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Predicting Reading and Spelling Difficulties in Transparent and Opaque Orthographies: A Comparison between Scandinavian and U.S./Australian Children

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Abstract

In this study, predictors of reading and spelling difficulties among children learning more transparent (Norwegian/Swedish) and less transparent (English) orthographies were examined longitudinally from preschool through Grade 2 using parallel versions of tests. A series of logistic regression analysis indicated three main findings. First, phonological awareness as a predictor of reading difficulties in the Scandinavian sample was time-limited to Grade 1, but remained as a significant predictor in the English-speaking sample. Second, phonological awareness predicted spelling difficulties similarly across orthographies. Third, preschool and kindergarten RAN was a significant predictor of reading and spelling difficulties at both Grades 1 and 2 across orthographies. The authors conclude that phonological awareness diminishes as a predictor of reading difficulties in transparent orthographies after the first years of schooling, that RAN is a better long term predictor of reading difficulties, and that phonological awareness is associated with spelling difficulties similarly in transparent and opaque orthographies.

Keywords

Reading and spelling difficulties; Orthographic transparency; Phonological awareness; Rapid naming; Letter knowledge

Predicting Reading and Spelling Difficulties in Transparent and Opaque Orthographies: A Comparison between Scandinavian and U.S./Australian Children

There are numerous studies from English-speaking countries focusing on differences in language and cognitive skills between normal readers and children with (or at risk for) reading difficulties (Catts & Hogan, 2003; McCardle, Scarborough, & Catts, 2001; Snowling, 2000; Vellutino, Fletcher, Snowling, & Scanlon, 2004). The overall findings from this research are that children with reading difficulties show deficiencies in letter knowledge (Pennington & Lefly, 2001; Snowling, Gallagher, & Frith, 2003), phonological awareness (Rack, Snowling, & Olson, 1992; Snowling, 1995; Stanovich & Siegel, 1994), rapid automatized naming (RAN; Wolf & Bowers, 1999), verbal memory (Swanson & Siegel,

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2001), and semantic and syntactic skills (Catts, Fey, Zhang, & Tomblin, 1999; Rego & Bryant, 1993). It is also well established that the same language and cognitive skills contribute to predict individual differences in reading acquisition across the normal range (Scarborough, 1998, 2001), as well as predicting reading difficulties (Catts, Fey, Zhang, & Tomblin, 2001; Muter & Snowling, 1998; O'Connor & Jenkins, 1999).

A growing number of studies from transparent European orthographies suggest that the course of reading acquisition as well as deficits underlying reading and spelling difficulties might differ across orthographies (Caravolas, 2005; Goulandris, 2003; Ziegler & Goswami, 2005). However, cross-linguistic studies that directly compare the relative contribution of language and cognitive development to literacy difficulties are still rare (but see Caravolas, Volin, & Hulme, 2005, Study 2). The overall purpose of the present study was to identify language and cognitive skills that predict reading and spelling difficulties across more (Norwegian/Swedish) and less transparent (English) orthographies. We report data from an ongoing international longitudinal twin study (ILTS) of early language and literacy development conducted in Norway, Sweden, U.S., and Australia (Byrne et al., 2008; Byrne et al., 2002; Byrne et al., 2006; Byrne et al., 2007; Byrne et al., 2005; Samuelsson et al., 2008; Samuelsson et al., 2005; Samuelsson et al., 2007). In all participating countries, parallel measures of cognitive and language functioning at preschool and kindergarten as well as tasks measuring reading and spelling skills at the end of Grades 1 and 2 were administered.

Normal literacy development in different orthographies

There are five cross-linguistic studies that directly examine patterns of prediction of early reading development in two orthographies using parallel versions of tests. Among these studies, there are three (Caravolas et al., 2005, compared Czech and English; Furnes & Samuelsson, in press, compared Norwegian/Swedish and English; Patel, Snowling, & de Jong, 2004, compared Dutch and English) suggesting that phonological awareness is a key predictor of individual differences in reading acquisition independent of the transparency of the orthography. In addition, in the Georgiou, Parrila, and Papadopoulos study (2008, compared Greek and English), phonological awareness predicted reading accuracy similarly in English and Greek. However, phonological awareness was only a predictor of reading speed in English. These findings contradict the finding by Mann and Wimmer (2002, compared German and English). They found that phonological awareness predict neither reading accuracy, nor reading speed in German. In fact, phonological awareness was only a predictor of reading (both accuracy and speed) in English. Overall, a majority of cross-language studies designed to directly examine patterns of prediction seem to suggest that there are few differences across orthographies when predicting reading skills from phonological awareness. These findings are in accordance with most research conducted in English-speaking countries.

A similar pattern of prediction across orthographies has also been reported for RAN. In the studies by Georgiou et al. (2008) and Furnes and Samuelsson (in press), RAN was a significant predictor of both reading speed and reading accuracy. The role of RAN in predicting reading acquisition in a transparent orthography has also been shown in the study by Mann and Wimmer (2002). However, there are contradictory findings. Patel et al. (2004) found that RAN was not associated with reading accuracy or reading speed in neither English, nor in Dutch. Note that there was no measure of RAN included in the study by Caravolas et al. (2005).

The studies by Caravolas et al (2005), Mann and Wimmer (2002), and Patel et al. (2004) are all cross-sectional studies and provide no reliable answers to what extent predictions of phonological awareness and RAN on reading acquisition are time limited. The studies by

Furnes and Samuelsson (in press) and Georgiou et al. (2008) are both longitudinal with the last assessment of reading skill being made at the end of Grade 1 and Grade 2, respectively. Therefore, the finding that phonological awareness is a predictor of individual differences in the early phases of reading development in transparent orthographies might not contradict previous research in transparent orthographies. In fact, one finding replicated in studies within transparent orthographies is that phonological awareness predicts individual variation in reading in the early phases, but ceases to show influence after the first grades (de Jong & van der Leij, 1999, 2002; Landerl & Wimmer, 2000; Leppänen, Niemi, Aunola, & Numri, 2006; Lervåg, Bråten, & Hulme, 2009; Verhagen, Aarnoutse, & van Leeuwe, 2008; Wesseling & Reitsma, 2000; Wimmer, Landerl, Linortner, & Hummer, 1991). It has been suggested that strong consistencies between graphemes and phonemes in transparent orthographies promote the development of phonological awareness (Goswami, Ziegler, & Richardson, 2005; Seymour, Aro, & Erskine, 2003). For example, in a cross-linguistic study by Seymour, Aro, and Erskine (2003), it was shown that children learning to read in a transparent writing system perform at ceiling level on decoding within the first year of schooling. Instead, RAN seem to be a significant predictor of individual differences in reading in transparent orthographies beyond the first phases of reading acquisition (e.g., de Jong & van der Leij, 1999; de Jong & van der Leij, 2002; but see Kirby, Parrila, & Pfeiffer, 2003, for a similar pattern in English).

