





ABSTRACT

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Learning to read: The effect of orthography

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This study addressed orthographic differences in reading acquisition, with a specific focus on the development of literacy skills in Finnish. From the perspective of reading acquisition the most interesting aspect of variation between orthographies is related to orthographic depth, which refers to the consistency of grapheme-phoneme (G-P) correspondences. English is at one end of the continuum of orthographic depth, with inconsistent G-P correspondences; while Finnish is located at the opposite end, with very consistent G-P correspondences. When assessing the pseudoword reading skills of children in grade levels 1–4 in English, and in six more regular orthographies, it was found that English children acquired phonological recoding skills notably later than children learning to read in more regular orthographies. Similar results were found in a comparison study of children's reading skills in 13 different European orthographies after one year of reading instruction. With most of the languages, the children had attained accurate and fluent foundation-level reading skills by the end of the year; but French, Portuguese, Danish, and especially English proved to be exceptions. The relationship between phonological abilities and emerging reading skills was assessed by means of a time-series data collection in a 13-month follow-up of six Finnish non-readers. The results revealed large variation in the rate of improvement of phonological abilities, and also in the relationship between different manipulation skills and reading acquisition. The development of reading skills was followed up in a group of Finnish children entering the first grade. One-third of the children were already able to read on school entry, and the development of the non-readers was rapid. Pseudoword and word reading, as well as spelling accuracy, developed simultaneously; suggesting that these skills are closely associated in a transparent orthography. The most important predictor of the development of reading and spelling accuracy was letter knowledge, followed by phoneme identification and pseudoword repetition skills. The results reveal a clear effect of orthography upon reading acquisition, and raise questions concerning the current models of reading acquisition.

Keywords: learning to read, orthography, reading acquisition, phonological recoding, orthographic depth, orthographic transparency

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CONTENTS

ABSTRACT

LIST OF PUBLICATIONS

1	INTRODUCTION	9
1.1	Differences between orthographies	11
1.1.1	Deep alphabetic orthography: English	12
1.1.2	Shallow alphabetic orthography: Finnish.....	14
1.2	Reading acquisition in different orthographies	15
1.2.1	Models of reading acquisition.....	15
1.2.2	Cross-linguistic findings of reading acquisition.....	17
1.2.3	Reading acquisition in highly transparent orthographies	18
1.3	Predictors of reading acquisition.....	19
1.4	Aims of the empirical studies	21
2	OVERVIEW OF THE ORIGINAL STUDIES.....	22
2.1	Study I: The development of phonological abilities and their relation to reading acquisition: Case studies of six Finnish children.....	22
2.2	Study II: Learning to read: English in comparison to six more regular orthographies	23
2.3	Study III: Foundation literacy acquisition in European orthographies	24
2.4	Study IV: The development of reading and spelling skills, and the predictors of accuracy and fluency: An intensive follow-up in a transparent orthography (Finnish)	26
3	GENERAL DISCUSSION.....	28
3.1	Reading acquisition and the orthographic depth	28
3.2	Reading acquisition in Finnish	31
4	CONCLUSIONS.....	35
	TIIVISTELMÄ	37
	REFERENCES.....	39

1 INTRODUCTION

The most important models of alphabetic literacy acquisition are presented as general models of the learning of alphabetic orthographies. The models are, however, typically based on research concerning the acquisition of a single orthography, that of English. If one examines research reports in the field of reading acquisition or dyslexia, one finds that reference to orthographic context is usually made only when the context is not English; in report titles, the explicit statement of a non-English language context is often required, whereas the explicit statement of the English language context is seldom seen. This bias is, of course, not the fault of the scholars working in the English-speaking countries, where cognitive psycholinguistics and research in reading acquisition has a long and competent tradition. It rather reflects the fact that the question of orthographic differences in reading acquisition in alphabetic orthographies has been outside of the focus of research, and that the implicit assumption has been that the non-English findings are somehow less universal than the findings concerning the English orthography.

Recently, there has been increased attention to the question of whether the difficulty of reading acquisition in alphabetic orthographies is related to the features of particular orthographies. This question has been brought into focus by virtue of a number of research findings that suggest that there is considerable variation in the rate of reading acquisition between orthographies, and that this variation is related to the so-called orthographic depth (transparency, regularity, consistency). The concept of orthographic depth refers to the consistency of the grapheme-to-phoneme correspondences of the orthography. In shallow (regular) orthographies, such as Finnish, the correspondences are direct and guided by simple rules, whereas in deep (irregular) orthographies, such as English, the relation between phonemes and graphemes is more equivocal and opaque.

The relative lack of research addressing the question as to whether the findings can be generalised across orthographies is somewhat surprising, since knowledge of the problems caused by irregular orthography is not new. The very same problems of reading acquisition in English that are discussed in this

thesis were the reason for experimenting in the 1960's with the Initial Teaching Alphabet (ITA), in which each phoneme of the English language was consistently represented with one grapheme. As Adams (1990, p. 256) observed, the effectiveness of ITA as compared to traditional English orthography in beginning reading instruction was shown in a variety of measures of literacy skills and linguistic development, and the advantage persisted at least through the fifth grade. Downing (1964, pp. 11-14) has listed a multitude of even earlier attempts to provide beginners with a more simple and more consistent script for learning to read English; the earliest date back to the seventeenth century.

While the question of differences between alphabetic orthographies has not received much attention in the field of reading acquisition, it has attracted more interest in studies of skilled reading and lexical access. The issue was first introduced into reading research as a result of findings concerning word recognition processes in Serbo-Croatian and English (Feldman & Turvey, 1983; Katz & Feldman, 1983; Lukatela, Popadic, Ognjenovic, & Turvey, 1980). The studies revealed that in Serbo-Croatian, word-recognition processes were biased towards phonemic coding, whereas in English, the orthographic processes were more important. The resulting "orthographic depth hypothesis", as formulated by Frost, Katz, and Bentin (1987), asserted that:

"...lexical word recognition in shallow orthographies is mediated primarily by phonemic cues generated prelexically by grapheme-to-phoneme translation. In contrast, lexical access for word recognition in a deep orthography relies strongly on orthographic cues, whereas phonology is derived from internal lexicon."

The later formulations of this hypothesis are less stringent in labelling the core processes "orthographic" or "phonological" according to the depth of the writing system, since phonological processing has also been shown to be involved in word recognition in deep orthographies (Lukatela & Turvey, 1999). Ziegler, Perry, Jacobs, and Braun (2001) have suggested that the main difference between word recognition in deep and shallow orthographies relates to the varying sizes of the processing units that are necessary for successful decoding, and the varying need to switch between different "grain-size" levels.

From the point of view of reading acquisition, the orthographic depth hypothesis implies several further hypotheses. Since the grapheme-phoneme correspondences are simple and straightforward in shallow orthographies, the development of phonological recoding - the ability to build word pronunciation on the basis of grapheme-phoneme correspondences - should be rapid. The mastery of phonemic assembly, which is based on grapheme-phoneme correspondences, is sufficient for accurate word recognition. In deep orthographies, on the other hand, grapheme-phoneme correspondences are complex and irregular, and the beginning reader has to supplement (and replace) grapheme-phoneme conversion strategies with recognition of rime units or attempts at whole word recognition (Ziegler et al., 2001). Therefore, the learning process should be more protracted.

The following chapters aim to summarise the differences between alphabetic orthographies that are thought to have an effect upon the acquisition

of literacy. A specific focus concerns aspects of the English and Finnish orthographies, which lie at opposing ends of the orthographic depth continuum. The research findings concerning early literacy development across alphabetic orthographies are summarised, as well as the findings concerning the skills that have been shown to predict reading acquisition in different alphabetic orthographies.

1.1 Differences between orthographies

Different writing systems (orthographies) can be classified according to the levels of linguistic information that is coded in the script. DeFrancis (1989, p. 56) has pointed out that all writing systems are based on phonetic aspects of language. This is the case even with Chinese, that is commonly perceived as a script consisting of only semantic coding, and that is correspondingly often mislabelled as "pictographic", "logographic", "ideographic" or "morphemic". He has presented a classification that is based on, firstly, whether the phonetic components are represented with graphic or alphabetic symbols; secondly, whether written symbols represent syllables, consonant sounds, or all the phonemes of the language; and thirdly, whether the orthographic code also includes non-phonetic clues such as morphological information. DeFrancis' classification is represented in Table 1.

TABLE 1 Classification of orthographies, and examples of orthographies falling in these categories according to DeFrancis (1989).

