Swedish. Swedish is the minority language, and 5.2% of the population speaks it as their first language (Statistics Finland, 2019). By law, the Swedish-speaking population has the right to use and access services in their own language, which includes education in Swedish-speaking schools. The year children turn seven they start their nine-year compulsory education, where the formal instruction in reading and spelling starts.

In the Finnish school context, early identification of reading fluency and spelling deficits is stated in the national curriculum to ensure suitable interventions for pupils at risk for later reading and spelling deficits (Finnish National Board of Education, 2014). Consequently, teachers are already in the first grades putting effort into narrowing the gap between pupils with poor and excellent reading fluency and spelling skills.

## Participants

The participants ( $N = 467$ ) were selected from a longitudinal study ( $n = 565$ ) conducted in Swedish-speaking schools in Finland. Totally 22 randomly selected schools from four different areas in Finland participated. The participants attended Grade 1 in autumn 2015. The focus of this study was on monolingual Swedish ( $n = 247$ ) and simultaneously bilingual Finnish-Swedish pupils ( $n = 220$ ) that participated at all measurement points during grades 1 through 3. In total 221 girls (52.5% monolingual) and 246 boys (53.2% monolingual) participated. The mean age of participating pupils in Grade 1 was 7.82 years ( $SD = 0.31$ ). The mean age in Grade 2 was 8.82 years ( $SD = 0.30$ ), and in Grade 3, it was 9.82 years ( $SD = 0.30$ ). Pupils with other language backgrounds (Finnish language, multilingual, or bilingual other than Finnish-Swedish; 11.7%) and pupils with missing results (5.7%) from any of the measures used in this study were excluded.

## Procedure

The longitudinal study followed the ethical guidelines of the Finnish National Board on Research Integrity (2019). Information about the study was sent to the parents. The parents were encouraged to discuss possible benefits and disadvantages with their child before returning a written consent for their child's participation in the study. Participation in the study was voluntary for both schools and families. Parents reported whether the child was monolingual Swedish or bilingual Finnish-Swedish via a questionnaire at the beginning of the study. A monolingual child speaks Swedish with both parents. Correspondingly, a bilingual child speaks Swedish with one parent and Finnish with the other one. Data collection for reading and spelling measures took place at three time points at the end of the academic year (April) in Grade 1 (2016), in Grade 2 (2017), and in Grade 3 (2018). Trained testers administered the assessments during the regular school day.

## Measures

Pupils' reading and spelling skills were measured at three time points (Grades 1, 2, and 3) using the standardised ILS-screening test for Finnish-Swedish children (Risberg et al., 2019). The ILS-screening test aims to both identify pupils at risk for RSD and follow up their skills during the early grades. In this study, we used identical measurement tasks, and the same pupils were examined throughout the three time points. The measurements consisted of tasks on reading fluency and spelling accuracy. The reading tasks were administered individually, while the spelling measure was accomplished as a paper-pen task in a group setting.

### Reading fluency

The reading fluency measure consisted of three reading tasks: word reading, pseudoword reading and text reading. All reading tasks were time-limited. It was not possible for the pupils to read all words, pseudowords or text within the time limit, and therefore Cronbach's alpha was not measured. The theoretical maximum scores are mentioned below.

### Word reading

Pupils read a list of common Swedish words presented in vertical columns. They read aloud the words as quickly and correctly as possible in 45 s. The list began with short words (two letters) and extended gradually to longer words. The wordlist included frequent Swedish words with both regular and irregular spelling. The score was the number of words read with the correct stress within the time limit. The maximum score was 120.



### ***Pseudoword reading***

Pupils read a list of pseudowords presented in vertical columns. They read aloud the pseudowords as quickly and correctly as possible in 45 s. The pseudowords were based on and resembled real Swedish words. The first pseudowords consisted of two letters, and they expanded gradually. The pseudowords could be stressed in various ways as long as all graphemes were included. The score was the number of correctly read pseudowords within the time limit. The maximum score was 120.

### ***Text reading***

Pupils read aloud a text about a fox as quickly and correctly as possible within 60 s. The score was the number of words read correctly within the time limit. There was no demand for correct intonation when reading the text since the instruction was to read quickly and correctly. Still, the pupils had to read single words with the correct stress. The maximum score was 272.

### ***Spelling***

The spelling measure consisted of 20 common Swedish words. Seven words were short letter-sound corresponding words, whereas the other 13 words had irregular structures. Cronbach's alphas were .82 in Grade 1, .78 in Grade 2, and .76 in Grade 3. The score for a pupil was the number of correctly spelled words, and consequently, the maximum score was 20. The test leader repeated the words twice.

The correlations and descriptive statistics based on raw scores for all tasks included in the study are presented in [Table 1](#). Results revealed high correlations, especially between reading tasks.

### ***Data analyses***

Confirmatory factor analyses (CFA) were conducted to test the factor structure for the three reading tasks. As the spelling task consisted of one composite score, CFA was not performed on that measure. The goodness of the model fit was based on the chi-square test ( $\chi^2$ ), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Standardised Root Mean Square Residual (SRMR) and the Root Mean Square Error of Approximation (RMSEA). Model fit values strongly confirmed the structure of one reading fluency variable comprising the three reading tasks: Grade 1:  $\chi^2(3) = 1815.712$ ,  $p < .001$ ; CFI = 1.000; TLI = 1.000; SRMR = 0.000; RMSEA = 0.000; Grade 2:  $\chi^2(3) = 1329.838$ ,  $p < .001$ ; CFI = 1.000; TLI = 1.000; SRMR = 0.000; RMSEA = 0.000; Grade 3:  $\chi^2(3) = 1197.880$ ,  $p < .001$ ; CFI = 1.000; TLI = 1.000; SRMR = 0.000; RMSEA = 0.000. Factor loadings ranged between .87 and .98.

