

Ann-Christina Kjeldsen

The Nordic Model: Language games promoting literacy skills-

A 10 year phonological intervention follow-up from kindergarten to grade 9





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*To all children
To my beloved ones,
Emmet, Johan, and Ulrika*

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The Bornholm intervention study, which has now become a classic study in the field of reading research with over 2000 citations according to Google Scholar (retrieved 250418) and 634 citations according to the Web of Science (retrieved 250418), was carried out by the Swedish professor Ingvar Lundberg and his colleagues. Ingvar Lundberg's pioneering research was a spearhead and set the standard for all professionals with a pedagogic responsibility for children's literacy development. Starting his career as a public-school teacher in his home town Stockholm and continuing with life-long extensive research in language and reading development, Ingvar Lundberg was highly respected throughout Scandinavia as well as internationally. He never abandoned his first pedagogical challenge: the good development of every child in which the spoken and written language is the foremost tool of being a member of society. He was a source of inspiration, a role model and a guide to many, also to me. With gratitude I dedicate this thesis to him, Ingvar Lundberg, Honorary Doctor of Åbo Akademi University.

The starting point of the present Åland intervention study dates back some 20 years when kindergarten teachers in 'the Bornholm model project' in Åland challenged me to evaluate the intervention effects of the Bornholm language games in their kindergartens. I realized that this was not possible without involving interested and skillful researchers in the field, and I was fortunate to meet the best ones in all aspects.

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LIST OF ORIGINAL PUBLICATIONS

- I: Kjeldsen, A-C., Niemi, P., & Olofsson, Å. (2003). Training phonological awareness in kindergarten level children: consistency is more important than quantity. *Learning and Instruction*, 13(4), 349-365.doi:10.1016/S0959-4752(02)00009-9

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- II: Kjeldsen A-C., Kärnä, A., Niemi P., Olofsson, Å., & Witting, K. (2014). Gains from training in phonological awareness in kindergarten predict reading comprehension in grade 9. *Scientific Studies of Reading*, 18(6), 452-467.doi:10.1080/10888438.2014.940080

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- III: Kjeldsen, A-C., Saarento, S., & Niemi, P. (2019). Kindergarten training in phonological awareness: fluency and comprehension gains are largest for readers-at-risk through grades 1 to 9. *Journal of Learning Disabilities* 1-17, (in press).doi:10.1177/0022219419419847154

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AUTHOR'S CONTRIBUTION

Study I: The author initiated and conceived the intervention project from kindergarten to grade 2. The author planned and organized the data collection at each wave. The author had the main responsibility in cooperation with the other authors in writing the manuscript.

Study II: The author planned and organized the subsequent assessments and data collection until grade 9. The author had the main responsibility for data collection and writing the manuscript with the co-authors.

Study III: The author planned and organized the subsequent assessments and data collection until grade 9. The author had the main responsibility for writing the manuscript with the co-authors.

ABBREVIATIONS

DDP = Dutch Dyslexia Programme Study

ELINET = European Literacy Policy Network

ECE = Early Childhood Education

ECES = Early Childhood Education Study

IEA = International Association for the Evaluation of Educational Achievement

ILTS = International Longitudinal Twin Study

OECD = Organisation for Economic Co-operation and Development

PIRLS = Progress in International Reading Literacy Study

PISA = Programme for International Student Assessment

ÅSUB=Ålands statistik- och utredningsbyrå

SAMMANFATTNING

Den nordiska modellen: Systematisk språklek och tidig läs- och skrivutveckling- en 10-årig fonologisk interventionsstudie från förskola till och med årskurs 9

Ann-Christina Kjeldsen

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Eftersom knäckandet av den alfabetiska koden inte sker på samma sätt hos alla barn är tidiga pedagogiska interventioner viktiga. Internationell forskning inspirerad av Ingvar Lundbergs och hans kollegers banbrytande forskning (Lundberg, Frost & Petersen, 1988) på den danska ön Bornholm har fokuserat på dessa frågor. Lundbergs fonologiska förskole-intervention visade sig vara effektiv genom att kunna avlägsna en avsevärd del av den skillnad i läsförmåga som vanligtvis visar sig mellan normalläsande barn och barn med lässvårigheter. De danska fonologiska språklekarna modifierades till svenska och gick därefter under namnet Bornholms-modellen. I den föreliggande studien genomfördes denna modell i daghem och i skolor i landskapet Åland.