Taken together, cross-linguistic studies show that (a) phonological awareness and RAN are predictors of early reading development across orthographies, (b) the role of phonological awareness seem to be time-limited in transparent orthographies, and (c) RAN is a stronger long-term predictor of reading speed in transparent orthographies compared to phonological awareness.

Most cross-linguistic research has focused on the prediction of individual variation in reading. However, in a recent study of German children by Landerl and Wimmer (2008) it was shown that phonological awareness, not RAN, was a strong predictor to individual differences in spelling. A possible explanation is a higher demand on phonological awareness for spelling as transparent orthographies are more consistent and redundant in the direction of reading compared to spelling (Landerl & Wimmer, 2008). Thus, while phonological awareness ceases to show influence on normal reading after the first grades, it seems to be related to spelling beyond the first grades in transparent orthographies.

Reading and spelling difficulties in different orthographies

There is no previous longitudinal study on the prediction of reading and spelling difficulties across orthographies, but the prevailing view is that there might be differences between orthographies in explaining such difficulties.

The finding that phonological awareness plays a time-limited role on individual differences in reading in transparent orthographies has also been confirmed in several studies comparing normal readers and children with reading difficulties. Studies from transparent orthographies such as Dutch (van den Bos, 1998; Wesseling & Reitsma, 2000), Finnish (Holopainen, Ahonen, & Lyytinen, 2001), and German (Landerl & Wimmer, 2000; Wimmer, 1993, 1996; Wimmer & Landerl, 1997, Study 2; Wimmer & Mayringer, 2002; Wimmer, Mayringer, & Landerl, 1998) have reported that impairments in phonological awareness account for reading difficulties in the first year of schooling, but not after some years in school. Similar to research on normal development in reading, measures of RAN seem to be better at discriminating between normal readers and children with reading difficulties after a few years of reading instruction (Brizzolara et al., 2006; de Jong & van der Leij, 2002, 2003; Holopainen et al., 2001; van den Bos, 1998; Wimmer, 1993; Wimmer et al., 1998; Wimmer, Mayringer, & Landerl, 2000; Wolf, Pfeil, Lotz, & Biddle, 1994). Finally, phonological

awareness seems to contribute to group differences in spelling (i.e., poor vs. normal spellers) in a similar way as for English-speaking children (Caravolas et al., 2005, Study 2). Thus, in examining prediction of literacy difficulties across orthographies it seems reasonable to analyze the prediction of reading and spelling difficulties separately.

Differences in home/preschool literacy environment between Scandinavia and U.S./ Australia

In the present study, some important differences between Australia (New South Wales) and the United States (Colorado), on the one hand, and Scandinavia (Norway and Sweden), on the other hand, might have an influence on early language and cognitive skills. Note that most children in the participating countries have attended a preschool programme (94% in Australia, 85% in Colorado, and 90% in Scandinavia) with the average attendance being 17.3 hour per week in Australia, 16.8 in Colorado, and 25.7 hours in Scandinavia. In Australia and the United States there is a tradition at both home and preschool to emphasize literacy activities earlier compared to Scandinavia, and most children have already learned about letter names and letter sounds by the time they enter kindergarten (Samuelsson et al., 2005). In addition, about 10–15 percent of the children in Australia and U.S. have developed some skills in reading at preschool age (these percentages are taken from the present study). Compulsory school starts at kindergarten around age 5 to 6 in both Australia and the U.S., but in New South Wales, Australian children enter a school system mandating that at least 35% of a full school week should be devoted to literacy instruction. Colorado children, in contrast, attend kindergarten 3–4 hours each day, and there is no state-mandated curriculum for teaching literacy. In Scandinavia, compulsory education starts in Grade 1 when the child is 7 years old (Lundberg, 1999), that is, approximately 1 year later compared to Australia and the U.S., and there is an established tradition among parents in Scandinavia that teaching literacy should take place in school and not in kindergarten. Note that children in Norway have received formal literacy instruction from age 6 since 2006 (this change in the curriculum was made after data collection in the present study). Instead, preschool and kindergarten curriculum in Norway and Sweden emphasize social, emotional and aesthetic development rather than explicit teaching of literacy. This means that preschool cognitive and language skills among children in the Scandinavian sample are less affected by preschool reading skills. In addition, in kindergarten Scandinavian children normally learn about letter names and letter sounds without receiving formal reading and spelling instruction, and about 50% of the children have developed some reading and spelling skills at the end of kindergarten (Samuelsson et al., 2007). These differences in early literacy exposure between countries suggest that Scandinavian children might perform poorly on prereading tasks emphasizing letter knowledge. We have no data, or direct observations available concerning the content or strategies used for early literacy instruction, but a mix of grapheme-phonemes correspondences and whole word recognition strategies are common among teachers across the four countries.

The present study

The main purpose of the present study was to compare the prediction of reading and spelling difficulties at the end of Grades 1 and 2 across transparent and opaque orthographies. No previous cross-language study has been designed to directly compare the prediction of group differences in reading and spelling across orthographies.

In the ILTS, parallel versions of tests measuring a range of language and cognitive skills at the end of preschool and kindergarten as well as reading and spelling skills at the end of Grades 1 and 2 are administered. At preschool, a total of 17 tests measuring phonological awareness, RAN, letter knowledge, verbal memory and semantic and syntactic skills were used as predictors of reading and spelling difficulties at Grades 1 and 2. At kindergarten,

seven tests measuring phonological awareness, RAN, and letter sound knowledge were used as predictors of reading and spelling difficulties at Grades 1 and 2.

Although we developed parallel tasks and stimulus material across test sites in this study, cross-linguistic mean comparisons were not carried out due to educational and cultural differences between samples. Instead, the questions to be addressed are the prediction of reading and spelling difficulties at Grades 1 and 2 from language and cognitive skills measured before (preschool) and after (kindergarten) children receive teaching in letter knowledge and/or formal reading instruction in school (cf. Holopainen et al., 2001). In general, we hypothesized that phonological awareness, RAN and letter knowledge should be stronger predictors of reading and spelling difficulties at both Grades 1 and 2 compared to preschool skills of verbal memory and syntactic/semantic skills (de Jong & van der Leij, 1999; Vellutino et al., 2004). We also hypothesized a similar pattern of predictions from preschool to Grades 1 and 2 reading and spelling difficulties across orthographies. However, as a transparent orthography seems to promote the development of phonological awareness more rapidly than English, we hypothesize different patterns of prediction of reading difficulties from kindergarten to Grade 1 and in particular to Grade 2. First, we hypothesized that both phonological awareness and RAN measured at kindergarten should continue to predict reading and spelling difficulties in English. Second, we expected that kindergarten phonological awareness should diminish as a predictor of reading difficulties in Scandinavia and that RAN only should continue to discriminate between normal readers and children with reading difficulties. Finally, we also hypothesized that phonological awareness should predict spelling difficulties in a similar way across orthographies as well as across grades.