Latent transition analyses (LTA) started by identifying the best fitting solution by conducting a series of latent profile analyses (LPA), separately for each time point. The principle of LPA is to group individuals with similar profiles of the measured variables into distinct classes (Muthén & Muthén, 2000). Z-scores were used in order to make results from the reading and spelling variables comparable.

The goal with LPAs is to find the smallest number of classes that best describe the association between the variables (Muthén & Muthén, 2000; Nylund et al., 2007). The number of classes is added stepwise until an optimal model that fits the data is found. The optimal model was chosen based on the following statistical criteria; Akaike information criterion (AIC), Bayesian information criterion (BIC), Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR) and entropy value. Lower values in AIC and BIC indicate better fitting models together with a high entropy value. The entropy value, ranging from 0 to 1, indicates how well participants can be assigned to one profile. Numbers close to 1 represent a high probability of accurate classification (Asparouhov & Muthén, 2012; Halpin & Kieffer, 2015).



**Table 1.** Correlations and descriptive statistics for measures in reading fluency and spelling in Grades 1, 2 and 3.

	1	2	3	4	5	6	7	8	9	10	11	12	Min	Max	Skewness	Kurtosis
1. Word reading 1	1	.845	.761	.915	.816	.777	.930	.850	.800	.574	.651	.687	0	81	0.599	0.148
2. Word reading 2		1	.828	.786	.868	.805	.802	.867	.804	.466	.573	.625	3	85	0.241	−0.103
3. Word reading 3			1	.714	.782	.860	.706	.774	.832	.404	.500	.567	4	95	0.126	−0.028
4. Pseudoword 1				1	.818	.786	.904	.803	.770	.542	.612	.631	0	63	0.480	0.280
5. Pseudoword 2					1	.873	.774	.829	.780	.414	.519	.554	3	65	0.222	−0.115
6. Pseudoword 3						1	.732	.767	.797	.369	.473	.521	0	76	0.198	0.442
7. Text reading 1							1	.870	.804	.629	.701	.704	2	177	1.108	1.421
8. Text reading 2								1	.890	.577	.665	.697	0	222	0.734	1.376
9. Text reading 3									1	.506	.610	.659	30	247	0.609	0.587
10. Spelling 1										1	.703	.654	1	20	0.472	0.164
11. Spelling 2											1	.745	5	20	−0.250	−0.686
12. Spelling 3												1	4	20	−1.359	2.284

Note. All correlations are significant at  $p < 0.001$ .

LTA was conducted to investigate the stability and change of reading fluency and spelling skills profiles. LTA is a longitudinal extension of LPA, which models the prevalence of profile membership and takes into account the incidence of transitions between profiles over time (Collins & Lanza, 2010). LTA provides the probability that the pupil will be in the same profile at the following time points (Grades) and the probability that the pupil will transition into another profile. Transition probabilities denote the probability of changing from one profile to another, ranging from 0 to 1, meaning that values close to 1 indicate a strong probability of transition (Nylund-Gibson et al., 2014).

We conducted a one-way analysis of variance (ANOVA) to investigate differences in reading fluency and spelling performance between the profiles in Grades 1–3. The eta square ( $\eta^2$ ) was used to measure the effect size for differences between groups.

A chi-square test was used to investigate the association between reading fluency and spelling profiles and between language and gender groups. With the support of adjusted residuals in each cell, we examined whether differences in gender or language occurred.

We utilised the MPLUS programme (version 8; Muthén & Muthén, 1998/2015) to conduct the CFAs, LPAs and LTAs. ANOVA and chi-square analysis were conducted using SPSS version 27.

## Results

### *Profiles of reading and spelling skills*

First, we investigated what kind of reading fluency and spelling profiles could be found in Grades 1–3. The LPAs revealed that a three-profile solution fitted the data well at all time points; although BIC continued to decrease, the VLMRV indicated that the three-profile solution described the data significantly better than the two-profile solution, whereas the four-profile solution was not significantly better than the three profiles. The three-profile solution corresponded with some previous findings (Holopainen et al., 2020; Psyridou et al., 2020), whereas additional profiles resulted in groups with rather few pupils. See Table 2 for fit indices.

Profiles in the three grades were named low performing (Grade 1: 34%; Grade 2: 34%; Grade 3: 8%), average performing (Grade 1: 50%; Grade 2: 53%, Grade 3: 32%) and high performing (Grade 1: 16%; Grade 2: 13%; Grade 3: 60%).