Det första syftet med den aktuella studien var att undersöka effekten av två olika träningsdoser, en dos på 100% och en dos på 60%. Det andra syftet var att undersöka långsiktiga träningseffekter på ordavkodning och läsförståelse från årskurs 1 till och med årskurs 9. Slutligen var det tredje syftet att undersöka läsutvecklingen hos tränade och icke-tränade barn med risk för läs- och skrivsvårigheter.

Träningsprogrammet följde den ursprungliga danska interventionen (Lundberg et al., 1988). Det bestod av metalingvistiska lekar och övningar som genomfördes med 6-åriga barn i daghemmens förundervisning i 15–20 minuter dagligen under ett helt år och två månader i början av det första skolåret. Träningsprogrammet följde en hierarkisk struktur. Totalt 209 barn, som utgjorde två tredjedelar av en ålderskohort på Åland, testades i specifika och allmänna språkfärdigheter i början och i slutet av det sista året på daghem före skolstarten vid 7 års ålder. Efter det testades barnens läs- och skrivförmåga sex

gångar totalt genom grundskolan till och med årskurs 9, då ännu 191 av de ursprungliga 209 elever deltog i studien.

Den föreliggande studien upprepade resultaten, som uppvisats av Lundberg m.fl. (1988) även för den förkortade träningsversionen med 60% av det ursprungliga språkleksprogrammet. Både normalläsande elever samt elever som i förskoleåldern bedömts med risk för läs- och skrivsvårigheter drog nytta av daghemsinterventionen. I ögonfallande var att efter åk 1, var andelen barn med lässvårigheter hälften mindre bland de tränade barnen jämfört med de icke-tränade barnen. Interventionen hade effekt på ordavkodning till och med årskurs 6, samt på läsförståelsen till och med årskurs 9. Resultaten diskuteras utgående från metakognitiva insikter i läsning som blivit stimulerade genom systematisk fonologisk träning i förskolan.

Det är av största vikt att ansvariga inom skolväsendet garanterar en kontinuerlig och evidensbaserad pedagogik genom nationella, distriktsvisa och lokala läroplaner för att tillhandahålla de bästa tänkbara inlärningsmiljöerna. Då samverkan fungerar mellan läsforskare, skoladministratörer, skolledare, och slutligen lärare som på alla stadier arbetar direkt med barnen, kommer detta att från tidiga år befrämja deras läs- och skrivutveckling. Den bästa framtida investeringen är en välfungerande undervisning, där läsning och skrivning är tydligt och starkt målbestämda.

ABSTRACT

Because cracking the alphabetic code will not occur in the same way for all children, sufficiently early pedagogic interventions are of vital importance. International research inspired by the groundbreaking study of Ingvar Lundberg and his colleagues (Lundberg, Frost & Petersen, 1988) on the Danish Island of Bornholm has focused on these issues. Lundberg's phonological kindergarten intervention proved effective, removing a considerable part of the gap in reading skills which usually emerge in the early grades between normally advancing and struggling readers. The Danish model was modified into Swedish phonological language games, the so-called Bornholm Model, and was, in the present study, carried out in kindergartens and schools on the Åland Islands, an autonomous archipelago district between Finland and Sweden.

The first aim of the present thesis was to study the effect of the intervention with two different training doses of 100% and 60%. The second aim was to examine the long-term training gains in word reading and reading comprehension through grades 1 to 9. Finally, the third aim was to examine the reading development of trained and untrained children-at-risk for reading difficulties. The training program followed the original Danish Bornholm model (Lundberg et al., 1988) and consisted of metalinguistic games and practices, which were given in 15-20 minutes daily sessions during the last year in kindergarten to 6-year old children and continuing during the first two months in the beginning of grade 1. The program advanced in a hierarchic and structured manner. Altogether 209 students, comprising two thirds of an annual age cohort on Åland Islands, were assessed in specific and general language skills at the beginning and at the end of the last year in kindergarten before the school start at age 7. After this their reading and spelling skills were assessed six times through compulsory school until grade 9, when 191 students were still participating in the study. In the present thesis, it was shown that the gains of phonological kindergarten training on subsequent reading skills, can be obtained both with a 100% and 60% training dose. Both mainstream readers and readers-at-risk for reading difficulties benefitted from the kindergarten training. It was also shown that the intervention had an effect on decoding through grade 6 and on reading comprehension through grade 9, albeit quite small effects. Regarding readers-at-risk there were approximately half the amount in the trained condition compared to the control condition from grade 1 based on the results in decoding in grade 1 and reading comprehension through the grades 6

and 9. It was shown that the initial level of training gains in phonological awareness and word decoding at the end of kindergarten and in grade 1 kept its position throughout the school grades. The results are discussed in terms of metacognitive insights into reading that are stimulated through strictly systematic kindergarten training in phonological awareness.