Methods

Participants

The sample consisted of 754 same-sex twin pairs from Australia and the United States and 249 same-sex twin pairs from Scandinavia, a total of 1003 pairs, or 2006 children. By using a twin sample we might run the risk of underestimating the population variance. However, when comparing estimated variances across measures at each test occasion for the full sample of twins (N = 2006) with a sample consisting of only one twin from each pair (N = 1003), only marginal differences were obtained. For this reason we decided to include the full sample of twins in the analyses. In addition, this allows us to identify a sufficient sample of children with reading difficulties in both orthographies. New cohorts of twins are recruited each year, so at the time of writing the follow-up testing at the end of kindergarten, Grade 1, and Grade 2 was not complete for Australia, the United States, and Sweden. The Norwegian sample had been tested at all four test phases. Mean performances between orthographies rely on the number of children assessed at each test occasion, whereas longitudinal analyses rely on the number of children assessed at Grades 1 and 2, respectively. Mean age, total sample sizes, gender distribution, and numbers of children with reading and spelling difficulties in each sample are given in Table 1. Only participants for whom the predominant language of their country was the first language spoken at home were selected. None of the children had been indentified as hearing impaired. There were no significant differences in parents' mean years of education in Scandinavia (M = 13.9, SD = 2.9) and U.S./Australia (M = 14.0, SD = 2.1).

Materials and procedure

All tests included in this study have been described previously (e.g., Byrne et al., 2002; Byrne et al., 2007; Samuelsson et al., 2005). Thus, abbreviated details of most tests are presented in the following sections. Scandinavian versions of the subtests from the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R; Wechsler, 1989) and the Illinois

Test of Psycholinguistic Abilities (ITPA; McCarthy & Kirk, 1961) have been translated and standardized previously in Norway and Sweden. The remaining language and cognitive tests as well as reading and spelling tests were all English in origin and have been translated and adjusted into Norwegian and Swedish for this project (see Samuelsson et al., 2005, for further details). There was a high degree of overlap between the English and Scandinavian measures and approximately 90% of the material in these tests was translated without having to change the original words and pictures. In fact, the phonemic as well as the syllabic structures of a majority of words and pictures translated from English to Norwegian and Swedish were highly comparable (see examples provided for in the descriptions of some tests measuring phonological awareness). Cronbach's alpha estimates of reliability for the measures are only available for the U.S. data. However, monozygotic twin correlations provide lower-bound reliability estimates for the measures, and these have been reported to be reasonably high and comparable for most tests across test sites (see Samuelsson et al., 2005, for further details).

The children across test sites were tested annually from preschool to Grade 2. The assessments at preschool level were administered over five separate sessions (each lasting for about 1 hr), occupying 1 or 2 weeks, and were carried out in either the children's home or preschools. The assessments at kindergarten, Grade 1, and Grade 2 were administered in either the children's home or schools in a single session of 1 hour between March and June each year in Scandinavia, or in the summer (cf. U.S./Australia). These differences in time of assessment across countries results in some age differences at each test occasion.

Preschool assessments

Letter Knowledge—Letter recognition from names and sounds was used to measure letter knowledge. In these tasks, the tester said the name or the sound of a letter, and the child was required to point out one letter out of four on a card that represented that name or sound. Each task consisted of 26 lowercase letters and was presented to all children in the same random order.

Phonological Awareness—Six tasks were administered to measure phonological awareness. Three tests measured syllable and phoneme blending, word elision, and syllable and phoneme elision. In the test measuring syllable and phoneme blending children were asked to combine syllables (e.g., *sis-ter* in English and *søs-ter* in Norwegian) and then phonemes (e.g., *m-o-p* in English and *h-o-pp* in Norwegian) to form a word. In the test measuring word elision children were asked to delete a single-syllable word from a compound word to form a new word (e.g., *boy* from *cowboy* in English and *gutt* from *avisgutt* in Norwegian). In the test measuring syllable and phoneme elision children were asked to delete a syllable or phoneme from a word to form a new word (e.g., *ger* from *tiger* or *h* from *hear* in English and *raff* from *sjiraff* and *h* from *høre* in Norwegian). Sound matching, from the Comprehensive Test of Phonological Processes (CTOPP; Wagner, Torgesen, & Rashotte, 1999), was used as a fourth test of phonological awareness. In this test children were required to recognize which of three words started (e.g., *neck* and *nut* in English and *nakke* and *nøtt* in Norwegian) or ended (e.g., *cap* and *lip* in English and *knapp* and *sopp* in Norwegian) with the same sound as a target word. A fifth test measured rhyme and final phoneme matching. In this test children were asked to recognize rhyme (e.g., that *peep* rhymes with *sheep*, and not with *truck* or *frog*, in English and that *hus* rhymes with *mus*, and not with *bil* or *frosk*, in Norwegian) and final phoneme (e.g., that *bat* ends with the same sound as *kite*, and not as *mail* or *sock*, in English and that *sokk* ends with the same sound as *krakk*, and not as *kopp* or *skjegg*, in Norwegian). Finally, we included a phoneme identity training test where children were required to learn to identify initial and final phonemes.

Rapid Naming—Rapid naming was measured by the object and colour naming subtests from the CTOPP (Wagner et al., 1999).

Verbal Memory—The story memory subtest from the Wide Range Assessment of Memory and Learning (WRAML; W. Adams & Sheslow, 1990), sentence memory from the WPPSI-Revised battery (WPPSI-Revised; Wechsler, 1989), and Gathercole's Nonword Repetition Test (Gathercole, Willis, Baddeley, & Emslie, 1994) was administered to measure verbal memory.

Syntactic and semantic skills—The Hundred Picture Naming Test (Fisher & Glenister, 1992), Vocabulary from the WPPSI-Revised battery (WPPSI-Revised; Wechsler, 1989), the Grammatic Closure subtest from the Illinois Test of Psycholinguistic Abilities (ITPA; McCarthy & Kirk, 1961), and productive morphology designed after Berko (1958), were administered to measure syntactic and semantic skills.

Kindergarten assessments

Letter knowledge—Letter recognition of sounds was used to measure letter knowledge in kindergarten (identical with the test of letter recognition of sounds used at preschool).