**Table 2.** Information criteria values for different class solutions for Grades 1, 2 and 3.

Classes	AIC	BIC	PVLMR	Entropy	Group sizes
Grade 1					
1	2656.575	2673.160			467
2	2398.808	2427.832	0.0000	0.851	373, 94
<b>3</b>	<b>2364.011</b>	<b>2405.474</b>	<b>0.0054</b>	<b>0.666</b>	<b>235, 158, 74</b>
4	2349.300	2403.202	0.3252	0.829	25, 12, 104, 326
5	2341.107	2407.448	0.8613	0.776	297, 10, 86, 50, 24
6	2330.872	2409.652	0.0254	0.705	6, 134, 50, 205, 48, 24
Grade 2					
1	2656.575	2656.575			467
2	2491.860	2520.884	0.0000	0.672	210, 257
<b>3</b>	<b>2441.710</b>	<b>2483.173</b>	<b>0.0004</b>	<b>0.705</b>	<b>248, 60, 159</b>
4	2425.021	2478.923	0.3521	0.715	168, 58, 53, 188
5	2414.695	2481.036	0.0526	0.791	6, 81, 157, 135, 88
6	2405.826	2484.606	0.1605	0.792	7, 57, 87, 121, 71, 124
Grade 3					
1	2656.575	2673.160			467
2	2470.640	2470.640	0.0094	0.857	64, 403
<b>3</b>	<b>2374.043</b>	<b>2415.506</b>	<b>0.0291</b>	<b>0.803</b>	<b>36, 282, 149</b>
4	2350.716	2404.618	0.4046	0.693	123, 33, 217, 94
5	2307.248	2373.589	0.0042	0.759	5, 40, 129, 215, 78
6	2298.378	2377.158	0.3122	0.778	11, 3, 201, 35, 138, 79

Note. The optimal model in bold.

**Table 3.** Performance in reading fluency and spelling in Grades 1, 2 and 3 based on z-scores.

										F (3,467)	p	$\eta^2$
	Low			Average			High					
	n			n			n					
	M	SD	95% CI	M	SD	95% CI	M	SD	95% CI			
Grade 1												
	158			235			74					
Reading fluency	−0.95	0.45	[−1.02, −0.88]	0.10	0.46	[0.04, 0.15]	1.71	0.58	[1.59, 1.86]	801.606	*	0.776
Spelling	−0.82	0.58	[−0.91, −0.73]	0.08	0.66	[0.00, 0.17]	1.48	0.73	[1.31, 1.65]	324.069	*	0.583
Grade 2												
	159			248			60					
Reading fluency	−0.85	0.68	[−0.96, −0.75]	0.15	0.61	[0.07, 0.22]	1.65	0.54	[1.50, 1.80]	358.332	*	0.607
Spelling	−1.09	0.56	[−1.18, −1.00]	0.38	0.57	[0.31, 0.45]	1.31	0.39	[1.21, 1.41]	546.816	*	0.702
Grade 3												
	36			149			282					
Reading fluency	−1.37	0.77	[−1.63, −1.12]	−0.60	0.65	[−0.72, −0.51]	0.49	0.82	[0.40, 0.60]	160.609	*	0.409
Spelling	−2.44	0.73	[−2.68, −2.19]	−0.60	0.45	[−0.67, −0.52]	0.63	0.38	[0.58, 0.67]	990.879	*	0.409

The low performing group performed similarly in both reading fluency and spelling in Grade 1, while in Grade 2 they performed slightly lower in spelling than in reading fluency. In Grade 3, the low performing group was distinct, but smaller, with very low results in reading fluency and even lower results in spelling (see Table 3).

The average performing group performed close to the mean in reading fluency and spelling in both Grade 1 and 2. In Grade 3, corresponding results were though more below than close to mean (-.60). The high performing group had rather high scores in reading fluency and a bit lower results in spelling. In Grade 3 they performed lower than in the previous grades.

Results from LPAs did not reveal a dissociation between reading fluency and spelling at any level of performance in any of the grades. ANOVAs were conducted and revealed significant differences between the three profiles at all time points. Effect sizes were moderate, with the highest values in Grade 1 and 2. In the Appendix a table is provided with information on performance in the reading fluency subtests and spelling test for language groups and gender separately.

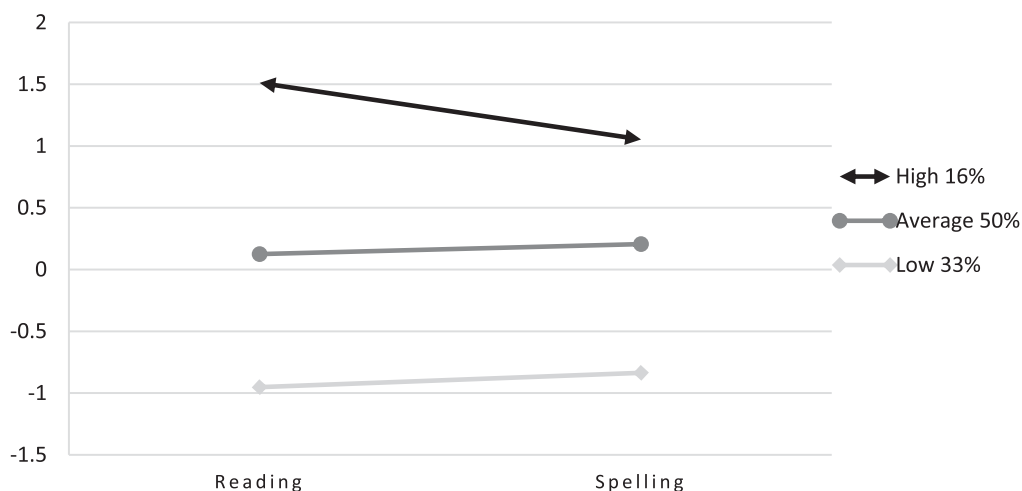
### **Stability and change from grade 1 to grade 3**

Based on the LPA results, a three-profile solution was specified for all time points to investigate stability and change between measurement points through LTA.