It is of vital importance that responsible individuals in the school systems secure a continuous, evidence-based and good-practice pedagogy for the best learning environments through national, district and local school curricula. Subsequently, when a co-operating networking is in place between reading researchers, school administrators, principals and finally teachers at all levels who work directly with children, this will promote children's literacy achievement from the early years on. The best investment for the future is well functioning education system, where reading and spelling is vigorously targeted.

1 INTRODUCTION

One of the most important issues for every teacher is developing and stimulating their pupils' literacy skills. This is a school-long-task covering all grades and subjects. Primary school teachers are in the front line when they set the stage for the crucial and magical moment of young pupils' reading debut. Teachers of all subjects and grades know their foremost task is stimulating students' oral and written language competence. Special teachers do their best to find methods of overcoming the increasing gap for those struggling and failing with reading and spelling acquisition.

This was also my daily challenge as special education teacher over many years. I met too many pupils, most often boys in their upper teens, who had lost all interest in school studies. The real cause was not laziness, a lack of capacity or other similar reasons but the fact that they were not able to read properly; obviously, it was this reading disability that caused most of their difficulties in school. This was both a shock and a new insight for me and I realized that something crucial had to be done much earlier in school grades or perhaps even before school entry. Then one day I accidentally read an article about the Nordic Bornholm model – an evidence-based kindergarten intervention to prevent later reading difficulties in school. That article led to a plan to start implementing the Bornholm model in kindergartens belonging to my school district. It would be worthwhile – I then thought - if it could save even one child from reading failure at school.

The school is part of society. The demands of literacy required by society will also become the demands of the school. These literacy demands are variable over time and the consequences for poor readers not coping with them will be devastating both from an individual as well as a socio-economic perspective. Since the 1980s, much effort has been put into literacy research, covering a wide range of theories and methods aimed to prevent reading and spelling difficulties and improve the individual's literacy skills. Nevertheless, the mission is incomplete so far. Joining this international effort, an intervention of training phonological awareness among kindergarten children was carried out in the Åland Islands, an autonomous Swedish-speaking archipelago region in south-western of Finland. My first plan was only to implement the Danish evidence-based Bornholm kindergarten intervention (Lundberg, Frost, & Petersen, 1988), with the purpose of preventing reading and spelling difficulties. However, the motivation and commitment of all the teachers working with the phonological

language games made them eager to know the possible subsequent effects, and this led to the replication of the original Bornholm study with a two-year follow-up starting in 1997 (Kjeldsen, 2000). Both Åland and Bornholm are islands surrounded by the Baltic Sea. Since people tend to stay on these more isolated areas, conditions are favorable for longitudinal studies. The longitudinal follow-up was eventually extended to grade 9, thus including children's literacy development from the beginning of kindergarten until the end of comprehensive school in grade 9.

International reading assessments have been carried out during the few last decades (International Association for the Evaluation of Educational Achievement, IEA; Programme for International Student Assessment, PISA; Progress in Reading Literacy Study, PIRLS) that have placed students in Finland in the topmost position for reading ability; albeit admittedly with some declining tendency over the years (Lundberg & Linnakylä, 1993; Välijärvi, Linnakylä, Kupari, Reinikainen, Malin, & Puhakka, 2001). The PISA study (2009) ranked the students in Åland between their Finnish and Finnish-Swedish peers. However, Finland as a whole had the largest gender-related difference among the participating 65 countries (Harju-Luukkainen & Nissinen, 2011) and with a similar gender difference in PISA 2012 (Harju-Luukkainen, Nissinen, Stolt, & Vettenranta, 2014). PISA 2015 reports that, on average, about 20% of the 15-year-olds in the 72 participating countries and less than 12% of the 15-year-olds in Finland lack a functional reading ability required by modern society. This ability is rated as being under baseline level 2 in PISA 2015 (Organisation for Economic Co-operation and Development, OECD, Available: [www-oecd.org/pisa/](http://www.oecd.org/pisa/)). The amount and complexity of written text as well as the required quality of reading comprehension increases along with each school grade. Students without sufficient reading comprehension skills will struggle during school and often fail to reach the educational goals. This tendency is shown by the fact that about 16% of Finnish male students and 7% of Finnish female students leave comprehensive school without a functional reading ability with boys performing more than a year behind the level of girls (PISA, 2016).