Phonological awareness—Syllable and phoneme elision, syllable and phoneme blending, and sound matching from the CTOPP (Wagner et al., 1999) were used as tests of phonological awareness in kindergarten

Rapid naming—Three subtests from the CTOPP (colors, digits, and letters) were used as measures of rapid automatized naming

Grade 1 and Grade 2 assessments

Reading and spelling—Identical tests were administered to measure reading and spelling skills at Grade 1 and 2. The Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) was used to measure phonological decoding and word recognition, and the spelling subtest from the Wide Range Achievement Test (WRAT; Jastak & Wilkinson, 1984) was used to measure spelling.

Identification of children with reading and spelling difficulties in Grade 1 and 2 across orthographies—Groups of normal readers and children with reading difficulties were identified within each sample (i.e., English-speaking children and Scandinavian children) using a cut-off criterion at the 15th percentile (1 SD) on a composite word reading score (see Catts et al., 2001; Meyer, Wood, Hart, & Felton, 1998, for similar procedures). Since the correlations between the two reading tests were around .90 within each sample and across grade, the composite score was created by calculating the sum of age- and gender-adjusted z-scores on word recognition and phonological decoding at Grades 1 and 2, respectively. The same cut-off criterion was used to identify children with normal spelling skills and children with spelling difficulties. Note that children identified with reading and spelling difficulties in Grade 1 were not necessarily the same children identified with reading and spelling difficulties at Grade 2. The overlap between Grades 1 and 2 was 71 and 56 percent for word reading and 58 and 51 percent for spelling in the U.S./Australian and Scandinavian sample, respectively. Similarly, children identified with reading difficulties were not always the same children identified with spelling difficulties within one grade. The overlap between reading and spelling difficulties was 62 and 60 percent at Grade 1 and 61 and 43 percent at Grade 2 in the U.S./Australian and Scandinavian sample, respectively. The reason why children with reading and spelling difficulties are more stable

in the U.S./Australian sample is due to educational differences where these children receive formal literacy instruction earlier compared to children in the Scandinavian sample.

Results

Mean performances and standard deviations on tasks measuring language and cognitive skills and reading and spelling skills across samples at each test occasion are presented in the first result section. In the next section, a series of logistic regression analyses within each sample were conducted to identify language and cognitive skills that predict reading and spelling difficulties at Grade 1 and Grade 2 in school. In addition, these regression analyses were repeated by including interaction terms of all predictors by orthography to test whether the predictors of reading and spelling difficulties were significantly different between orthographies.

Samples means and variances for all measures across orthographies

Descriptive statistics for the entire sample of U.S./Australian and Scandinavian children are given in Table 2. Note that the RAN tests (registered in seconds) were assessed so that shorter times indicated better performance. The remaining tests were registered as total number correct, with higher scores indicating better performance.

As can be seen in Table 2, there were no floor or ceiling effects (except for preschool sound matching) in the two samples in the tests measuring language and cognitive skills neither at preschool, nor at kindergarten. In fact, means and standard deviations across English-speaking and Scandinavian children are quite comparable for most of the measures, except for letter name and letter sound knowledge at the preschool phase and in kindergarten. However, a closer look at the distribution of the variables indicates some problems. Note that the numbers in brackets represent measures of skewness. In the English-speaking sample, sound matching (1.69), RAN object (2.11), and RAN colour (1.62) measured in preschool were positively skewed. The Scandinavian sample yielded a similar pattern; sound matching (2.32), RAN object (1.68), and RAN colour (1.01). In kindergarten letter sound knowledge was negatively skewed in U.S./Australia (−3.31) and Scandinavia (−1.14), respectively. All the RAN tests measured in kindergarten were positively skewed in both samples ranging between 1.66 and 2.11 in the U.S./Australian sample and between 1.80 and 2.04 in the Scandinavian sample. Finally, the score distribution of the reading and spelling tests were approximately normal, the one exception being the distribution of the scores for phonological decoding in Scandinavia in Grade 1 with a skewness of 1.34. Although there were some tests of language and cognitive skills at preschool and kindergarten that were not normally distributed, the strategy in the present study was to consequently use two or more subtests for each skill. This procedure allows us to create composite variables of language and cognitive skills at preschool and kindergarten (see below). These composite measures not only secure reliability, but also reduce problems associated with skewness.

Preschool language and cognitive skills predicting reading and spelling difficulties in Grade 1 and Grade 2 across orthographies

A total of 17 tests were used to create composite variables as predictors at preschool. This structure of composite variables was based on prior factor analyses and theoretical considerations (Samuelsson et al., 2005) resulting in five preschool predictors of reading and spelling difficulties at Grades 1 and 2. The composite variables were letter knowledge, phonological awareness, RAN, verbal memory, and semantic and syntactic skills. To create these variables, we calculated the sum of age- and gender-adjusted z-scores separately for each sample. The sum of these z-scores was then divided by the number of measures underlying each composite variable. The same procedure was used to create composite

variables of phonological awareness and RAN at Kindergarten. Note that letter knowledge was measured by letter-sound knowledge only at kindergarten.

Group differences in reading—Separate logistic regression analyses for the U.S./Australian and Scandinavian samples using preschool letter knowledge, phonological awareness, RAN, verbal memory, and semantic and syntactic skills as predictors of reading difficulties at Grade 1 and Grade 2 are displayed in Table 3. In these analyses, all predictor variables were entered simultaneously.

In Grade 1, the logistic regression analyses provided models that fitted the data well, χ^2 (5, N = 1201) = 129.3, $p < .001$, for U.S./Australia, and χ^2 (5, N = 277) = 39.0, $p < .001$, for Scandinavia, and explained 18 % and 23 % of the variance (Nagelkerke R^2) in the U.S./Australian sample and the Scandinavian sample, respectively. There were three significant predictors of reading difficulties in the English-speaking sample: Letter knowledge, phonological awareness, and RAN. Both letter knowledge and phonological awareness yielded negative b-values and the odds ratio for group differences in reading was below 1. In other words, the higher the scores on phonological awareness and letter knowledge, the less likely it is that a child develop reading difficulties. RAN yielded positive b-values and the odds ratio for group differences in reading was above 1. Thus, a one-unit increase in RAN would increase the risk of reading difficulties. In other words, the faster the child is on RAN reduce the risk of developing reading difficulties. Corresponding findings for the Scandinavian sample indicated two significant predictors: Phonological awareness and RAN.

In Grade 2, the fit of the models was satisfactory, χ^2 (5, N = 1193) = 104.9, $p < .001$, for U.S./Australia, and χ^2 (5, N = 265) = 40.1, $p < .001$, for Scandinavia, and the amount of variance (Nagelkerke R^2) explained were 15 % in U.S./Australia and 25 % in Scandinavia. Letter knowledge, phonological awareness, and RAN were all significantly associated with reading difficulties in the U.S./Australian sample. In the Scandinavian sample, however, the only skill that predicts reading difficulties was RAN.