LTA results with three profiles were very similar to the solutions gained in the separately conducted grade specific LPAs (see Figure 1). The entropy value of the LTA model was 0.95, strongly supporting the three-profile model. Grade specific entropy values were also high, indicating support for three profiles (Grade 1: 0.874; Grade 2: 0.880; Grade 3: 0.880).

The low performing profile comprised 33% of the pupils in all grades, the average performing group comprised 50% and the high performing group 16% of the pupils. As LTA takes into account the results from all three grades at the same time while estimating the stability in the profiles over time, the number of pupils in each profile may fluctuate from the initial LPA. The time-invariant results for reading fluency and spelling were almost equal in the profiles, indicating that reading and spelling were closely related in the early school years.

Possible configurations were 27, however, the transition probabilities indicated strong stability in profiles of reading fluency and spelling in the first three years in school. In fact, almost 99% (N = 462) belonged to the same profile through the early school years and the only transitions occurred from the high to the average performing profile (1%) from Grade 1–2.



**Figure 1.** Reading fluency and spelling profiles

### **Language and gender differences within the profiles**

We examined both language and gender distributions within the profiles derived from LTA in the different grades. There were equal distributions of monolingual and bilingual pupils within the three profiles. By using a chi-square test, we found no significant difference between language groups (Grade 1,  $\chi^2(2) = .105$ ,  $p = <0.05$ ; Grade 2,  $\chi^2(2) = .471$ ,  $p = <0.05$ ; Grade 3,  $\chi^2(2) = .471$ ,  $p = <0.05$ ). Likewise, gender was equally distributed within the three profiles. Results showed no significant differences between the profiles: (Grade 1,  $\chi^2(2) = 2.278$ ,  $p = <0.05$ ; Grade 2,  $\chi^2(2) = 2.928$ ,  $p = <0.05$ ; Grade 3,  $\chi^2(2) = 2.928$ ,  $p = <0.05$ ).

### **Discussion and conclusion**

The aim of this person-centred study was to investigate what kind of profiles of reading fluency and spelling skills could be found among monolingual and simultaneously bilingual pupils during the first three grades in school, how stable the profiles were, and whether there were language and gender differences within the profiles.

Our hypothesis finding two profiles, low performing (H1) and typically performing (H2), was not confirmed. Results revealing three profiles aligned well with some earlier findings, taking into account high performing pupils as well (Holopainen et al., 2020; Psyridou et al., 2020). Results from LPA and LTA were similar in terms of level of performance and amount of pupils in the profiles, except for results of LPA in Grade 3. In Grade 3, the difference between the average and high performing groups decreased and furthermore, the low performing group comprised a lower number of pupils than in previous grades, and with lower results. A possible reason for this could be the fast development of reading fluency and spelling during the first two grades, when most of the pupils make progress and become rather fluent readers and accurate spellers (e.g., Aro, 2017; Lerkkanen et al., 2004). Consequently, the difference between average and high performing pupils in reading fluency and spelling could decrease during Grade 3. On the other hand, the gap between pupils with average or high performance compared to pupils with more persistent reading fluency and spelling deficits could possibly become more distinct.

Reading fluency and spelling did not dissociate at any stage of development (H3), meaning that no profile was solely good readers and poor spellers or vice versa. This result indicates reading fluency and spelling as strongly related skills in the first years of school (e.g., Georgiou et al., 2020; Treiman et al., 2019). Most of the previous studies have used predefined cut-off scores to

investigate the dissociation of these skills (e.g. Eklund et al., 2015; Moll et al., 2020). Dissociation between reading and spelling, in favour of spelling, is usually found as pupils grow older, which could be related to better phonological awareness that improves spelling skills (Moll et al., 2020; Moll & Landerl, 2009). Conclusions drawn by Leppänen et al. (2006) stated that decoding and spelling are closely interlinked processes in the first two years of school, meaning that the improvement of one skill had a positive influence on the other reciprocally. Our results show reading fluency and spelling skills as closely associated, even though we did not investigate the reciprocal relationship between reading fluency and spelling. Our results are also in line with several previous studies showing that pupils are often poor in both reading and spelling (de Jong & van der Leij, 2003; van Bergen et al., 2012).

As we expected (H4), the results showed stability of reading fluency and spelling skills during the first three years of school. However, contradictory to our hypothesis (H5), no significant transitions were detected between the profiles at any stage of development. Pupils with average and high reading fluency and spelling skills seem likely to continue on an average level and at the top of the distribution respectively. Furthermore, the low performing pupils continue struggling with reading and spelling throughout the first school years. This result is comparable to other studies about the stability of reading and spelling skills, although these studies comprise a longer time (e.g., Eklund et al., 2015; Landerl & Wimmer, 2008; Parrila et al., 2005).

A previous Finnish study (Lerikkanen et al., 2004) investigating the stability of profiles of reading performance (word reading and reading comprehension) from the fall of Grade 1 to the fall of Grade 2 showed opposite results to our study, considering both the number of poor readers and the transitions between profiles. The poor readers comprised 10% at every time point (compared to 33% in our study) and were characterised by poor decoding skills and poor reading comprehension. This group displayed the least stability throughout the study. This result was explained by the rapid development of word reading skills after some time of reading instruction in school and by well-developed pre-reading skills (Lerikkanen et al., 2004). It could also be due to early identification of needs (e.g., Solheim et al., 2021), and effective interventions during the first months in school (e.g., Virinkoski et al., 2021).