Graphic symbols		Alphabetic symbols			
Syllabic		Consonantal		Alphabetic	
"Phonetic"	"Meaning + Phonetic"	"Phonetic"	"Meaning + Phonetic"	"Phonetic"	"Meaning + Phonetic"
<i>Japanese</i>	<i>Chinese</i>	<i>Phoenician</i>	<i>Egyptian</i>	<i>Greek</i>	<i>Korean</i>
<i>Yi</i>	<i>Mayan</i>	<i>Hebrew</i>		<i>Latin</i>	<i>English</i>
	<i>Sumerian</i>	<i>Arabic</i>		<i>Finnish</i>	

It is worth noting that the classification described above is one of many, and the categories are not discrete. Nevertheless, it underlines the point that all orthographies share a phonetic base, and that inside each of the three representational levels (syllabic, consonantal, and alphabetic), orthographies can be classified according to whether morphological information is coded into script, or whether the orthography is "purely" phonetic. This is also the case with alphabetic orthographies. The orthographies that are "purely" phonetic have consistent grapheme-phoneme correspondences. English is an extreme example of a language in which morphological information is also coded in

spelling. This creates inconsistency in grapheme-phoneme correspondences. There are also other alphabetic orthographies that share a similar morphophonemic nature, including Danish, which has a reputation of poor fit between spelling and sound. Whereas these two orthographies are symmetrical, that is, irregular both in the direction of spelling-to-sound and sound-to-spelling, some orthographies are irregular in one direction only. French is relatively regular from the perspective of reading, whereas it is less so from the point of view of spelling. The same can also be said about German. The Romanic languages are generally thought of as being relatively regular and symmetrical. At present, there exists no common measure for quantifying the transparency of an orthography, although the calculations made for a few orthographies have been published. On the spelling body-rime level, 31% of English monosyllabic words are inconsistent (Ziegler, Stone & Jacobs, 1997); the corresponding figure for French is 12% (Ziegler, Jacobs & Stone, 1996); and 16% for German (J. Ziegler, personal communication, February 20, 2001). It should be noted that the above figures are not calculated on the basis of grapheme-phoneme correspondences, where the inconsistencies supposedly are much more frequent, especially for English.

Because objective measures of consistency are lacking, the term "regular orthography" has been used somewhat liberally, and studies investigating the effect of orthographic consistency have done so usually in comparison with the extreme, namely English. The "transparency" of an orthography can be best thought of as a continuum. Whereas we might remain uncertain as to where on this continuum each orthography is objectively located, we can be certain of the extreme positions of this continuum. English is one of the most irregular alphabetic orthographies, and Finnish is certainly one of the most regular.

1.1.1 Deep alphabetic orthography: English

English is an example of an orthography where the written script does not fully represent the phonemic structure of spoken language. According to Ehri, Nunes, Willows, Schuster, Yaghoub-Zadeh and Shanahan (2001, p. 253), there are "about 41" phonemes in English; in the ITA there were 44 characters with a distinct corresponding phoneme (Downing, 1964, p. 15). The number of graphemes is much higher and many graphemes consist of multiple letters. A phoneme can be marked with a variety of graphemes, depending on the context, and vice versa.

DeFrancis (1989, pp. 201-208) listed a number of factors behind the complex correspondence of spoken and written English. More than half of the words of the present-day English vocabulary are of foreign origin, mostly from Latin or French. Often, the spelling and pronunciation of the loan words was preserved in English. The historical changes of pronunciation in French have resulted in loan words with differing pronunciations in English depending on the time they were borrowed (*chant* – *chiffon*). One major factor resulting in a gulf between spoken and written language has been the lack of standardisation of the spelling until the middle of the eighteenth century. Until that time, there

was great variation between writers in the spellings of particular words. With the publication of the first dictionary, "the chaos began to be systematized – not ended, merely codified", as DeFrancis (1989, p. 203) has stated. In the creation of the dictionary, a principle of preserving historical spellings was used. Thus, the spellings of the words often reflect their etymology at the expense of pronunciation (e.g., *debt* – *debitus* [lat.]).

Another feature that affects the inconsistency of spoken and written English relates to the marking of morphemic components. The English spelling system is often characterised as morphophonemic. Whereas the spelling of roots in English is basically phonemic – although in a complicated manner – the spelling of derivatives and compounds tends to be morphemic (Venezky, 1970, p. 120). The established graphemic form of the base is retained as much as possible, regardless of the phonemic alterations. Thus, in words like *nation* and *nationality*, the spelling of the root is similar, despite different pronunciation. As another example of this morphophonemic spelling, the regular past tense ending is spelled *-ed*, although it has three different pronunciations. DeFrancis (1989, p. 207) has noted that unique spellings for a considerable number of homophones (e.g., *sight*, *site*, and *cite*) are another reflection of the morphophonemic nature of English orthography.

The principle of preserving historical spellings and the morphophonemic nature of the language are the root causes of great irregularity in the grapheme-phoneme correspondences. As examples, DeFrancis (1989, p. 204) listed 11 different spellings for the long /i/ sound in words *machine*, *me*, *fee*, *sea*, *field*, *conceive*, *key*, *quay*, *people*, *subpoena*, and *Caesar*, and 14 different spellings for the /sh/ sound in words *shoe*, *nation*, *sugar*, *issue*, *mansion*, *mission*, *suspicion*, *ocean*, *nauseous*, *conscious*, *chaperon*, *schist*, *fuchsia*, and *pshaw*. A given grapheme often has many different pronunciations and, conversely, a given phoneme can be spelled with many different graphemes. According to Venezky (1970), just two single-letter graphemes (r and v) have only one corresponding sound that cannot be produced by other combinations and that are never silent. The rules governing the choices of grapheme-phoneme pairings are complex, and the spelling of a phoneme (pronunciation of a grapheme) depends on the context. Adams (1990, p. 242) noted that, to represent spelling-to-sound mappings of 80 to 90 percent of most regular English words, hundreds of grapheme-phoneme correspondences are involved. She also listed the 150 most frequent words in English schoolbooks and calculated that only 23% of these could be read with knowledge of basic letter sounds (Adams, 1990, p. 274). There are also a number of words that are completely irregular, in that they don't follow even the complex grapheme-phoneme rules, such as the words *two* or *yacht*. A beginning reader is thus posed with a complex task of recoding. Venezky (1970, p. 129) has summarised the consequences as follows:

"In the first place, a person who attempts to scan left to right, letter by letter, pronouncing as he goes, could not correctly read most English words. Many of the English spelling-to-sound patterns require, at a minimum, a knowledge of succeeding graphemic units. How, for example, is initial e- to be pronounced if the following units are not known (cf. erb, ear, ever,

eight)? This is just the beginning of the problem. In some patterns the entire word must be seen – and this is true of almost all polysyllabic words since stress patterns are significant for vowel quality. The implication here is that single pass left-to-right scanning is unproductive except for some monosyllabic words."

1.1.2 Shallow alphabetic orthography: Finnish

Whereas English is an example of a morphophonemic alphabetic orthography, Finnish is an example of an almost purely phonemic alphabetic orthography. The grapheme-phoneme correspondences are regular and symmetrical, and the morphophonemic features are few. The number of phonemes is relatively small and each phoneme is marked with a corresponding single letter (with one exception), which makes the Finnish orthography transparent also at the graphemic level. Here, the most relevant features of the Finnish orthography from the point of view of literacy acquisition will be summarised (for a more detailed description see Lyytinen, Aro, & Holopainen, 2004).

The number of standard Finnish consonant phonemes is 13 (/p/, /t/, /k/, /m/, /n/, /l/, /r/, /s/, /h/, /j/, /v/, /d/, and /ŋ/), and the number of vowel phonemes is 8 (/i/, /e/, /ä/, /y/, /ö/, /u/, /o/, and /a/). There are three additional consonant sounds, which are used in recent loan words only (/b/, /g/, and /f/). Each phoneme is marked with the corresponding single letter, except the phoneme /ŋ/, which is marked with the letter *n* when short (in letter combination *nk*) and with the digraph *ng* when long. All phonemes can have two phonemic quantities, long and short, with the exception of /d/, /h/, /j/, and /v/. The long quantity is consistently marked by doubling the corresponding letter. With knowledge of the basic letter-sound correspondences and phonemic assembly skill, a reader is able to decode practically any Finnish word or pseudoword.

There are ten syllable types: CV, CVC, CVV, CVVC, VC, V, VV, CVCC, VVC, and VCC. The longest syllable consists of four phonemes. A syllable – and consequently, a word – never begins with a consonant cluster. However, some loan words can have initial clusters. Consonant clusters can appear at the end of the syllables, but never at the end of the word. The syllables are perceptually salient units of the spoken language because the main stress in Finnish is placed on the first syllable and the secondary stress on every second syllable thereafter. In the initial reading materials, the syllables are explicitly marked in the texts and syllabic segmentation is a central part of early reading and spelling instruction.