Follow-up analyses using hierarchical logistic regressions were performed to examine whether the predictors of reading difficulties at Grades 1 and 2 differed significantly across orthographies. In these analyses, orthography was entered at the first step as a dichotomous variable. Letter knowledge, phonological awareness, RAN, verbal memory, and semantic/syntactic skills were entered at the second step. Finally, the interaction terms between cognitive and language skills and orthography were entered at the third step, that is, Orthography × Letter Knowledge, Orthography × Phonological Awareness, Orthography × RAN, Orthography × Verbal Memory, and Orthography × Syntactic/Semantic skills. Significant interactions with orthography were observed at Grade 1 suggesting that letter knowledge was a stronger predictor to reading difficulties in the U.S./Australian sample (*Wald* = 6.9, $p < .05$) and that RAN was a stronger predictor to reading difficulties in the Scandinavian sample (*Wald* = 4.6, $p < .05$). There were no significant interactions observed at Grade 2.

Group differences in spelling— Table 4 displays patterns of prediction of spelling difficulties at Grades 1 and 2 across orthography.

In Grade 1, the overall model fit, χ^2 (5, N = 1207) = 102.3, $p < .001$, for U.S./Australia, and χ^2 (5, N = 277) = 46.6, $p < .001$, for Scandinavia, was significant, and the amount of variance (Nagelkerke R^2) accounted for was 15 % in the U.S./Australian sample and 28 % in the Scandinavian sample. Phonological awareness and RAN was significantly associated

with spelling difficulties in both samples. Letter knowledge also predicted group differences in spelling in the U.S./Australian sample, but not in the Scandinavian sample.

In Grade 2, the models provided good fit to the data, χ^2 (5, N = 1196) = 100.3, $p < .001$, for U.S./Australia, and χ^2 (5, N = 265) = 22.5, $p < .001$, for Scandinavia, and the amount of variance (Nagelkerke R^2) explained were 15 % in U.S./Australia and Scandinavia, respectively. Again, phonological awareness was a significant predictor of spelling difficulties in both samples. Letter knowledge and RAN did also discriminate between normal spellers and children with spelling difficulties in the U.S./Australia sample, but not in the Scandinavian sample. Finally, follow-up analyses with interaction terms show that the pattern of prediction from preschool language and cognitive skills on group differences in spelling did not differ significantly between the samples.

Kindergarten letter knowledge, phonological awareness, and RAN predicting reading and spelling difficulties in Grade 1 and Grade 2 across orthographies

Group differences in reading—We performed two new logistic regression analyses with kindergarten letter knowledge, phonological awareness, and RAN as predictors of reading difficulties at the end of Grades 1 and 2 (see Table 5).

In Grade 1, the logistic regression analyses provided significant model fit, χ^2 (3, N = 1408) = 351.9 $p < .001$, for U.S./Australia, and χ^2 (3, N = 280) = 63.7, $p < .001$, for Scandinavia, and explained a substantial amount of variance (Nagelkerke R^2) in the U.S./Australian (40 %) and Scandinavian (36 %) sample, respectively. As can be seen in Table 5, letter knowledge, phonological awareness, and RAN were all significantly associated with reading difficulties in both U.S./Australia and Scandinavia.

In Grade 2, the analyses provided models that fitted the data well, χ^2 (3, N = 1327) = 245.9, $p < .001$, for U.S./Australia, and χ^2 (3, N = 268) = 47.5, $p < .001$, for Scandinavia, and the amount of variance (Nagelkerke R^2) explained were 31 % in U.S./Australia and 29 % in Scandinavia. Similar to the findings for Grade 1, letter knowledge and RAN continue to predict reading difficulties in Grade 2 across orthographies. Phonological awareness was a significant predictor in the U.S./Australian sample, but failed to discriminate between normal readers and children with reading difficulties in the Scandinavian sample.

Follow-up analyses showed that letter knowledge was a stronger predictor of reading difficulties in the Scandinavian sample in Grade 2 (*Wald* = 4.1, $p < .01$), and that phonological awareness was more strongly associated with reading difficulties in the U.S./Australian sample in Grade 2 (*Wald* = 5.7, $p < .001$). There was no significant interaction between orthographies for RAN.

Group differences in spelling—The prediction of spelling difficulties in Grades 1 and 2 are displayed in Table 6.

In Grade 1, the overall model fit, χ^2 (3, N = 1415) = 245.8, $p < .001$, for U.S./Australia, and χ^2 (3, N = 280) = 87.4, $p < .001$, for Scandinavia, was significant, and explained 28 % (U.S./Australia) and 48 % (Scandinavia) of the variance (Nagelkerke R^2), respectively. As can be seen in Table 6, letter knowledge, phonological awareness, and RAN were all significantly associated with spelling difficulties in both samples.

Findings for Grade 2 were χ^2 (3, N = 1331) = 235.7, $p < .001$, for U.S./Australia, and χ^2 (3, N = 268) = 37.5, $p < .001$, for Scandinavia, and the amount of variance (Nagelkerke R^2) explained were 30 % in U.S./Australia and 24 % in Scandinavia. Similar to the findings in Grade 1, letter knowledge, phonological awareness, and RAN continue to predict spelling

difficulties in Grade 2 across samples. Follow-up analyses indicated that the pattern of prediction were not statistically different across the two samples.

Discussion

In every alphabetic writing system studied to date, conscious awareness of the sounds in words and the ability to accurately identify them in spoken words (i.e., phonological awareness) has been widely regarded as crucial for learning how to read (e.g., Bast & Reitsma, 1998; Byrne, 1998; Høien, Lundberg, Stanovich, & Bjaalid, 1995; Leppänen et al., 2006; Lie, 1991; Lundberg, Olofsson, & Wall, 1980; Müller & Brady, 2001; Rack et al., 1992; Skjelfjord, 1987; Snowling, 2000; Vellutino et al., 2004; Wimmer et al., 1991; Ziegler & Goswami, 2005). Recently, however, it has been argued that phonological awareness might be a less important or time-limited component skill for children learning to read in transparent orthographies such as Dutch (de Jong & van der Leij, 1999, 2002, 2003; van den Bos, 1998), Finnish (Holopainen et al., 2001; Leppänen et al., 2006), and German (Landerl & Wimmer, 2000; Wimmer, 1993, 1996; Wimmer & Mayringer, 2002; Wimmer et al., 2000). Instead, this research has shown that RAN seems to be a more prominent predictor of reading skill across grades. It should be noted, however, that few studies exist that have attempted to compare directly the relative importance of language and cognitive skills for individual differences in reading across languages using parallel version of tests (but see Caravolas et al., 2005; Furnes & Samuelsson, in press; Georgiou et al., 2008; Mann & Wimmer, 2002; Patel et al., 2004). In these studies, there is some support for the view that phonological awareness and RAN might contribute to reading in the normal range differently across orthographies, but the overall pattern of findings is that there are more similarities than dissimilarities in predicting reading in different alphabetic writing systems.