These opposite results to our study regarding stability are probably explained by the fact that our first measurement time was at the end of Grade 1, after the first rapid phase of development of reading skills had passed. Moreover, reading comprehension was not included in our study, which makes these two studies not completely comparable in sense of reading profiles. Instead, the inclusion of spelling in our study could have an impact on the profiles and their stability compared to the study of Lerikkanen et al. (2004). It is possible that inclusion of the spelling test identified pupils with both reading fluency and spelling deficits. Previous studies have shown that RSD is often persistent which could partly explain the high stability in our study (Eklund et al., 2015; Landerl & Wimmer, 2008).

Our results considering the stability of reading fluency and spelling skills might not be surprising, since they are in line with most of the prior research on reading and spelling development (e.g., Landerl & Wimmer, 2008). Still, it is of great concern that a pupil's poor performance in reading fluency and spelling at the end of Grade 1 seems to be a guideline for the following two grades in school. Pupils with low results in the spring of Grade 1 made progress in the following years, but so did the other pupils. The educational system in Finland should guarantee support to pupils as soon as there is a need (Finnish National Board of Education, 2014). But, are the interventions effective enough to support pupils struggling with reading fluency and spelling from an early stage? This finding is important from a pragmatic perspective in school, confirming the importance of regular screenings of the pupils' reading and spelling skills in the early school years (Grimm et al., 2018; Solheim et al., 2021; Virinkoski et al., 2018). Furthermore, it is important to understand the stability of early reading fluency and spelling skills to facilitate the decision of who should receive support for reading and spelling, and when the support should be initiated (Solheim et al., 2018; Virinkoski et al., 2021).

As we expected, the results revealed equal amounts of monolingual and simultaneously bilingual pupils in all profiles (H6). These results are comparable to those of another Finnish study (Vataja et al., 2022) showing that simultaneously bilingual pupils had better or equal results compared with monolingual pupils on reading fluency tasks and similar results on a spelling task. Prior research suggests that bilingual pupils have strong word and nonword reading skills both in their first and second languages partly because of their early simultaneous capacity to transfer across two languages with similar alphabets (e.g., Bialystok, 2005; Durgonoğlu et al., 1993). Swedish and Finnish also resemble each other in language structure, although Swedish is more complex than Finnish (Aro, 2017). Therefore, the equal numbers of monolingual Swedish and simultaneously bilingual Finnish-Swedish pupils in all profiles in all three grades could to some extent, be explained that despite minor differences the languages are close to each other. Furthermore, previous research (e.g. Bratlie et al., 2022; Verhoeven, 2000) have revealed equal or almost equal performance in the early school years for L2 learners compared to native speakers in reading fluency, but moderate differences in spelling in favour of pupils speaking the majority language. Opposite results to Bratlie et al. (2022) were found by Zhao et al. (2016) where bilinguals performed better than monolinguals in the spelling of real words. Our equal results in spelling and reading fluency in both language groups might therefore seem obvious and natural, especially when our comparisons were between monolingual and simultaneously bilingual pupils. Still, it is important from the low performing pupils' perspective to highlight and emphasise that difficulties in reading fluency and spelling are not primarily due to a simultaneously bilingual background and difficulties should therefore be reacted upon immediately by giving support as early as possible.

Furthermore, no gender differences were found at any grade level in any of the profiles (H7). The beginning of the reading and spelling process seems to be on the same level for both boys and girls, even in the low performing group. Limbrick et al. (2012) revealed similar findings among first and second graders with no gender differences on reading fluency assessments. However, there was a tendency that gender differences increased with years of schooling in favour of girls. Prior research has shown similar results in favour of girls in comparable age groups to that in this study (e.g., Psyridou et al., 2020; Wolff, 2010).

The focus of the reading tasks in this study was on reading fluency and not on reading comprehension, which could explain the equal distributions of monolingual and simultaneously bilingual pupils, as well as gender, in all profiles. In addition, individual tests with a time limit could be motivating for both boys and girls.

## Limitations and future research

This study has some limitations that should be considered. The study focused on reading fluency and spelling measured for the first time in the spring of Grade 1. The pupils' starting level in the fall of Grade 1 was not examined in this study, considering basic pre-reading skills such as letter knowledge, early ability to read and spell words, phonological awareness or rapid automatised naming (e.g., Furnes & Samuelsson, 2010, 2011; Torppa et al., 2016). On a pragmatic level, the teachers in schools seldom know the pupils' cognitive predictive status either. Teachers have to rely on screening results of pupils' progress in reading and spelling in order to offer suitable support.

Neither was reading comprehension included, although this often has been measured in earlier studies of reading profiles (Catts et al., 2012; Torppa et al., 2007; Wolff, 2010). Whereas this can be considered as a limitation, it could also be a strength when strictly focusing on basic skills like reading fluency and spelling accuracy in the first grades. Since early intervention is crucial at an early stage in school, it would have been precious to know whether especially low performing pupils had received support, what kind of support and the amount of support they had received.

Previous longitudinal studies of reading profiles have included reading comprehension as one variable that has a natural impact on what kind of profiles are found (Holopainen et al., 2020; Torppa et al., 2007; Wolff, 2010). The effect of language background on reading comprehension

would also be interesting to investigate in future research. A study by Catts et al. (2012) focusing on late-emergent poor readers concluded that early identification of poor decoding skills might not find pupils performing below average in later reading comprehension. However, prior research agrees on measurements of reading fluency at an early stage of school in the identification of risk for future reading deficits (e.g., Niileksela & Templin, 2019). Screening pupils' reading and spelling skills require reliable measurement tools. We used a new standardised screening test, and for future research, it would be a topic to evaluate its psychometric criteria to assure its purpose in the long-term prediction and identification of pupils at risk.