Most Finnish words are polysyllabic. There are only approximately 50 monosyllabic words (Kyöstiö, 1980, p. 37), and most of these are conjunctions or interjections. The words tend to be long because of highly productive compounding, a rich derivational system, and agglutinative morphology. Whereas Finnish orthography is transparent, the Finnish morphology is complicated and opaque. With different combinations of case (15), plural marker, and a variety of clitics, any noun can have over 2000 orthographic forms, of which 150 are so-called core forms (Niemi, Laine, & Tuominen, 1994;

for an example see Karlsson, 1996). For Finnish verbs, this figure is even higher. A verb can have 12 000 - 18 000 forms, when the inflections for tense, mood and person, and cliticisation are included (Niemi et al., 1994). When derivation and highly productive compounding is taken into account, the number of lexical environments in which a typical Finnish root can exist is vast. Since affixation often affects the stem (e.g., *lammas* - *lampaan*) the Finnish morphological system is best described as agglutinative-fusional. It should be noted that, irrespective of the morphological complexity of the word, the spelling is consistent with the pronunciation.

From the perspective of literacy acquisition, the Finnish orthography is in many ways optimal. The grapheme-phoneme correspondence system is perfectly regular, and the number of phonemes is small. Thus, the number of correspondence rules required for phonological recoding is very small. Because the graphemes are single letters, the written words explicate the otherwise abstract phonemic structure of the words for the reader. Consonant clusters are rare, and the phonemic structure of syllables is simple. These factors should be beneficial to the process of learning to read, since they allow a systematic use of left-to-right phonological recoding, basically at the level of single letters, without the need for explicit graphemic parsing. From another point of view, the effectiveness of logographic/orthographic strategies in word recognition is severely handicapped by the above-mentioned features of Finnish morphology. The ability to recognise roots does not suffice, since words are often inflected and these inflections can also affect the root.

The challenges posed by the Finnish orthography relate to the length of the words and the coding of phonemic length, which, in the case of stop consonants, does not perfectly match the spoken language. It is also worthy of note that the few morphophonological features in the Finnish orthography that violate the consistency of spelling are also related to phonemic length; after certain lexical morphemes before clitics, in some compound words, and at some word boundaries in sentences, the following suffix or word initial consonant is lengthened in spoken language, but this lengthening is not marked in the orthography (*tulepa* - /tulep:a/; *vaatekauppa* - /va:tek:aup:a/; *tule tänne* - /tule t:änne/).

1.2 Reading acquisition in different orthographies

1.2.1 Models of reading acquisition

Almost all English-based models of reading acquisition have in common the idea of dual processing routes for word recognition, which are employed right from the outset: one route based on the phonological process of letter-sound translation and the other based on sight word recognition. Different models suggest a somewhat differing developmental sequence for these processes.

Some models have described a preliminary process of visual word recognition, which is followed by the letter-sound translation processes (Frith, 1985; Gough & Hillinger, 1980). The model put forward by Seymour (e.g., 1997, 1999) has described these two processes as parallel, with both required for further orthographic development. Ehri (1992) has proposed an integrative theory, where an interactive relation of these processes is postulated: letter-sound knowledge and partial phonological cues form the basis for visual word-recognition skills.

Consequently, this common assumption of dual processing skills as necessary for reading acquisition has led to models of impaired reading acquisition that describe different types of reading problems, depending on the component skill that is most affected. This distinction has traditionally been reflected in numerous sub-type models of reading disabilities (e.g., Boder, 1973; Lovett, 1987), as well as in the contrast between "phonological dyslexia" (disorder of grapheme-phoneme translation) and "surface dyslexia" (disorder of word-specific lexical processing) (e.g., Ellis, 1985). Lately, connectionist approaches to word recognition have resulted in computational models of word recognition that seem to model well both normal word-recognition skills and the dyslexic performance. These models contradict the item-specific mechanisms postulated in the above-mentioned dual processing models, and suggest that the cognitive system adheres to certain probabilistic principles of computation for implicit learning in quasi-regular domains, such as English orthography (e.g., Plaut, McClelland, Seidenberg, & Patterson, 1996).

Despite the above-described dissociation of the sub-lexical and lexical processes in early reading development in English, there is currently a common consensus that phonological processing skills are the most important skills for reading development. In an extensive review of findings concerning reading acquisition, Share (1995) stated that the quintessential problem ("sine qua non") of reading acquisition is phonological recoding, the ability to independently generate pronunciations for novel orthographic strings. According to this "self-teaching hypothesis", phonological recoding has a primary role in reading acquisition and the orthographic or visual-based skills serve a secondary role: the orthographic lexicon develops with increasing reading experience and "self-teaching". Phonological recoding is based on the application of grapheme-phoneme correspondence rules and analogical mechanisms and is the basis for the development of orthographic knowledge (Share, 1995). The benchmark measure of phonological recoding skill is, naturally, the pseudoword reading task. Goswami and Bryant (1990) claimed that onset and rime-level correspondences, in particular, are central to early reading development. Currently, there is an ongoing British debate on the question as to whether reading acquisition is based primarily on small-unit (phoneme) or large-unit (onsets and rimes) correspondences (see Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002; Goswami, 2002a; Bryant, 2002).

1.2.2 Cross-linguistic findings of reading acquisition

Most cross-linguistic comparisons of reading acquisition have been pairwise comparisons of English and a supposedly more regular orthography. One of the earliest studies of this kind was carried out by Öney and Goldman (1984). They compared the pseudoword reading skills of Turkish and American children at first and third grades. The results showed that the Turkish children were more accurate and also faster than the American children at the first grade, the accuracy percentages being 94% and 59%, respectively. At the third grade, the ceiling was reached by both groups, but the Turkish children were still the more fluent readers. Other studies have reported similar differences in Turkish-English comparisons also in word-recognition skills of children at the second grade (Öney, Peter, & Katz, 1997), and at the first grade (Durgunoğlu & Öney, 1999).

Since the study by Öney and Goldman (1984), a number of comparisons have shown a similar difference in phonological recoding skills between English children and children acquiring literacy skills in other orthographies. Most of these studies concern German-English comparisons and, in summary, German-speaking children have consistently showed better phonological recoding skills than English-speaking children. Wimmer and Goswami (1994) reported a clear advantage for German children up till the fourth grade. In her replication, Landerl (2000) showed that the performance of the English children was better with phonics instruction, but still the German children outperformed the English children in the first and second grades. Goswami, Ziegler, Dalton and Schneider (2001) reported large differences in phonological recoding accuracy between German and English children up till the reading age of 9 years. Frith, Wimmer and Landerl (1998) reported similar differences up until grade four, even in sub-samples of children with perfect word recognition skills. A similar difference in phonological recoding has also been reported in a comparison of the pseudoword reading skills of German and American children at grades one and two (Näslund, 1999), and even between German- and English-speaking dyslexic children with a comparable lag in their reading skills (Landerl, Wimmer, & Frith, 1997).

Reports concerning comparisons of English and other more regular orthographies are few, but the findings are consistent. Thorstad (1991) showed that Italian children outperformed English children in word recognition and spelling. Goswami, Porpodas and Wheelwright (1997) reported a phonological recoding difference between Greek and English children up until a reading age of 9 years. A similar difference in early pseudoword reading accuracy has also been reported between English and French, and English and Spanish children (Goswami, Gombert, & de Barrera, 1998), as well as English and Welsh children (Spencer & Hanley, 2003).

As Landerl (2000) has noted, there exists not a single empirical study that shows the reverse finding that English children are better in phonological recoding than children in any other alphabetic orthography. The same conclusion can also be reached from studies that assess the development of

pseudoword reading skills in a single orthography. The reported pseudoword reading error rates of English-speaking first-grade children have been high, between 40% and 80% (Jorm, Share, MacLean, & Matthews, 1984; Juel, Griffith, & Gough, 1986; Seymour & Elder, 1986; Treiman, Goswami, & Bruck, 1990). These error rates show that the acquisition of efficient phonological recoding skills in English seems to take more than one year of reading instruction. Corresponding findings with Finnish, Turkish, Italian, Greek, German, Dutch or Portuguese samples, have shown error rates below 25% for first grade children (Coenen, van Bon, & Schreuder, 1997; Cossu, Gugliotta, & Marshall, 1995; Holopainen, Ahonen, & Lyytinen, 2001; Öney & Durgunoğlu, 1997; Pinheiro, 1995; Porpodas, 1989, 1999; Wimmer & Hummer, 1990).

1.2.3 Reading acquisition in highly transparent orthographies

Reading acquisition, and especially the development of phonological recoding skills, seems to be slower in English, than in other, more regular orthographies. While the development of efficient recoding skill takes more than a year in English, in the most regular alphabetic orthographies such as Finnish, Greek, Turkish, and Italian, development seems to be close to ceiling after one year of reading instruction (Cossu et al., 1995; Holopainen et al., 2001; Öney & Durgunoğlu, 1997; Porpodas, 1999). It seems clear that the development of phonological recoding skills takes place *during* the first grade, and at the end of the school year the most interesting phase of reading acquisition has already passed. Therefore the few studies that have followed reading acquisition during the first grade are worthy of closer inspection.