It has also been suggested that phonological awareness and RAN might be differently involved in predicting group differences in term of normal readers and children with reading difficulties. Several studies conducted within countries with a transparent orthography seem to suggest that RAN remains as a manifest problem in children with reading difficulties whereas deficits in phonological awareness are manifested as a problem only in the very first stages of literacy acquisition (e.g., de Jong & van der Leij, 2002, 2003; Wimmer, 1993; Wimmer et al., 2000). However, there is only one previous study designed with the purpose of directly examining deficits in phonological awareness (RAN was not included in this study) across orthographies (Caravolas et al., 2005, Study 2). In their study, they found that children with dyslexia show deficits in phonological awareness to the same extent in both a transparent and opaque orthography (i.e., Czech vs. English). It should be noted, however, that the children in the Caravolas et al. study (2005) was selected based on spelling difficulties, which according to Wimmer and colleagues (Landerl & Wimmer, 2008; Wimmer & Mayringer, 2002; Wimmer et al., 2000) is more related to deficits in phonological awareness than measures of reading skills in transparent orthographies.

The present study is the first to examine patterns of prediction from language and cognitive skills to early reading and spelling difficulties across two orthographies (i.e., Norwegian/ Swedish vs. English). A particular strength in this study is that we were able to assess a range of language and cognitive skills as well as the development of literacy skills at different ages. Such longitudinal design allow for a distinction between predictions made by individual differences in prereading skill observed prior to formal reading instruction. In addition, this design allow us to examine corresponding predictions made by the same language skills where individual differences are exposed to a reciprocal effect from early skills in reading and spelling (cf. Goswami et al., 2005).

The complete pattern of predictions from preschool and kindergarten to Grade 1 and Grade 2 group differences in reading and spelling within each orthography as well as analyses of interactions between orthographies are quite complex. In the remaining part of this discussion we will concentrate on the role of phonological awareness, RAN and letter knowledge in the prediction of reading and spelling difficulties across orthographies separately. Note that preschool verbal memory and syntactic and semantic skills did not predict reading and spelling difficulties across orthographies at Grades 1 and 2. In addition, there were no significant interactions between these preschool skills and orthography. We would also like to be explicit before interpreting our findings, that obtained differences in the pattern of prediction of reading and spelling difficulties between U.S./Australia and Scandinavia might partly be explained by an artefact of smaller power of the Scandinavian analyses. This is particularly the case whenever the English speaking results is significant and the Scandinavian is not, but there is no significant interaction between the two orthographies (e.g., in the case of preschool phonological awareness as a predictor of Grade 2 reading difficulties). An absence of interaction effects between orthographies is indicted when the confidence intervals overlap. It is hoped that with larger samples in this progressive study in future years that these intervals will narrow, alleviating the uncertainties currently surrounding the interpretation of some prediction patterns across orthography.

Phonological awareness and orthography

In general, preschool phonological awareness was a reliable predictor of reading and spelling difficulties within orthography at both Grade 1 and Grade 2. In addition, there were no significant interactions between preschool phonological awareness and orthography suggesting that the impact of phonological awareness in predicting reading and spelling difficulties are similar across orthography. However, there is one exception from this general pattern. Preschool phonological awareness did not predict group membership in reading at Grade 2 in the Scandinavian sample. This finding seems to replicate previous research indicating that the impact of phonological awareness gradually decreases as an important skill underlying individual differences in reading in transparent orthographies (de Jong & van der Leij, 1999, 2002; Leppänen et al., 2006; Lervåg et al., 2009; Verhagen et al., 2008; Wimmer et al., 1991). Our study extends this finding to reading difficulties (de Jong & van der Leij, 2003; Holopainen et al., 2001; Landerl & Wimmer, 2000; van den Bos, 1998; Wimmer, 1993). Our findings are also in accordance to a recent study by Landerl and Wimmer (2008) suggesting that phonological awareness is similarly important across orthographies in spelling (see also Caravolas, 2004).

The findings regarding kindergarten phonological awareness as a predictor of reading and spelling difficulties at Grade 1 and Grade 2 across orthographies were identical to those obtained from preschool. Interestingly, however, this time there was a significant interaction between kindergarten phonological awareness and orthography in predicting reading difficulties at Grade 2. This finding provide even more convincing support that phonological awareness diminish as a key skill in predicting reading in the normal range as well as reading difficulties beyond early stages of reading development in transparent orthographies. Thus, our study reinforce the idea that a strong reciprocal effect from early reading development on phonological awareness in transparent orthographies reduce the role of phonological awareness in accounting for individual differences in reading as well as in discriminating between normal readers and children with reading difficulties (Caravolas, 2005; Goswami et al., 2005; Seymour et al., 2003; Ziegler & Goswami, 2005). Again, our findings support previous studies suggesting that phonological awareness continue to account for spelling development as well as group differences in spelling in transparent

orthographies similar to that reported in English-speaking samples (Caravolas, 2004; Caravolas, Hulme, & Snowling, 2001; Landerl & Wimmer, 2008).

RAN and orthography

Preschool RAN of objects and colours predicted significantly Grade 1 and Grade 2 group membership in reading in both orthographies. In addition, the interactions between RAN and orthography in Grade 1 were significant suggesting that preschool RAN was a better predictor in distinguishing between normal readers and children with reading difficulties in the Scandinavian sample. These findings correspond surprisingly well with previous research suggesting that RAN is a consistent longitudinal predictor of individual differences in reading (de Jong & van der Leij, 1999, 2002; Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; Wagner et al., 1997) as well as in predicting reading difficulties across more and less transparent orthographies (de Jong & van der Leij, 2003; Sunseth & Bowers, 2002; Wimmer et al., 2000; Wolf & Bowers, 1999). RAN was also a significant predictor of spelling difficulties across orthographies at Grade 1, but only in the English-Speaking sample at Grade 2. However, there was no significant difference between orthographies neither in Grade 1 nor in Grade 2. These findings are consistent with some previous accounts in the literature, suggesting that RAN appears to be an important predictor of spelling in English (Savage, Pillay, & Melidona, 2008). Our findings contrasts, however, with recent claims by Wimmer and colleagues that RAN is less involved in spelling in transparent orthographies (Landerl & Wimmer, 2008; Wimmer & Mayringer, 2002).