Literacy demands are a life-long skill determined by the highly specialized functions of today's society. "Reading literacy is absolutely the most important individual skill you have to have to live in modern society" (Arffman, 2015). The new curriculum for comprehensive schools in Finland and shared by Åland, emphasizes good basic skills of which reading and writing ability, and the ability to learn how to learn are the foremost (Heinonen, 2016).

2 REVIEW OF LITERATURE

2.1 Linguistic awareness

The now all-important and ubiquitous concept of linguistic awareness was coined by Ignatius Mattingly (1972), a well-known American linguist. Being an essential prerequisite for learning to read and write, it can be defined as an independent and conscious reflection of the language, shifting the attention from the meaning of words to their form, and from what is said to how it is said (Lundberg, 1978, 1984; Tornéus, 1983). This means a departure from the usual holistic reception of spoken words as directly meaning-bearing (Olofsson, 1985). The Bornholm kindergarten study of phonological language games, constituting the starting point of this thesis, emerged from the concept of linguistic awareness (Lundberg et al., 1988).

Gombert¹ (1992) has defined the following four levels in the development of linguistic awareness: awareness of the first linguistic skills, epi-linguistic awareness, meta-linguistic awareness and finally the level of automation of metaprocesses. These levels of acquisition function as links in a chain, where the former is an essential prerequisite for the latter (Seymour, 1999). In their longitudinal study with preschool children, Carroll, Snowling, Hulme, & Stevenson (2003) specified the levels of epi-linguistic and metalinguistic awareness. The first comprises the implicit large-segment sensitivity of sound similarity such as rhyme, word and syllable awareness. The second comprises a subsequent explicit awareness of small segments, the phonemes. This development, which progresses from the discovery of words, syllables and finally to the phonemes, works at its strongest between 4 to 6 years old (Adams, 1990; Muter, Hulme, Snowling, & Taylor, 1998) and reaches its peak when the child is about 6 years old (Frost, Madsbjerg, Niedersøe, & Olofsson, 2005; Liberman, 1973). In order to reach a mastery level in linguistic awareness, repetition of the metalinguistic skills of automatization is needed (Frost, 1999). Metalinguistic development starts in early childhood (Marazita & Merriman, 2004) and continues throughout life (Edwards & Kirkpatrick, 1999). A study of 748 six-year-old Greek students found that children make use of their metalinguistic

¹ Before the new millennium the terms meta-linguistic awareness and correspondingly meta-phonological awareness were used in reading research. In the following text the terms linguistic awareness and phonological awareness will be used.

insights in order to facilitate their processing of language input, thus supporting their oral language skills (Vassiliu et al., 2016). Metalinguistic awareness comprises the specialized linguistic areas of phonological awareness, word awareness, semantic awareness and pragmatic awareness, where the areas cooperate with each other to attain the full acquisition of oral and written literacy skills required to achieve the final goal of reading comprehension (Tunmer & Hoover, 1992).