Öney & Durgunoğlu (1997) followed the reading acquisition of a group of Turkish children during the first grade, with assessments in October, February and May. Since both reading and spelling accuracy in word and pseudoword tasks were highly correlated (.92 to .72), they reported combined scores for both reading and spelling. The most striking finding was the rapid growth in word reading and spelling skills: in October, the children's accuracy percentage in a reading task was 26%, in February it had increased to 72%, and in May it had reached the ceiling level, 93%. Correspondingly, spelling accuracy was 20% in October and 92% in May. The high correlations of word recognition and pseudoword reading, and the ceiling level of both the reading and spelling tasks at the end of the school year were interpreted as reflecting the simplicity of the Turkish grapheme-phoneme correspondence system. Cossu (1999) has reported a follow-up of Italian first-graders with assessments of reading and spelling skills in October, January, March, and May. The results showed the steepest development in accuracy between October and January. By January, reading accuracy was already around 80% and spelling accuracy around 60%. In this study, the development of spelling lagged behind reading throughout the first year, and also a small but consistent lexicality effect in favour of words was present. Holopainen et al. (2001) assessed the pseudoword reading accuracy of Finnish first grade children in January and May, and the accuracy percentages were 73% and 88%, respectively.

These studies suggest that reading acquisition in Turkish, Italian, and Finnish proceeds at a completely different rate from what has been reported in irregular orthographies, such as English. It is worthy of note that the development of word recognition, phonological recoding, and spelling seem to go hand in hand in Turkish, which is, like Finnish, completely transparent and symmetrical at the level of single letters. The Italian data showed a lexicality effect, and spelling accuracy seemed to emerge later than reading accuracy. These same differences persisted until the second grade in the study by Cossu et al. (1995). The authors have interpreted this as reflecting the partial structural independence of these skills. Another possibility could be that context-specific grapheme-phoneme correspondences in Italian require more explicit rule-based knowledge in spelling than in reading, since the phonemic context affecting the correspondence is readily visible to a reader.

1.3 Predictors of reading acquisition

The importance of phonological awareness as a central precursor for later developing reading skills is widely accepted. Phonological awareness refers to the child's awareness of sub-lexical segments of speech sounds; the realisation that words can be divided into constituent sound segments. There is a lot of evidence showing that the progress children make in learning to read is critically dependent on their phonological skills (see Goswami & Bryant, 1990; Wagner & Torgesen, 1987, for reviews). In a quantitative meta-analysis of experimental training studies of phonological awareness, Bus and van IJzendoorn (1999) showed that phonological training reliably enhances both phonological and reading skills. They also concluded that gains produced by means of phonological training are more robust and consistent when phonological awareness has been trained together with letter-sound correspondences; claiming that the letters may draw the child's attention to the sounds of spoken words, and as visual symbols, also anchor the phonemes perceptually.

The term "phonological awareness" covers awareness of phonological segments of various size (syllable, onset, rime, and phoneme) and there is still disagreement concerning the role of these units in reading acquisition (Hulme et al., 2002; Goswami, 2002a; Bryant, 2002). However, the awareness of phonemes, the smallest constituents of speech, has largely been considered as the most important phonological sub-skill for learning to read (e.g., Høien, Lundberg, Stanovich, & Bjaalid, 1995; Muter, Hulme, Snowling, & Taylor, 1998; Nation & Hulme, 1997). In addition, the original formulations of the phonological-deficit explanation of dyslexia state that the awareness of the phonemic level of language, in particular, poses special difficulties for conscious access because of co-articulation (e.g., Shankweiler & Liberman, 1976). In a quantitative meta-analysis of controlled experimental training studies, Ehri

et al. (2001) concluded that phonemic awareness training is more effective than alternative forms of instruction with regard to reading and spelling skills. They also noted that phonemic awareness instruction has been shown to be more effective when trained together with letters.

It is easy to understand why access to the phonemic levels of speech is necessary for literacy acquisition and especially for phonological recoding; in alphabetic orthographies, the speech sounds are coded into script at the phonemic level. However, the relationship between phonemic awareness and reading seems to be complex. The findings with adult illiterates seem to suggest that phonemic awareness is more a product than a pre-requisite of alphabetic literacy (Morais, Cary, Alegria, & Bertelson, 1979; Lukatela, Carello, Shankweiler, & Liberman, 1995). This notion is supported by the findings that letter knowledge is highly correlated with phoneme awareness measures (Bowey, 1994; Johnston, Anderson, & Holligan, 1996; Lukatela et al., 1995).

Furthermore, the development of phoneme awareness seems to be more rapid in transparent orthographies than in English. The results from orthographies such as Italian, Turkish, Finnish, Norwegian, Greek and German, show that phonemic awareness is at ceiling level relatively soon after the beginning of reading instruction (Cossu, Shankweiler, Liberman, Katz, & Tola, 1988; Durgunoğlu & Öney, 1999; Holopainen, Ahonen, & Lyytinen, 2002; Høien et al., 1995; Porpodas, 1999; Wimmer, Landerl, Linortner, & Hummer, 1991). In a comparison of phonemic awareness in German and American children, Mann and Wimmer (2002) quite convincingly showed that the level of phonemic awareness depends on literacy experience and literacy development. Their results support the view that phonemic awareness does not develop as a function of spontaneous linguistic restructuring as such, but more as a result of literacy exposure. From the cross-linguistic point of view, especially interesting are the findings that suggest that in more transparent orthographies, phonological or phonemic awareness largely predicts the very early development of phonological recoding skills, and that they do not seem to be very good predictors of reading problems (Holopainen et al., 2001, 2002; de Jong & van der Leij, 1999; Landerl & Wimmer, 2000; Öney & Durgunoğlu, 1997; Poskiparta, Niemi, & Vauras, 1999; Wimmer, 1993; Wimmer et al., 1991). On the basis of these findings, it could be hypothesised that phonological awareness is associated with reading acquisition as long as reliable individual differences in reading accuracy exist. This could explain the somewhat contradictory results between orthographies. Another related factor causing differences might be the varying measures of reading outcome employed. In English studies, pure accuracy measures are often used, whereas in more regular orthographies, the measures usually include reading speed. It is also worthy of note that relatively few prediction studies have paid any attention to children's literacy skills before school entry. This makes the interpretation of the results more complicated; phonological awareness could have been confounded with children's early literacy experience.

There is evidence to show that reading problems in more transparent orthographies are reflected in reading speed, rather than reading accuracy (e.g., Lundberg & Høien, 1990; Porpodas, 1999; Rodrigo & Jimenez, 1999; Wimmer, 1993; Wimmer, Mayringer, & Landerl, 1998; Yap & van der Leij, 1993; Zoccolotti, de Luca, Di Pace, Judica, Orlandi, & Spinelli, 1999). There is also evidence that suggests that the development of reading fluency is associated more with early rapid-naming skills, than with early phonological awareness measures (Holopainen et al., 2002; Wimmer & Mayringer, 2002; Wimmer, Mayringer, & Landerl, 2000). Wolf, Bally, and Morris (1986) were the first to show that early differences in rapid-naming tasks were predictive of reading skills. Later, the predictive role of naming skills has been shown repeatedly, and rapid-naming skills have shown only modest correlations with phonological awareness measures (see Wolf & Bowers, 1999 for a review).

1.4 Aims of the empirical studies

This dissertation set out to assess orthographic differences in reading acquisition, with a specific focus on the development of reading skills in Finnish, which is a highly transparent orthography. Two of the studies were cross-language comparisons of reading acquisition, where the main interest was in the development of the phonological recoding skills of children learning to read in different orthographies. Two studies were follow-ups of the early literacy development of Finnish children.

Study II was a replication and extension of the comparative study by Wimmer and Goswami (1994). The aim was to see whether the original findings of the differences between English and German children can be generalised across other orthographies more regular than English. In Study III, reading acquisition was compared in thirteen different orthographies of varying orthographic depth. The aim was to assess whether orthographic depth already exerts effects from the very beginning of learning to read, with reference to the theoretical model of foundation literacy acquisition developed by Seymour (e.g., 1997, 1999).

Studies I and IV aimed to clarify reading acquisition in Finnish. In Study I, the development of six Finnish non-reading children was followed up for a period of 13 months. The main research questions addressed the relation between emerging phonological abilities and reading skill, and inter-individual variation in the development of these skills. Study IV was an intensive follow-up of Finnish children entering the first grade. The purpose of the study was to clarify the development of literacy skills during the first grade, and especially during the early months of reading instruction. Another goal was to investigate whether language-related skills measured at school entry predict the way literacy skills will develop.