At kindergarten, a composite variable of RAN (i.e., letters, digits, and colours) was a significant predictor of reading and spelling difficulties at Grade 1 and Grade 2 in both orthographies. Moreover, there were no significant interaction effects between RAN and orthography. Although the theoretical mechanism underlying the impact of RAN on reading and spelling is debated (Bowers & Wolf, 1993; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997), our findings are in line with previous studies showing that RAN is a significant predictor of early reading and spelling in both transparent and less transparent orthographies (Kirby et al., 2003; Savage et al., 2008; Wimmer & Mayringer, 2002; Wolf & Bowers, 1999). Note also that this was the case irrespective of using non-alphanumeric RAN tasks at preschool or alphanumeric tasks that was mainly used at kindergarten. Our findings also provide convincing support that RAN rather than phonological awareness is a long-term predictor of reading difficulties in transparent orthographies (cf. Wimmer, 1993).

Letter knowledge and orthography

Learning how to read and spell is critically dependent on the combination of two fundamental skills, phonological awareness and letter knowledge (M. J. Adams, 1990; Byrne, 1998). Together these skills are required for children to discover the alphabetic principle (i.e., that letters or letter clusters represents sounds in spoken language). In the present study, however, we found that preschool letter knowledge only predict reading and spelling difficulties in the U.S./Australian sample and not in the Scandinavian sample. However, the interaction between letter knowledge and orthography was only significant in predicting reading difficulties at Grade 1. The odds ratio scores for letter knowledge as a predictor were quite comparable across orthographies for both reading and spelling difficulties, at least for three out of four analyses, and thus, this difference might be explained by the larger sample size in U.S./Australia. Another possible explanation is that letter knowledge depends on direct teaching and practice (cf. Näslund & Schneider, 1996). That is, individual differences in letter knowledge obtained in the Scandinavian sample are not accounted for by any response to teaching but rather by home literacy practices varying between families. However, somewhat higher levels of informal and even formal literacy instruction at both home and preschool in Australia and the United States might contribute

to individual differences in print knowledge more dependent on variations of learning. In a previous report from the ILTS, Samuelsson et al. (2005) reported a significantly lower score on preschool letter knowledge in the Scandinavian sample than in the U.S./Australian sample. This is consistent with the relatively lower amount of shared book reading and letter-based activities with parents, and the lack of emphasis on teaching letters in Scandinavian preschools (also reported in Samuelsson et al., 2005). Thus, as long as individual differences in letter knowledge are not related to variations of learning capabilities, these differences are not likely to predict reading and spelling difficulties in school. However, similar analyses at the end of kindergarten, when children had received teaching in letter names and letter sounds for about one year, revealed that letter knowledge predicted reading and spelling difficulties in Scandinavia in a similar way as in U.S./Australia. Thus, the different role of preschool letter knowledge in predicting literacy difficulties at Grades 1 and 2 across orthographies is more likely accounted for by cultural and educational differences rather than differences between regular and less regular writing systems.

To conclude, the present study add to a growing number of studies suggesting that phonological awareness diminishes as a predictor of reading difficulties in transparent orthographies after the first years of schooling (e.g., de Jong & van der Leij, 2003; Holopainen et al., 2001; Landerl & Wimmer, 2000; Wimmer, 1993, 1996), that RAN is a better long term predictor of reading difficulties in transparent orthographies (Wimmer, 1993), and that phonological awareness is associated with spelling difficulties similarly in transparent and opaque orthographies (Landerl & Wimmer, 2008).

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Table 1

Mean Age (standard deviation), Total Sample Size, and Sex Distribution at Preschool, Kindergarten, Grade 1, and Grade 2 in U.S./Australia and Scandinavia

Characteristics	U.S./Australia	Scandinavia
Preschool		
Age (in months)	58 (2.8)	61 (1.7)
Total sample size	1508	498
Girls (%)	49	50
Kindergarten		
Age (in months)	74 (4.0)	81 (3.4)
Total sample size	1496	406
Girls (%)	49	50
Grade 1		
Age (in months)	87 (4.6)	93 (3.8)
Total sample size	1463	292
Girls (%)	49	50
Grade 2		
Age (in months)	100 (4.8)	105 (3.6)
Total sample size	1375	280
Girls (%)	51	50

Table 2

Means and Standard Deviations (raw scores) of All Measures in Preschool, Kindergarten, Grade 1, and Grade 2 in U.S./Australia and Scandinavia

	U.S./Australia		Scandinavia	
Variables	***M***	***SD***	***M***	***SD***
Preschool				
Letter recognition from sounds	12.4	5.9	11.0	5.8
Letter recognition from names	17.3	6.8	11.7	6.0
Syllable and phoneme Blending	6.5	2.5	6.3	2.5
Sound matching	3.9	3.3	3.4	3.2
Word elision	7.1	3.0	7.7	3.0
Syllable and phoneme elision	4.0	1.9	3.4	1.8
Rhyme and final sound	8.7	3.1	9.3	3.1
Phoneme identity training	62.1	19.2	51.2	16.2
Rapid Object Naming (in seconds)	126.0	40.6	127.7	35.1
Rapid Colour Naming (in seconds)	142.2	51.7	156.7	50.2
Nonword repetition	14.0	6.1	13.7	5.1
WPPSI Sentence Memory	18.6	5.9	17.7	6.7
WRAML Story Memory	8.5	6.1	7.1	5.7
Confronting naming	78.1	9.4	78.8	9.6
WPPSI Vocabulary	19.9	6.9	18.7	5.4
Grammar	13.3	4.9	15.0	4.8
Morphology	11.1	5.1	11.0	5.2
End of Kindergarten				
Letter recognition from sounds	24.4	3.1	21.0	5.7
Sound matching	12.3	5.4	11.1	6.3
Syllable and phoneme blending	9.0	4.1	7.3	4.8
Syllable and phoneme elision	6.1	3.6	5.1	4.4
Rapid Colour Naming (in seconds)	94.8	29.8	100.8	32.3
Rapid Digit Naming (in seconds)	80.1	32.5	93.5	35.0
Rapid Letter Naming (in seconds)	87.3	37.7	105.6	40.6
End of Grade 1				
Word recognition	82.6	33.4	50.8	32.0
Phonological decoding	35.6	22.6	31.4	19.4
Spelling	13.1	5.2	16.4	7.1
End of Grade 2				
Word recognition	110.3	28.8	85.8	30.9
Phonological decoding	51.1	24.7	46.0	20.0
Spelling	18.2	5.8	24.2	6.3

Note. WPPSI = Wechsler Preschool and Primary Scale of Intelligence; WRAML = Wide Range Assessment of Memory and Learning.