2.1.1 Phonological awareness

The phonological aspect of linguistic awareness has maintained its central role in reading research for over three decades, resulting in about 4500 scientific articles (retrieved 0318, Web of Science). There should be no doubt of the critical role of phonological awareness for reading acquisition which has been supported by reading researchers world-wide in different languages ranging from transparent to deep orthographies (Ball & Blachman, 1991; Bus & Ijzendoorn, 1999; Høien, Lundberg, Stanovich, & Bjaalid, 1995; Lundberg et al., 1988; Schneider, Küspert, Roth, Visé, & Marx, 1997; Wagner & Torgesen, 1987). As Lundberg (1991, 16) put it: “Without phonological insight there is no way to use the alphabetic system productively in reading and spelling”. Phonological processing involves the ability to discover, store and produce the sound structure of one’s own spoken language (Mann & Ditunno, 1990; Wagner & Torgesen, 1987). Spoken words consist of an acoustic complexity of co-articulated sounds (Liberman, Cooper, Shankweiler, & Studdert-Kennedy, 1967; Lundberg, 1987). In order to transform the continuous stream of sounds to grapheme strings, the sounds have to be segmented into their corresponding sounds, phonemes. This is a complex and abstract task, because the phonemes differ in their acoustic appearance depending on their position in the word. The complexity also appears in the inconsistency of the phoneme-grapheme correspondences. Some phonological units have diverse spellings while some orthographic units represent many different pronunciations (Glushko, 1979; Ziegler, Stone, & Jacobs, 1997). Phonological awareness is based on the ability of manipulating the phonemes in different directions: dividing words in their separate sounds by phoneme analysis and putting the sound units together by phoneme synthesis (Nesdale, Herriman, & Tunmer, 1984).

Phonological processing develops from identifying similar sounds in words and syllables to the most refined processes of deleting, adding, reversing and isolating single phonological units (Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor 2002; Lewkowicz, 1980). This phase in the child’s language

development is crucial for deciphering the alphabetic code, which is an obstruction area for literacy development. From Broadbent's (1958) "bottle-neck theory" of attention some similarities can be drawn regarding the complex, abstract and attention demanding process of rapidly transforming phonemes to graphemes and vice versa. By cracking the alphabetic code the child masters a self-teaching instrument for subsequent literacy development (Lundberg, 1984, 1996). Prognostic studies have shown that phonological awareness is a causally efficient component (Hulme, Bowyer-Crane, Carroll, Duff, & Snowling, 2012), although not a sufficient component in grade 1 reading acquisition (Badian, 1994; Blachman, 1984; Bradley & Bryant, 1983; Bus & IJzendoorn, 1999; Lundberg et al., 1980; Torgesen, Morgan, & Davies, 1992). The predictive power of individual differences in phonological awareness is not only limited to early reading acquisition but extends at least to grade 4 (Holopainen, Ahonen, Tolvanen, & Lyytinen, 2000; Leppänen, 2006; Leppänen, Aunola, Niemi, & Nurmi, 2008; Lerkkanen, Rasku-Puttonen, Aunola, & Nurmi, 2004; Mäkinen, 2002; Wagner et al., 1997). The classical words of Bryant & Goswami (1987, 439) are still valid: "The discovery of a strong relationship between children's phonological awareness and their progress in learning to read is one of the great successes of modern psychology". The prognostic power of phonological skills in kindergarten on later reading development indicate correlations ranging from 0.30 to 0.75 (e.g. Lundberg et al., 1980; Muter & Snowling, 1998; Stanovich, Cunningham, & Feeman, 1984; Vandervelden & Siegel, 1995). In a recent meta-analysis by Suggate (2016), altogether 71 reading interventions with an average length of 11 months reported the effect size of post-tests (Cohen's $d = 0.37$), with a decreasing trend in follow-up tests (Cohen's $d = 0.22$). On the other hand, a meta-analysis of 22 studies showed that intelligence measures have no prognostic significance to responses to reading interventions (Stuebing, Barth, Molfese, Weiss, & Fletcher, 2009).

Many kindergarteners spontaneously develop their phonological awareness by rhyming, playing with language sounds (Lundberg, 1987; Naclér & Magnusson, 1988) and nursery rhymes (Bradley & Bryant, 1983; Bryant, Bradley, Maclean, & Crossland, 1989; Bryant & Bradley, 1985). This informal epi-phonological awareness develops in language stimulating environments during childhood (Gombert, 1992) where parents and other adults are important role models and sources of inspiration, for example when reading aloud to children (Chambers, 2011; Olaussen, 1989). When homes and kindergartens offer high-quality oral learning environments it will promote children's phonological skills (Frank & Schneider, 2014; Goswami & Bryant,