2 OVERVIEW OF THE ORIGINAL STUDIES

The cross-linguistic studies reported in the present work, Study II and Study III, were carried out in the context of the COST A8 ("Learning Disorders as a Barrier to Human Development") network of European researchers. The studies would not have been possible without the collaboration of a number of researchers in the respective countries. Study II was an extension of an earlier comparison study reported by Wimmer & Goswami (1994). The stimulus materials were prepared in each language by the collaborators, who also organised the local data collection and scoring according to the guidelines provided by the authors. The data were aggregated and analysed by the authors. The outline of the design for Study III was created in the COST A8 subgroup for cross-linguistic studies. The design was finalised by the authors, who also coordinated the stimulus preparation and data collection in cooperation with the collaborators in the respective countries. The data were aggregated and analysed by the authors.

2.1 Study I: The development of phonological abilities and their relation to reading acquisition: Case studies of six Finnish children

In this study, the development of six non-readers was followed for a period of 13 months. The main questions addressed in the study concerned the relation between emerging phonological abilities and the basic reading skill, and the degree of inter-individual variation in the development of phonological manipulation skills. The participants were six non-reading Finnish children whose school entry had been postponed because of underdeveloped social skills and immature group-work abilities. Their ages varied between 7 years, and 7 years 9 months at the beginning of the study. The children's phonological abilities were individually assessed every four weeks. Altogether, there were 12

assessments. During the follow-up period the children participated in a training program that targeted phonological, visuomotor, and metacognitive skills.

The measures of phonological abilities included tasks that assessed rhyme detection, syllable deletion, phoneme identification, phoneme deletion, and phoneme synthesis. The reading criterion used was the ability to read three simple nonword syllables.

When investigating the development of phonological skills in relation to the time point of mastering the basic reading skill at group level, it was evident that the children showed rhyme-detection and phoneme-identification skills months before learning to read. Syllable-deletion abilities seemed to develop gradually up to the time point when the children learned to read, whereas phoneme synthesis skill, and especially phoneme deletion skill, showed improvement mainly after reading acquisition. Observation of the individual development of phonological skills revealed considerable inter-individual variation in the development of these skills. The children achieved basic reading ability with varying sets of phonological abilities. Syllable-deletion and phoneme-identification skills seemed to be the phonological subskills that most consistently preceded reading acquisition, even though they did not seem to predict the time-point of learning to read.

It was concluded that the predictive value of phonological abilities was not high at the individual level. On the basis of the findings, it seemed justifiable to ask, whether the tests of phonological manipulation skills measure abilities that are cognitively independent and separate from reading skill, or whether they merely reflect emerging literacy skills, especially in an orthography where single letters are consistently related to corresponding phonemes. It was also hypothesised that in a transparent orthography, phonemic awareness might be more strongly related to letter knowledge, and develop simultaneously.

2.2 Study II: Learning to read: English in comparison to six more regular orthographies

In this study, the method developed by Wimmer and Goswami (1994) was applied to an investigation of the reading skills of German-, English-, Dutch-, Spanish-, French-, Swedish-, and Finnish-speaking children at grades 1-4. The aim was to see whether the original findings of differences between English and German children generalise across other orthographies more regular than English. The total sample consisted of 759 children. The ages of the language groups differed due to variation in school entry age in the participating countries. The English and French children enter school at 5 years of age; Austrian (German), Spanish, and Dutch children at 6 years; and Finnish children (Finnish- and Swedish-speaking samples) at 7 years.

Three list-reading tasks were used: (1) numeral naming, (2) number-word reading, and (3) pseudoword reading. The pseudowords were constructed on

the basis of the number words in each language. The errors in numeral-naming and number-word reading tasks were few. In the pseudoword reading task, the attainment of high accuracy was a much more protracted process for English children than for the children reading more regular orthographies. At the end of the first grade, the pseudoword reading accuracy levels were around 85% for the German-, Dutch-, French-, Spanish-, and Finnish-speaking children and above 90% for Swedish-speaking children. The accuracy level of English children at that point was 50%, and they did not attain the high accuracy shown by first-graders in other orthographies until the fourth grade. The variance in the performance of English children was large. 23% of the whole English sample read less than half of the pseudoword items correctly; only 3 of the 649 children in other orthographies matched this figure. The ratio of pseudoword-reading speed and numeral-naming speed was used as an index of recoding speed. It revealed that Finnish, Swedish and Spanish children were generally the fastest in phonological recoding. The corresponding ratio of number-word reading speed and numeral-naming speed showed that for English, German, Dutch, and Spanish first-graders, the reading of number words took twice the time of numeral naming, whereas the difference was much smaller for Swedish, French, and Finnish children. Between the first and the second grade, there was a rapid progress in number-word reading speed in all orthographies. However, the larger standard deviations of English, German, and Dutch children reflected a more protracted development in the fluency of number-word reading.

The conclusion was that phonological recoding skill was easily acquired in all the alphabetic orthographies involved in the study, with the exception of English. This finding was interpreted to underline the need for a revision of English-based characterisations of reading development, and challenge the notion of phonological recoding skill as a developmental hurdle that is generally difficult to surmount. Apparently, the difficulty of phonological recoding is specific to English with its complex grapheme-phoneme relations. The problem may be further aggravated by instruction methods that do not explicitly introduce children to word recognition via phonemic assembly, and possibly also the young age of the English school children. The observed differences in reading speed were hypothesised to reflect various orthographic factors in addition to orthographic depth.

2.3 Study III: Foundation literacy acquisition in European orthographies

This study sought to extend the previous cross-linguistic comparisons to a wider range of European orthographies, and to determine the stage in reading acquisition at which the effect of orthographic depth becomes evident. The number of orthographies involved was 13 (Finnish, Greek, Italian, Spanish, German, Norwegian, Icelandic, Portuguese, Dutch, Swedish, French, Danish,

and English)¹. The children were assessed close to the end of the first grade. For English, Danish, and French, children from the second grade were also included. The total sample size was 684 children, and the sample sizes of the first-graders varied between 25 and 70 across orthographies. The theoretical context was provided by the foundation literacy framework developed by Seymour (e.g., 1997, 1999). This model proposes that reading is acquired in stages, so that basic foundational components are established in Phase 1, while the complexities of orthographic and morphographic structure are internalised in Phases 2 and 3. The foundation consists of a logographic process involved in the identification and storage of familiar words, and an alphabetic process, which supports sequential decoding. Both of these processes are thought to be dependent on the availability of letter-sound knowledge.

Three types of list reading tasks were used to assess: (1) letter knowledge; (2) very familiar word identification; and (3) pseudoword reading. The constructed pseudowords shared a similar structure across languages.

All groups of children achieved good letter-knowledge (90% or better) during the first school year. The variations observed in letter knowledge, or in the speed of letter identification, were not attributable to language differences. In familiar word reading, the variation between languages was related to orthographic depth. The accuracy of French, Portuguese, and Danish children was reduced in comparison to more regular orthographies. However, the most striking feature was the relative delay of Scottish children, who, at the end of the second grade, still showed clearly poorer familiar word-reading accuracy than children reading more regular orthographies at the end of the first grade. In nonword reading, the effects of orthographic depth paralleled those found for familiar-word reading. Further, the variability in the rate of progress in word and nonword reading was related to orthographic depth; the standard deviations in both accuracy and speed scores were greatly exaggerated, especially in Scottish and Danish, but also in Portuguese and French samples. In pseudoword reading, a smaller effect of syllabic structure was also observed; the children whose languages had simple syllable structures had a small advantage over children with languages with complex syllable structures in both pseudoword reading accuracy and speed. It was also shown that the lexicality effect was smaller in languages with simple syllable structures.

The study demonstrated that the time required to establish foundation literacy varies according to orthographic depth. More especially, English and Danish differed greatly from the other language groups. It was estimated that the rate of foundation literacy acquisition is slower by a ratio of about 2,5 : 1 in English than in most European orthographies. It was suggested that there is an abrupt effect of orthographic depth, that requires a different cognitive architecture for developing reading processes. When the complexity of grapheme-phoneme correspondences is above this threshold, the dual process system (alphabetic and logographic foundation) is involved in literacy

¹ The German-speaking sample consisted of both German and Austrian children. The sample of English-speaking children consisted of Scottish children.

acquisition, whereas in more regular orthographies, an alphabetic foundation is sufficient.

2.4 Study IV: The development of reading and spelling skills, and the predictors of accuracy and fluency: An intensive follow-up in a transparent orthography (Finnish)

This study was an intensive follow-up of Finnish children entering the first grade. The purpose of the study was to investigate the development of literacy skills during the first grade, and especially during the early months of reading instruction. Another goal was to study whether language-related skills measured at school entry predict the way in which literacy skills develop. The participants were 63 children entering the first grade. Their literacy skills were assessed four times during the autumn semester, at five-week intervals. The fifth assessment was carried out at the end of the first grade, in May. At each of these five assessment points, three reading tasks and a spelling task were used; the reading tasks were similar to those used in Study III, and they assessed: (1) letter knowledge, (2) very familiar word identification, and (3) pseudoword reading. In addition to these, letter-writing and pseudoword-spelling tasks were administered. The first assessment at school entry also included an assessment of phonological skills, rapid naming, and morphological skills for those children who did not reach a predefined criterion for being able to read. This sub-sample of non-readers at school entry consisted of 31 children.