Table 3

Results of Logistic Regression Analyses Predicting Difficulties in Word Reading in (a) Grade 1 and (b) Grade 2 from Five Preschool Skills

	U.S./Australia				Scandinavia			
Variables	***B***	***SE***	***OR***	***CI***	***B***	***SE***	***OR***	***CI***
(a)								
Constant	−2.14	.11	*NA*		−2.35	.27	*NA*	
LK	−.59	.13	.55***	.43 – .72	.25	.29	1.28	.72 – 2.27
PA	−.84	.22	.43***	.28 – .66	−1.20	.44	.30**	.13 – .72
RAN	.26	.09	1.30**	1.08 – 1.56	.74	.20	2.10***	1.40 – 3.13
VM	−.18	.17	.84	.60 – 1.18	.08	.36	1.08	.54 – 2.18
Syn/Sem	.09	.18	1.10	.77 – 1.56	−.29	.39	.75	.35 – 1.59
(b)								
Constant	−2.00	.10	*NA*		−2.44	.29	*NA*	
LK	−.41	.12	.66***	.52 – .84	−.51	.36	.60	.30 – 1.23
PA	−.72	.21	.49***	.33 – .73	−.31	.41	.74	.33 – 1.64
RAN	.36	.09	1.43***	1.20 – 1.70	.79	.21	2.21***	1.47 – 3.32
VM	−.01	.17	1.00	.71 – 1.39	−.22	.35	.80	.40 – 1.60
Syn/Sem	−.01	.18	.99	.70 – 1.41	−.28	.38	.76	.36 – 1.59

Note. OR = Odds Ratio; CI = 95 % Confidence Interval; NA = not applicable; LK = Letter knowledge; PA = Phonological awareness; RAN = Rapid automatized naming; VM = Verbal memory; Syn/Sem = Syntactic and semantic skills.

** $p<.01$;

*** $p<.001$.

Table 4

Results of Logistic Regression Analyses Predicting Difficulties in Spelling in (a) Grade 1 and (b) Grade 2 from Five Preschool Skills

	U.S./Australia				Scandinavia			
Variables	***B***	***SE***	***OR***	***CI***	***B***	***SE***	***OR***	***CI***
(a)								
Constant	−2.06	.10	*NA*		−3.03	.38	*NA*	
LK	−.50	.13	.61***	.47 – .78	−.73	.42	.48	.21 – 1.11
PA	−.89	.21	.41***	.27 – .63	−1.40	.49	.25***	.09 – .65
RAN	.32	.09	1.37***	1.15 – 1.63	.59	.21	1.80***	1.19 – 2.74
VM	.07	.17	1.07	.77 – 1.49	−.69	.40	.50	.23 – 1.09
Syn/Sem	.22	.18	1.24	.88 – 1.77	.42	.41	1.52	.68 – 3.40
(b)								
Constant	−2.13	.11	*NA*		−2.34	.26	*NA*	
LK	−.39	.13	.68***	.53 – .87	.15	.30	1.16	.65 – 2.09
PA	−1.19	.22	.30***	.20 – .47	−1.06	.43	.35*	.15 – .81
RAN	.23	.09	1.26*	1.06 – 1.51	.37	.21	1.44	.96 – 2.16
VM	.03	.17	1.03	.74 – 1.45	−.59	.37	.55	.27 – 1.15
Syn/Sem	.30	.19	1.35	.94 – 1.93	.21	.39	1.23	.57 – 2.66

Note. OR = Odds Ratio; CI = 95 % Confidence Interval; NA = not applicable; LK = Letter knowledge; PA = Phonological awareness; RAN = Rapid automatized naming; VM = Verbal memory; Syn/Sem = Syntactic and semantic skills.

* $p<.05$;

*** $p<.001$.

Table 5

Results of Logistic Regression Analyses Predicting Difficulties in Word Reading in (a) Grade 1 and (b) Grade 2 from Letter Knowledge, Phonological awareness, and RAN in Kindergarten

	U.S./Australia				Scandinavia			
Variables	***B***	***SE***	***OR***	***CI***	***B***	***SE***	***OR***	***CI***
(a)								
Constant	−2.53	.13	*NA*		−2.78	.34	*NA*	
LK	−.49	.10	.61***	.51 – .74	−.58	.22	.56*	.36 – .87
PA	−1.19	.16	.30***	.22 – .42	−1.03	.43	.36*	.16 – .82
RAN	.74	.10	2.09***	1.71 – 2.56	.89	.24	2.44***	1.52 – 3.92
(b)								
Constant	−2.38	.12	*NA*		−2.26	.25	*NA*	
LK	−.18	.09	.83*	.70 – .99	−.67	.23	.51***	.33 – .79
PA	−1.04	.15	.36***	.27 – .48	−.13	.35	.88	.44 – 1.76
RAN	.76	.10	2.13***	1.75 – 2.60	.87	.23	2.38***	1.53 – 3.72

Note. OR = Odds Ratio; CI = 95 % Confidence Interval; NA = not applicable; LK = Letter knowledge; PA = Phonological awareness; RAN = Rapid automatized naming.

* $p<.05$;

*** $p<.001$.

Table 6

Results of Logistic Regression Analyses Predicting Difficulties in Spelling in (a) Grade 1 and (b) Grade 2 from Letter Knowledge, Phonological awareness, and RAN in Kindergarten

	U.S./Australia				Scandinavia			
Variables	***B***	***SE***	***OR***	***CI***	***B***	***SE***	***OR***	***CI***
(a)								
Constant	−2.21	.11	*NA*		−3.65	.52	*NA*	
LK	−.41	.09	.66***	.56 – .79	−.84	.24	.43***	.27 – .69
PA	−1.03	.14	.36***	.27 – .47	−2.07	.58	.13***	.04 – .39
RAN	.35	.09	1.42***	1.19 – 1.69	.66	.25	1.94**	1.18 – 3.18
(b)								
Constant	−2.41	.12	*NA*		−2.51	.30	*NA*	
LK	−.22	.09	.80*	.68 – .96	−.43	.22	.65*	.42 – .99
PA	−1.29	.15	.28***	.20 – .37	−.99	.40	.37*	.17 – .82
RAN	.42	.10	1.52***	1.26 – 1.83	.44	.22	1.55*	1.01 – 2.39

Note. OR = Odds Ratio; CI = 95 % Confidence Interval; NA = not applicable; LK = Letter knowledge; PA = Phonological awareness; RAN = Rapid automatized naming.

* $p<.05$;

** $p<.01$;

*** $p<.001$.