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## References

- Aro, M. (2017). *Learning to read Finnish*. In L. Verhoeven, & C. Perfetti (Eds.), *Learning to read across languages and writing systems* (pp. 416–436). Cambridge University Press.
- Aro, M., & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied Psycholinguistics*, 24(4), 621–635. <https://doi.org/10.1017/S0142716403000316>
- Asparouhov, T., & Muthén, B. (2012). Using Mplus TECH11 and TECH14 to test the number of latent classes. *Mplus Web Notes*, 14, 22.
- Bialystok, E. (2005). *The impact of bilingualism on language and literacy development*. In T. K. Bhatia, & W. C. Ritchie (Eds.), *The handbook of bilingualism* (pp. 577–601). Wiley-Blackwell.
- Bialystok, E. (2017). The bilingual adaption: How minds accommodate experience. *Psychological Bulletin*, 143(3), 233–262. <https://doi.org/10.1037/bul0000099>
- Bratlie, S. S., Gustafsson, J., & Torkildsen, J. v. K. (2022). Effectiveness of a classroom-implemented, App-based morphology program for language-minority students: Examining latent language-literacy profiles and contextual factors as moderators. *Reading Research Quarterly*, 57(3), 805–829. <https://doi.org/10.1002/rrq.447>
- Caravolas, M. (2004). Spelling development in alphabetic writing systems: A cross-linguistic perspective. *European Psychologist*, 9(1), 3–14. <https://doi.org/10.1027/1016-9040.9.1.3>
- Catts, H. W., Compton, D., Tomblin, J. B., & Bridges, M. S. (2012). Prevalence and nature of late-emerging poor readers. *Journal of Educational Psychology*, 104(1), 166–181. <https://doi.org/10.1037/a0025323>
- Collins, L. M., & Lanza, S. T. (2010). *Latent class and latent transition analysis; with applications in the social, behavioral, and health sciences*. John Wiley and Sons.
- Compton, D. L., Fuchs, D., Fuchs, L. S., Elleman, A. M., & Gilbert, J. K. (2008). Tracking children who fly below the radar: Latent transition modeling of students with late-emerging reading disability. *Learning and Individual Differences*, 18(3), 329–337. <https://doi.org/10.1016/j.lindif.2008.04.003>
- de Jong, P. F., & van der Leij, A. (2003). Developmental changes in the manifestation of a phonological deficit in children learning to read a regular orthography. *Journal of Educational Psychology*, 95(1), 22–40. <https://doi.org/10.1037/0022-0663.95.1.22>
- Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428–1446. <https://doi.org/10.1037/0012-1649.43.6.1428>