On average, the children already knew 16 out of 23 letters at school entry, and over a third of the children read at an accuracy level of 90%. The same level of accuracy in spelling was reached by 17,5% of the children. The variability in literacy skills was large, especially in reading and spelling, where the distributions were practically dichotomous. The development of reading and spelling accuracy was fast, and individual development was characterised by rapid leaps between successive assessment points. At the end of the school year, the children's accuracy was at ceiling level in all tasks. Until the end of the first grade, the correlation between word and pseudoword reading performance remained high, indicating the use of similar processes in both tasks. To examine the development of literacy skills, the relation between the development of reading and spelling accuracy, and their association with reading speed at the end of the grade, the accuracy scores were subjected to a latent growth curve analysis with categorical variables. The analysis revealed that in the development of reading and spelling accuracy, there was variation only in the initial level of accuracy (intercept), and not in the type of development (slope). The levels of accuracy in reading and spelling were very highly correlated (.995), showing that the development of these skills is concurrent. The developmental rate of accuracy had only a modest association with reading speed outcome.

The best predictors at school entry for the development of accuracy in reading and spelling were letter knowledge, phoneme identification, and pseudoword repetition. No school entry language measures had clear associations with reading speed at the end of the school year.

The findings give strong support for the orthographic depth hypothesis of reading acquisition. In phonological recoding, the Finnish first-graders reached the accuracy level of Scottish second-graders (reported in Study III) after ten weeks of reading instruction. The concurrent development of early reading and spelling skills is thought to reflect the symmetrical, bidirectional regularity of the Finnish orthography. The lack of dissociation between word and pseudoword reading supported the notion that similar alphabetic and serial strategies are used in early reading in Finnish, irrespective of the reading materials.

3 GENERAL DISCUSSION

3.1 Reading acquisition and orthographic depth

The main question addressed in this dissertation was, whether there are differences in reading acquisition between children trying to break the orthographic code in different languages. The answer to this question is definitely affirmative. In Study II, the English-speaking children struggled with the acquisition of phonological recoding skill, whereas the French-, German-, Dutch-, Spanish-, Swedish-, and Finnish-speaking children seemed to acquire the skill with little difficulty. At the end of the first grade, the reading accuracy in the above-mentioned more regular orthographies was generally between 85% and 93%, with little room for further improvement in the pseudoword reading task that was administered. The exception was English, where the children reached the same high accuracy level only at fourth grade. The English children were also consistently slowest in pseudoword reading until the fourth grade. Study III demonstrated similar differences in the early reading skills. The acquisition of elementary word-recognition skills, as well as phonological recoding skills, occurred more slowly in Portuguese, French, and Danish, than in the majority of the languages, and the delay was greatly exaggerated in English. On the basis of the Scottish findings, it could be estimated that the readers of English require over 2,5 years to achieve the level that was achieved within the first year of reading instruction in the majority of European orthographies involved. In Study II, the English-speaking children approached a 90% accuracy level in phonological recoding three years later than children in other orthographies. Generally, the results showed an effect of orthographic depth in both familiar word recognition and phonological recoding tasks, and a smaller effect of syllable complexity in phonological recoding.

It is especially remarkable that, in Study III, the effect of orthographic depth was present in simple pseudoword reading tasks where the assembly with basic letter sounds would suffice, and without any complex graphemes or contextual effects to be taken into account before accessing pronunciation.

Similarly, the effect of the syllabic complexity of the orthography was present in materials with no consonant clusters. Accordingly, in Study II, the responses of English children were scored in an especially lenient manner: any grapheme-phoneme translation that occurred in real words was accepted. Thus, the observed orthographic effects upon early literacy cannot be interpreted as by-products of the variation between task requirements in different languages.

These findings give strong support to the notion of qualitative differences between transparent and opaque orthographies in the process of reading acquisition. With reference to the foundation literacy model presented by Seymour (1997, 1999), it can be suggested that literacy acquisition in transparent orthographies is based on a single process of alphabetic assembly. Further, the empirical support for a logographic stage in reading acquisition is vague in transparent orthographies (e.g., Wimmer & Hummer, 1990). In a transparent orthography, the knowledge of grapheme-phoneme correspondences and phonemic assembly are effective and sufficient tools for decoding any kind of word. Thus, the child is prepared for efficient "self-teaching" (see Share, 1995) and the fast build-up of an orthographic word lexicon from the very early stages of literacy acquisition. In opaque orthographies, the development of alphabetic processing skills is hampered by complex grapheme-phoneme correspondences. Furthermore, the child encounters common words that require the knowledge of complex graphemes, contextual effects upon pronunciation, and irregularities. Therefore, separate logographic processing skills and word-specific knowledge is required from an early stage. The early literacy development has to be based on two separate processing skills instead of one, which compromises the developmental rate of basic literacy skills.

In cross-linguistic comparisons, the interpretation of the results is complicated by a number of confounding factors that are often impossible to control. The age of school entry, and the methods of reading instruction employed vary between countries. There are also a number of cultural and social factors that might exert their effect upon the results. However, as was shown in Study III, the overall correlations between age and reading performance were weak or non-significant. No doubt, it is safe to say that the young age of British school entrants does not exactly help in the task of acquiring phonological recoding skills, but it can nonetheless be concluded that the observed effects of orthographic depth are not due to age differences.

Another factor that is often inextricable from the effects of orthography in cross-linguistic studies is the variation in reading-instruction methods. In transparent orthographies, reading instruction is typically based on phonics, as it is in Finland. In opaque orthographies, such as English, early reading instruction is usually a mixture of phonics and whole-word methods. The claim that the observed differences in reading acquisition are due to differences in reading instruction methods, would, of course, offer a relatively easy solution for the problems of slow reading acquisition in English. Actually, there is evidence to suggest that phonics teaching is beneficial for the development of phonological recoding skills in English (for a review see Snowling, 1996).

However, Landerl (2000) showed that English-speaking children who had received consistent phonics instruction, were nonetheless outperformed by German children in phonological recoding, although they performed better than children receiving standard instruction in English. The most plausible conclusion is that orthographic depth and reading-instruction methods are naturally linked. When the orthography allows systematic rule-based teaching of grapheme-phoneme correspondences, that is also the natural choice for a reading-instruction method. Correspondingly, in less transparent orthographies, more whole-word oriented teaching methods are required, since explicit teaching of grapheme-phoneme correspondence rules is difficult.

A third factor that might have an effect upon the observed cross-linguistic differences relates to cultural and social differences between countries, and correspondingly, orthographies. In some countries, the kindergarten programs explicitly discourage any school-related activities such as the teaching of letters, whereas in other countries, the teaching of letters, and print exposure are an essential part of kindergarten activities. It is also possible that the literacy related activities in families vary between countries as a function of, for example, the quality of the library system or the extent of newspaper circulation. Again, the socio-economic differences between countries, and the variability of socio-economic status (SES) within each country might have an effect upon literacy acquisition. Duncan and Seymour (2000) have shown that SES has an effect upon foundation literacy acquisition in Scotland. The effect of cultural and social differences on reading acquisition can be truly controlled only in multilingual countries where reading acquisition can be assessed in different orthographic contexts, but within the same educational system and culture. Two Welsh studies fit these criteria (Ellis & Hooper, 2001; Spencer & Hanley, 2003). Both studies showed consistently that children learning to read Welsh, which is a relatively transparent orthography, acquired reading skills at a faster rate than their English-speaking peers.

In summary, it seems highly unlikely that the observed cross-linguistic differences would be caused by factors unrelated to orthographic depth. The findings of Study II and Study III are consistent with the previous comparisons of English and other orthographies. It is interesting to note that the actual outlier in both studies was English (and to a lesser extent Danish in Study III), and that the differences between the other orthographies were relatively small. This might seem counterintuitive if one considers orthographic depth as a continuum. There are at least two possible explanations for the lack of clear differences between more transparent orthographies. One is that the effect of orthographic depth is abrupt rather than graded. Thus, there is a threshold of orthographic depth, above which the phonemic assembly becomes unreliable, and compensating processes are required. From the point of view of beginning reading, it seems probable that this threshold is not related to the number of inconsistent spellings in a language as such, but to the number of explicit grapheme-phoneme rules that enable the assembly of the pronunciation. Another reason for the lack of differences between transparent orthographies

can be methodological. One could hypothesise that more demanding reading materials could elicit more subtle differences. After all, in both Study II and Study III, the reading accuracy was close to ceiling in most orthographies, and in both studies, the reading materials included only relatively simple word and pseudoword items. However, since the specific complexities of the orthographies vary greatly, the creation of a comparable set of more demanding items across languages is a challenging task, and requires more knowledge of the specific bottlenecks of reading development in different orthographies.