- Durgonoğlu, A. Y., Nagy, W., & Hancin-Bhatt, G. J. (1993). Cross-language transfer of phonemic awareness. *Journal of Educational Psychology*, 85(3), 453–465. <https://doi.org/10.1037/0022-0663.85.3.453>
- Ehri, L. C. (2000). Learning to read and learning to spell: Two sides of a coin. *Topics in Language Disorders*, 20(3), 19–36. <https://doi.org/10.1097/00011363-200020030-00005>
- Eklund, K., Torppa, M., Aro, M., Leppänen, P. H. T., & Lyytinen, H. (2015). Literacy skill development of children with familial risk for dyslexia through grades 2, 3, and 8. *Journal of Educational Psychology*, 107(1), 126–140. <https://doi.org/10.1037/a0037121>
- Etmanskie, J. M., Partanen, M., & Siegel, L. (2016). A longitudinal examination of the persistence of late-emerging reading disabilities. *Journal of Learning Disabilities*, 49(1), 21–35. <https://doi.org/10.1177/0022219414522706>
- Finnish National Board of Education. (2014). *Grunderna för läroplanen för den grundläggande utbildningen 2014* [National Core Curriculum for Basic Education 2014]. National Board of Education. [https://www.oph.fi/sites/default/files/documents/grunderna\\_for\\_laroplanen\\_for\\_den\\_grundlaggande\\_utbildningen\\_2014.pdf](https://www.oph.fi/sites/default/files/documents/grunderna_for_laroplanen_for_den_grundlaggande_utbildningen_2014.pdf)
- Finnish National Board on Research Integrity. (2019). *The ethical principles of research with human participants and ethical review in the human sciences in Finland: TENK guidelines 2019*. [https://tenk.fi/sites/default/files/2021-01/Ethical\\_review\\_in\\_human\\_sciences\\_2020.pdf](https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf)
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall, & M. Coltheart (Eds.), *Surface dyslexia. Neuropsychological and cognitive studies of phonological reading* (pp. 301–330). Lawrence Erlbaum Associates.
- Fuchs, D., Fuchs, L. S., & Vaughn, S. (2014). What is the intensive instruction and why is it important? *Teaching Exceptional Children*, 46(4), 13–18. <https://doi.org/10.1177/0040059914522966>
- Furnes, B., Elwér, Å., Samuelsson, S., Olson, R. K., & Byrne, B. (2019). Investigating the double-deficit hypothesis in more and less transparent orthographies: A longitudinal study from preschool to grade 2. *Scientific Studies of Reading*, 1–16. <https://doi.org/10.1080/10888438.2019.1610410>
- Furnes, B., & Samuelsson, S. (2010). Predicting reading and spelling difficulties in transparent and opaque orthographies: A comparison between Scandinavian and US/Australian children. *Dyslexia*, 16(2), 119–142. <https://doi.org/10.1002/dys.401>
- Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences*, 21(1), 85–95. <https://doi.org/10.1016/j.lindif.2010.10.005>
- Georgiou, G., Torppa, M., Landerl, K., Desrochers, A., Manolitsis, G., de Jong, P., & Parrila, R. (2020). Reading and spelling development across languages varying in orthographic consistency: Do their paths cross? *Child Development*, 91(2), 266–279. <https://doi.org/10.1111/cdev.13218>
- Geva, E., & Wiener, J. (2015). *Psychological assessment of culturally and linguistically diverse children and adolescents: A practitioner's guide*. Springer Publishing Company.
- Grimm, R. P., Solari, E. J., McIntyre, N. S., & Denton, C. A. (2018). Early reading skill profiles in typically developing and at-risk first grade readers to inform targeted early reading instruction. *Journal of School Psychology*, 69, 11–126. <https://doi.org/10.1016/j.jsp.2018.05.009>
- Halpin, P. F., & Kieffer, M. J. (2015). Describing profiles of instructional practice a new approach to analyzing classroom observation data. *Educational Researcher*, 44(5), 263–277. <https://doi.org/10.3102/0013189X15590804>
- Holopainen, L., Hoang, N., Koch, A., & Kofler, D. (2020). Latent profile analysis of students' reading development and the relations of cognitive variables to reading profiles. *Annals of Dyslexia*, 70(1), 94–114. <https://doi.org/10.1007/s11881-020-00196-9>
- Kuhn, M. R., Schwanenflugel, P. J., & Meisinger, E. B. (2010). Review of research: Aligning theory and assessment of reading fluency: Automaticity, prosody, and definitions of fluency. *Reading Research Quarterly*, 45(2), 230–251. <https://doi.org/10.1598/RRQ.45.2.4>
- Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology*, 100(1), 150–161. <https://doi.org/10.1037/0022-0663.100.1.150>
- Leppänen, U., Niemi, P., Aunola, K., & Nurmi, J.-E. (2006). Development of reading and spelling Finnish from pre-school to grade 1 and grade 2. *Scientific Studies of Reading*, 10(1), 3–30. [https://doi.org/10.1207/s1532799xssr1001\\_2](https://doi.org/10.1207/s1532799xssr1001_2)
- Lerkanen, M., Rasku-Puttonen, H., Aunola, K., & Nurmi, J. (2004). Reading performance and its developmental trajectories during the first and the second grade. *Learning and Instruction*, 14(2), 111–130. <https://doi.org/10.1016/j.learninstruc.2004.01.006>
- Limbrick, L., Wheldall, K., & Madelaine, A. (2012). Reading and related skills in the early school years: Are boys really more likely to struggle? *International Journal of Disability, Development, and Education*, 59(4), 341–358. <https://doi.org/10.1080/1034912X.2012.723939>
- Moll, K., Gangl, M., Banfi, C., Schulte-Körne, G., & Landerl, K. (2020). Stability of deficits in reading fluency and/or spelling. *Scientific Studies of Reading*, 24(3), 241–251. <https://doi.org/10.1080/10888438.2019.1659277>
- Moll, K., Kunze, S., Neuhoof, N., Bruder, J., & Schulte-Körne, G. (2014). Specific learning disorder: Prevalence and gender differences. *PloS One*, 9(7), e103537. <https://doi.org/10.1371/journal.pone.0103537>

- Moll, K., & Landerl, K. (2009). Double dissociation between reading and spelling deficits. *Scientific Studies of Reading*, 13(5), 359–382. <https://doi.org/10.1080/10888430903162878>
- Muthén, B. O., & Muthén, L. K. (2000). Integrating person-centered and variable-centered analyses: Growth mixture modeling with latent trajectory classes. *Alcoholism, Clinical and Experimental Research*, 24(6), 882–891. <https://doi.org/10.1111/j.1530-0277.2000.tb02070.x>
- Muthén, L. K., & Muthén, B. O. (2015). *Mplus User's Guide* (7th ed.) Los Angeles: Muthén & Muthén. (Original work published 1998).
- Niileksela, C. R., & Templin, J. (2019). Identifying dyslexia with confirmatory latent profile analysis. *Psychology in the Schools*, 56(3), 335–359. <https://doi.org/10.1002/pits.22183>
- Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*, 14(4), 535–569. <https://doi.org/10.1080/10705510701575396>
- Nylund-Gibson, K., Grimm, R., Quirk, M., & Furlong, M. (2014). A latent transition mixture model using the three-step specification. *Structural Equation Modeling*, 21(3), 439–454. <https://doi.org/10.1080/10705511.2014.915375>
- Parrila, R., Aunola, K., Leskinen, E., Nurmi, J.-E., & Kirby, J. R. (2005). Development of individual differences in reading: Results from longitudinal studies in English and Finnish. *Journal of Educational Psychology*, 97(3), 299–319. <https://doi.org/10.1937/0022-0663.97.3.299>
- Psyridou, M., Tolvanen, A., Lerkkanen, M.-K., Poikkeus, A.-M., & Torppa, M. (2020). Longitudinal stability of reading difficulties: Examining the effects of measurement error, cut-offs, and buffer zones in identification. *Frontiers in Psychology*, 10, 2841. <https://doi.org/10.3389/fpsyg.2019.02841>
- Risberg, A.-K., Vataja, P., Plyhm, L., Lerkkanen, M.-K., Aro, M., Westerholm, J., & Salmi, P. (2019). *ILS – Individuell Läsning och Skrivning. Kartläggningssmaterial för åk 1, 2, 3 och 5. Lärarhandledning* [ILS—Individual reading and writing. Tests for grade 1, 2, 3 and 5. Manual]. Niilo Mäki Institutet.
- Schaars, M. M., Segers, E., & Verhoeven, L. (2017). Predicting the integrated development of word reading and spelling in the early primary grades. *Learning and Individual Differences*, 59, 127–140. <https://doi.org/10.1016/j.lindif.2017.09.006>
- Solheim, O. J., Frijters, J. C., Lundetræ, K., & Uppstad, P. H. (2018). Effectiveness of an early reading intervention in a semi-transparent orthography: A group randomised controlled trial. *Learning and Instruction*, 58, 65–79. <https://doi.org/10.1016/j.learninstruc.2018.05.004>
- Solheim, O. J., Torppa, M., Henning Uppstad, P., & Lerkkanen, M. (2021). Screening for slow reading acquisition in Norway and Finland - a quest for context specific predictors. *Scandinavian Journal of Educational Research*, 65(4), 584–600. <https://doi.org/10.1080/00313831.2020.1739130>
- Statistics Finland. (2019). Population structure. [http://www.stat.fi/tup/tilastotietokannat/index\\_en.html](http://www.stat.fi/tup/tilastotietokannat/index_en.html)
- Torppa, M., Eklund, K., van Bergen, E., & Lyytinen, H. (2015). Late-emerging and resolving dyslexia: A follow-up study from age 3 to 14. *Journal of Abnormal Child Psychology*, 43(7), 1389–1401. <https://doi.org/10.1007/s10802-015-0003-1>
- Torppa, M., Georgiou, G. K., Lerkkanen, M.-K., Niemi, P., Poikkeus, A., & Nurmi, J. (2016). Examining the simple view of reading in a transparent orthography: A longitudinal study from kindergarten to grade 3. *Merrill-Palmer Quarterly*, 62(2), 179–206. <https://doi.org/10.13110/merrillpalmerquar1982.62.2.0179>
- Torppa, M., Parrila, R., Niemi, P., Lerkkanen, M., Poikkeus, A., & Nurmi, J. (2013). The double deficit hypothesis in the transparent Finnish orthography: A longitudinal study from kindergarten to grade 2. *Reading & Writing*, 26(8), 1353–1380. <https://doi.org/10.1007/s11145-012-9423-2>
- Torppa, M., Tolvanen, A., Poikkeus, A. M., Eklund, K., Lerkkanen, M.-K., Leskinen, E., & Lyytinen, H. (2007). Reading development subtypes and their early characteristics. *Annals of Dyslexia*, 57(1), 3–32. <https://doi.org/10.1007/s11881-007-0003-0>
- Treiman, R., Hulslander, J., Olson, R. K., Willcutt, E. G., Byrne, B., & Kessler, B. (2019). The unique role of early spelling in the prediction of later literacy performance. *Scientific Studies of Reading*, 23(5), 437–444. <https://doi.org/10.1080/10888438.2019.1573242>
- van Bergen, E., de Jong, P. F., Plakas, A., Maassen, B., & van der Leij, A. (2012). Child and parental literacy levels within families with a history of dyslexia. *Journal of Child Psychology and Psychiatry*, 53(1), 28–36. <https://doi.org/10.1111/j.1469-7610.2011.02418.x>
- Vataja, P., Lerkkanen, M.-K., Aro, M., Westerholm, J., Risberg, A.-K., & Salmi, P. (2022). The predictors of literacy skills among monolingual and bilingual Finnish-Swedish children during first grade. *Scandinavian Journal of Educational Research*, 66(6), 960–976. <https://doi.org/10.1080/00313831.2021.1942191>
- Vender, M., & Melloni, C. (2021). Phonological awareness across child populations: How bilingualism and dyslexia interact. *Languages*, 6(1), 39. <https://doi.org/10.3390/languages6010039>
- Verhoeven, L. (2000). Components in early second language reading and spelling. *Scientific Studies of Reading*, 4(4), 313–330. [https://doi.org/10.1207/S1532799XSSR0404\\_4](https://doi.org/10.1207/S1532799XSSR0404_4)
- Virinkoski, R., Lerkkanen, M.-K., Eklund, K., & Aro, M. (2021). Special education teachers' identification of students' reading difficulties in grade 6. *Scandinavian Journal of Educational Research*, 1–14. Advance online publication. <https://doi.org/10.1080/00313831.2020.1833241>

- Virinkoski, R., Lerkkanen, M.-K., Holopainen, L., Eklund, K., & Aro, M. (2018). Teachers' ability to identify children at early risk for reading difficulties in grade 1. *Early Childhood Education Journal*, 46(5), 497–509. <https://doi.org/10.1007/s10643-017-0883-5>
- Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: A specific disability in regular orthographies. *Journal of Educational Psychology*, 94(2), 272–277. <https://doi.org/10.1037/0022-0663.94.2.272>
- Wolff, U. (2010). Subgrouping of readers based on performance measures: A latent profile analysis. *Reading & Writing*, 23(2), 209–238. <https://doi.org/10.1007/s11145-008-9160-8>
- Zhao, J., Quiroz, B., Dixon, L. Q., & Joshi, R. M. (2016). Comparing bilingual to monolingual learners on English spelling: A meta-analytic review. *Dyslexia*, 22(3), 193–213. <https://doi.org/10.1002/dys.1530>