3.2 Reading acquisition in Finnish

In Study IV, one-third of the Finnish children performed in reading tasks at the accuracy level of 90% at school entry, that is, before the start of formal reading instruction. Since the methods used in Study IV allow direct comparison with the results of Study III, it is interesting to see how the performance of Finnish children at the beginning of reading instruction compared with the performance of English-speaking children at the end of first and second grade. On average, Finnish children read pseudowords at school entry more accurately than the English-speaking children at the end of the first grade. Furthermore, they needed only 10 weeks of reading instruction to surpass the pseudoword reading accuracy level of English-speaking children at the end of the second grade. This difference in the development of pseudoword reading skill shows convincingly that the task of phonological recoding is an easy one in Finnish, and that children do not seem to need much support in gaining an insight into the Finnish orthographic cipher.

Although the difference is striking, it is not unexpected from the point of view of the orthographic depth hypothesis. It is worth pointing out how closely the findings concerning the development of Finnish first-graders resembled the findings from the follow-ups of other transparent orthographies, especially Turkish (Öney & Durgunoğlu, 1997). The observed similarities of literacy development seem to parallel with the similarities of the orthographies: the Turkish orthography has regular bi-directional correspondences between phonemes and single letters (Raman & Baluch, 2001), similarly to Finnish. In both Finnish and Turkish, literacy acquisition was rapid, and many children entered school with reading skills. There was no dissociation between word and pseudoword reading as was revealed by the high correlations between these measures, and the development of spelling skills was concurrent with the development of reading. The findings concerning spelling and reading skills are especially interesting. Many transparent orthographies are less transparent in the direction of sound-to-spelling and, for accurate spelling, knowledge of phoneme-grapheme correspondences does not suffice: the child requires specific knowledge of orthographic word forms. This orthographic lexicon is built up with reading experience, so accurate spelling is supposed to follow

accurate reading. In Finnish and Turkish, a reverse phonological route should be sufficient for accurate spelling because of the bi-directional consistency of grapheme-phoneme correspondences. The effect of orthography on literacy has mostly been studied using reading tasks, and the aforementioned hypothesis concerning the dissociation of spelling and reading development as a function of asymmetrical transparency has yet to be studied. However, the current findings suggest that in an orthography where the grapheme-phoneme correspondences are bi-directionally consistent, spelling and reading develop concurrently.

Although the development of literacy skills seemed stable in Study IV, individual development was characterised by rapid leaps. From the inspection of individual growth curves, one could conclude that reading acquisition is an off/on event: in a relatively short period of time, the non-readers seemed to gain an insight into reading, and became readers. The distributions of the accuracy scores were practically dichotomous, as long as there were individual differences in reading accuracy. These findings, as well as the large inter-individual variation shown in Study I, underline the problems of interpreting group-level findings without taking into account the individual development.

Study I addressed the question of the relation between phonological skills and emerging reading skills. It showed that phonological skills have a limited predictive value in terms of how early the child will learn to read. The six children acquired a very basic phonological recoding ability with varying sets of phonological skills. Many skills showed improvement shortly before the child could be classified as a reader, or only thereafter. The two skills that most consistently preceded reading ability were syllable deletion and phoneme identification. In summary, the connection between phonological skills and reading ability was uncertain, with a lot of inter-individual, as well as intra-individual variation evident during the follow-up. The difficulty of making causal inferences relating to phonological awareness and literacy skills was underlined by the fact that five out of six children consistently gave letter-name responses in the phoneme identification task.

In Study IV, the development in reading and spelling accuracy was best predicted by letter knowledge at school entry. Of the phonological measures, the phoneme-identification and pseudoword-repetition tasks had a small but significant association with the development of accuracy. This is in accordance with a multitude of previous findings. Although the school entry measures had predictive value with regard to the rate of development of pseudoword reading and spelling accuracy, the variation they predicted was somewhat irrelevant, since at the end of the first grade, practically all children had learned basic phonological recoding skills. It is perhaps more interesting that no school entry measures were reliably associated with reading fluency, where there was large individual variation at the end of the school year. This is in contradiction with the findings of Holopainen et al. (2002) which showed that the only preschool measure reliably associated with reading performance at grade four was rapid-naming speed. However, it could be speculated that at the end of the first

grade, the measured fluency in reading is still burdened by the early instructional emphasis on reading accuracy. This effect might be amplified by the use of list completion times as a speed measure in Study IV. In list reading, a strategy emphasising accuracy would be reflected in careful checking of the response before moving on to the next. Measurements of reaction and production times in single-word recognition would possibly give a more reliable measure of the speed of word recognition at that point of reading development. It is also possible that the relevant variation in reading speed can be reached only later, when the basic skills have become more automatised for most children. However, the results underline the fact that reading accuracy, as such, is not a sufficient measure of reading proficiency. Most research has focused on reading accuracy, probably because the achievement of accurate recoding skills is a major hurdle to reading development in English-speaking countries. Slow reading speed as a phenotype of dyslexia is mostly reported in studies concerning learning problems in transparent orthographies. However, it would not be safe to conclude that fluency is not a problem in opaque orthographies such as English. This bias might be related to different diagnostic procedures: English tests of reading skills are often graded word-recognition tests where fluency is not measured, whereas reading speed is usually a factor in reading tests in languages with more transparent orthographies. It is also worthwhile to note that Lovett (1987), for example, has proposed an English-based subtype model of dyslexia, which describes problems in terms of either accuracy or fluency. One interesting question for further studies concerns the nature of the rapid and fluent word-recognition skills in a transparent orthography such as Finnish. It is yet to be determined whether fluent reading is based on lexical processes, or on the assembly of larger sublexical units such as morphemes or syllables, or whether fluent reading is based on the automatised of phonological recoding skills, still at the level of single graphemes.

It should be kept in mind that the conclusions above, concerning the role of predictive skills, are based on relatively small samples of children. In Study I, the aim was specifically to investigate the individual differences in the relationship between phonological skills and emerging reading skills. In Study IV, the sample was small because children reading at school entry were excluded from the school-entry assessment of language skills. The results should therefore be interpreted with caution. More conclusive answers concerning the nature of the relation between phonological development and emerging reading skill would also require earlier assessment of phonological skills, since at school entry, children in Finland already have a lot of experience of written language, and they also have close to perfect letter knowledge. Furthermore, the current concepts and measures of phonological awareness are problematic, since phonological awareness has been shown to have at least a reciprocal relationship with literacy experience and literacy instruction. In a transparent orthography, phonological tasks can be easily solved with the help of orthographic knowledge. It could be speculated that the true phonological

prerequisites of reading skills lie somewhere under phonological awareness, phonological memory, and naming, which are the current primary candidates for a language-related core-deficit of developmental dyslexia. The notion of an underlying deficit at the level of phonological representations seems promising in terms of accounting for the various findings relating to both normal development of reading acquisition, and reading disorders across orthographies (see Goswami, 2002b). Any attempt to answer the question is, however, beyond the scope of this thesis. A more conclusive answer is awaited from longitudinal studies of dyslexia-risk children.

4 CONCLUSIONS

The findings of this dissertation should not be interpreted as undermining the role of phonological skills in literacy acquisition. Quite the reverse: the development of early literacy skills in a transparent orthography seems to be completely dependent on the phonological apparatus of the beginning reader. However, it can be concluded that a transparent orthography treats even a phonologically immature reader in a lenient manner. It helps in explicating the alphabetic principle, the correspondence between spoken and written language, since the grapheme-phoneme correspondences are regular at the level of single letters. It does not burden the beginning reader with a plethora of correspondence rules; and together with a systematic phonics teaching it provides the beginning reader with a simple tool for successful word recognition, without the frustrations caused by contextual effects and irregularities. However, this does not necessarily mean that a child with reading problems in a transparent orthography fares well in comparison to a child struggling with larger overt reading problems in a less transparent orthography. The rate and content of instruction is usually based on the average performance of the group. The ease with which an average child acquires literacy is also a challenge for the teachers: very early reading instruction has to be adjusted to a wide range of individual skills and a wide range of individual needs.

To create a universal understanding of reading acquisition and developmental reading deficits, we need more research into individual orthographies. This notion may seem contradictory, but the current evidence shows that many aspects of reading development, and also failure in reading acquisition, are actually dependent on the specific orthographic context. Thus far, the orthographic context studied has most often been English. Only by gaining more insight into the differences between orthographies can we reach the universal features of reading acquisition across alphabetic orthographies. Therefore, studies that reveal the orthographic complexities affecting reading development in specific orthographic contexts are valuable. Especially important would be studies comparing the phenotype of dyslexia in different orthographies. Currently, such attempts are very few in number.

Finally, on the basis of the accumulating evidence concerning the differences in reading acquisition and also in reading problems between English and more transparent orthographies, one should keep in mind the warning given by Wimmer and Landerl (1997):

"... the researchers and teachers working within consistent orthographies are well advised not to base their theories and instructional choices solely on English findings."

TIIVISTELMÄ

Tässä tutkimuksessa tarkasteltiin kielen kirjoitusjärjestelmän yhteyttä lukemaan oppimiseen. Kahdessa osatutkimuksessa vertailtiin lukutaidon alkeiden kehittymistä eurooppalaisissa kielissä, ja kahdessa osatutkimuksessa puolestaan tarkasteltiin lukutaidon alkeiden kehittymistä suomenkielillä lapsilla.

Aakkosellisissa kirjoitusjärjestelmissä on yhteisenä periaatteena, että puhutun kielen foneemit (äänteet) merkitään kirjoitukseen grafeemeilla (kirjainmerkeillä tai kirjainmerkkien yhdistelmillä). Monien kielten kirjoitusjärjestelmää ovat muokanneet kuitenkin myös muut periaatteet, jotka vaikuttavat sanojen kirjoitusasuun. Kirjoitusjärjestelmässä voidaan pyrkiä säilyttämään lainasanan alkuperäiskielestä periytyvä kirjoitusasu, tai siinä voidaan pyrkiä säilyttämään sanan morfeemit (merkitysyksiköt) kirjoitusasultaan samanlaisina, vaikka sanan ääntämys eri rakenteissa vaihtelisikin. Nämä tekijät toimivat yleensä äänteellisen merkitsemisen periaatetta vastaan. Niinpä aakkosellisissa kirjoitusjärjestelmissä on suuria eroja sen suhteen, kuinka yksiselitteisiä ja johdonmukaisia grafeemi-foneemi (G-F) -vastaavuudet ovat. Epäsäännönmukaisissa kirjoitusjärjestelmissä puhutun kielen foneemi voidaan merkitä tekstiyhteydestä riippuen usealla eri grafeemilla, ja kirjoitetun kielen grafeemi voi puolestaan vastata useita erilaisia puhekielen foneemeja. Englannin kielen kirjoitusjärjestelmä on yksi kaikkein epäsäännönmukaisimmista aakkosellisista kirjoitusjärjestelmistä. Vastaavasti säännönmukaisissa kirjoitusjärjestelmissä G-F -yhteydet ovat selkeitä ja johdonmukaisia. Tällainen kirjoitusjärjestelmä on suomen kielessä, jossa 24 äännettä vastaa kontekstista riippumatta sama grafeemi. Yhtä poikkeusta (äng-äänne) lukuunottamatta tuo vastaavuus on täydellinen vieläpä yksittäisten kirjainmerkkien tasolla. Viime vuosina kertynyt tieto on antanut yhä selvempiä viitteitä siitä, että näillä kirjoitusjärjestelmän piirteillä on yhteys lukutaidon kehittymiseen.

Toisessa osatutkimuksessa tutkittiin lasten lukutaitoa seitsemässä eri kielessä (suomi, espanja, saksa, hollanti, ruotsi, ranska ja englantia) luokilla 1–4. Tehtävinä käytettiin numeroiden nimeämisen, numerosanojen lukemisen ja numerosanoista rakennettujen epäsanon lukemisen tehtäviä. Englantilaisia lapsia lukuun ottamatta lapset lukivat epäsanonja 85–93% tarkkuudella jo ensimmäisen kouluvuoden jälkeen. Englantilaiset lapset saavuttivat saman lukemistarkkuuden vasta neljäntenä kouluvuonna. Lukemistarkkuudessa erot muiden kielten välillä olivat pieniä, mutta lukemisen nopeudessa havaittujen erojen tulkittiin heijastavan kirjain-äänne -vastaavuuksien säännönmukaisuuden erojen lisäksi myös muita kirjoitusjärjestelmien eroja. Tulosten tulkittiin osoittavan, että fonologisen rekoodauksen taidon – kokoavan, sarjallisen lukutaidon – kehittyminen on erityisen haastavaa englanninkielessä, kun taas muissa kielissä lapset saavuttavat taidon suhteellisen nopeasti.

Kolmannessa osatutkimuksessa tutkittiin lasten lukutaitoa ensimmäisen kouluvuoden lopussa kaikkiaan 13 eri kielessä (suomi, kreikka, italia, espanja, saksa, norja, islanti, portugali, hollanti, ruotsi, ranska, tanska ja englantia).

Suurimmassa osassa tutkituista kielistä lapset olivat tarkkoja ja sujuvia tehtävissä, jotka mittasivat kirjainten tuntemista sekä tuttujen sanojen ja yksinkertaisten epäsanojen lukemista. Selkeästi heikoimpia lukemistehtävissä ensimmäisen kouluvuoden jälkeen olivat englanninkieliset lapset. Vielä kahden kouluvuoden jälkeen he olivat selvästi heikompia lukijoita kuin lapset useimmissa muissa kielissä yhden kouluvuoden jälkeen. Myös tanskan-, portugalini-, ja ranskankielisillä lapsilla sanojen tunnistamisen ja epäsanojen lukemisen taidot olivat ensimmäisen kouluvuoden jälkeen heikompia kuin muissa tutkituissa kielissä. Tulokset vahvistivat oletuksen kirjoitusjärjestelmän erojen, erityisesti kirjain-äänne -vastaavuuksien säännönmukaisuuden, vaikutuksesta lukutaidon kehittymiseen jo hyvin varhaisessa vaiheessa. Tulosten perusteella esitettiin oletus, että peruslukutaidon kehittyminen säännönmukaisissa kirjoitusjärjestelmissä perustuu äänteellisen, sarjallisen lukemisprosessin hallintaan, kun taas epäsäännönmukaisissa kirjoitusjärjestelmissä peruslukutaidon kehittyminen edellyttää sekä äänteellisen että tunnistavan lukemisprosessin hallintaa.

Ensimmäisessä osatutkimuksessa seurattiin 13 kuukauden ajan kuuden suomalaisen lapsen lukutaidon kehittymistä suhteessa kuukausittain mitattuihin fonologisiin taitoihin. Tulokset osoittivat, että fonologisten taitojen suhde kehittyvään lukutaitoon ei yksilötasolla tarkasteltuna ole selkeä. Fonologisista tehtävistä tavun poistaminen sanasta ja sanan alkuäänteen tunnistaminen kehittyivät johdonmukaisimmin ennen lukutaidon oppimista. Fonologisten taitojen kehittyminen ja kehityksen yhteys lukutaitoon vaihteli kuitenkin yksilöiden välillä paljon. Yksilötasolla tarkasteltuna fonologisten taitojen hallinta ennusti lukutaidon oppimisen ajankohtaa heikosti.

Neljännessä osatutkimuksessa seurattiin 63 suomalaisen lapsen lukutaidon kehittymistä ensimmäisen luokan aikana. Syyslukukaudella kehitystä seurattiin viiden viikon välein kaikkiaan neljästi ja viides seurantakerta oli kevätlukukauden lopussa. Kolmannes lapsista osasi lukea jo kouluun tullessaan. Ei-lukijoiden lukutaidon kehitys oli nopeaa ja yksilötasolla harppauksenomaista. Lukemisen ja kirjoittamisen tarkkuuden kehitykseen sovitettu kasvukäyrämalli osoitti, että lasten taitojen kehityskuluissa ei ollut eroja, vaikka lasten välillä oli tasoeroja. Lukemisen tarkkuus korreloi voimakkaasti kirjoittamisen tarkkuuteen, mikä heijasti näiden taitojen yhtenevää varhaista kehitystä. Sanojen ja epäsanojen lukemisen tarkkuuden voimakas korrelaatio osoitti leksikaalisuuden merkityksen olevan lukemisen alkuvaiheessa pientä. Koulun alussa ei-lukijoilta mitattu kirjaintuntemus oli paras lukemisen ja kirjoittamisen tarkkuuden kehityksen ennustaja. Alkuäänteen tunnistamisen ja epäsanojen toistamisen taidot olivat myös yhteydessä tarkkuuden kehitykseen. Yksikään kouluvuoden alussa käytetyistä kielellisten taitojen mittareista ei ollut selkeässä yhteydessä kouluvuoden lopussa mitattuun lukemisen nopeuteen.

Lukutaidon kehitys on yhteydessä opittavan kielen kirjoitusjärjestelmään. Lähinnä englanninkielen oppimiseen perustuvia malleja lukutaidon oppimisesta ei ole syytä soveltaa sellaisenaan muihin kirjoitusjärjestelmiin. Kielispesifien piirteiden tarkempi erottaminen lukutaidon oppimisen yleisistä piirteistä on tärkeää myös lukivaikeuksien paremmaksi ymmärtämiseksi.

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