2016). The accessibility of books is crucial for children's interest in literacy. It is of importance to note that interest together with semantic ability at the age of 3, in addition to phonological awareness at the age of 6, were predictive of reading comprehension at the age of 16 (Frost, Madsbjerg, Niedersøe, Olofsson, & Sørensen, 2005). Many children develop phonological awareness in parallel with the initial reading acquisition (Hatcher, Hulme, & Ellis, 1994; Schneider, Roth, & Ennemoser, 2000). However, training rather than age and maturity is the most effective way of acquiring phonological awareness (Adams, 1990, 331). The reciprocity hypothesis of phonological awareness has to date considerable support (e.g. Castles & Coltheart, 2004; Ellis, 1990; Mann, 1986; Morais, Cary, Alegria, & Bertelson, 1979; Read, Yun-Fei, Hong-Yin, & Bao-Qing, 1986; Stanovich, 1986; Wagner & Torgesen, 1987; Ziegler & Goswami, 2005). The hypothesis posits that a certain level of phonemic awareness is required in order to begin reading, and that the subsequent gains in reading promote phonological awareness, especially phoneme analysis such as deletion and tapping (Perfetti, Beck, Bell, & Hughes, 1987). However, results favoring a uni-directional influence from phonological awareness to reading have also been reported (Lundberg et al., 1988; Schneider et al., 1997) when children prior to formal reading instruction at school develop their phonological awareness in a systematic intervention.

What components of phonological awareness are critical for reading acquisition? Several alternatives have been demonstrated: A single-factor construct (Anthony & Lonigan, 2004; Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor, 2002; Lonigan, Burgess, & Anthony, 2000; Stahl & Murray, 1994); a two-factor construct consisting of rhyme awareness and phonological awareness (Carroll, Snowling, Hulme, & Stevenson, 2003; Muter, Hulme, Snowling, & Taylor, 1998); and another two-factor variant in terms of syllable awareness and phonological awareness, of which the latter was more important (Lundberg et al., 1988). Yopp (1988), suggested a two-factor solution comprising a simple and a composite phonological factor. A three-factor construct consisting of rhyme, syllable and phoneme awareness has also been suggested (Høien, Lundberg, Stanovich, & Bjaalid, 1995). The phonemes, as the basic linguistic elements, are present in all languages, also in those without an alphabet (Ho & Bryant, 1997; Lindblom, 1989). However, the phonological structure of languages differs. Transparent languages such as Finnish, Greek, and Italian, with a consistent phoneme-grapheme relationship for sound-letter correspondences are representatives of the small grain size of phonological awareness; while English, as an irregular language with a deep orthography uses

both phonological elements of large and small grain sizes for reading acquisition. Muter and Snowling (1998) suggested that rhyme awareness could be emphasized at a later level when teaching word families in reading and spelling. Similar patterns were seen in the more regular German language in the study of Wimmer, Landerl and Schneider (1994). Rhyme awareness was only modestly predictive of early reading and spelling at the end of grade 1, but was highly predictive of reading and spelling skills in grades 3 and 4 by facilitating the establishment of mental representations of written words. These studies presented evidence of a gradual developmental process in children to fully grasp phonemic representations.

2.2 Phonological interventions during 1970-2000

The Nordic countries: Denmark, Norway, Sweden and Finland, share a long common history and comprise a co-operating area with similar social, cultural and political standards. Situated in a remote corner of Europe with a modest number of inhabitants from a global aspect, the Nordic countries have achieved a visible place in international literacy research. This research covers a complementary set of different approaches and some of the landmark examples will be described below.

The Nordic countries have a common base for their school systems. All children start school at the age of seven and the compulsory education lasts for nine years. The late school start, compared to most other countries, enables researchers to study children during a fairly long pre-reading phase. The original Bornholm study (Lundberg et al., 1988) showed the possibility of conducting a phonological kindergarten² intervention before formal reading instruction at school, and thus provided evidence of the impact of phonological awareness on early reading ability. Altogether 235 six-year-old Danish kindergarteners participated for 20 minutes a day in a phonological training program; the program lasted for 8 months during the year before school entry. The intervention group on the Danish island of Bornholm, was compared to 155 peers living on the Danish mainland and receiving an ordinary kindergarten program. The intervention consisted of language games ranging from easier to more complex ones and following a consistent structure. The first part of the

² Kindergarten = the year immediately preceding the first school year. The term preschool is used synonymously worldwide. (ÅL: Barnsomsorgens förundervisning, Ålands landskapsregering 2013; FI: Esiopetus, Opetushallitus 2016).

training consisted of listening, rhyming, identifying sentences and words and manipulating syllables. The final parts of the program comprised games, manipulating phonemes through analysis and synthesis, and finding their positions in words.

This ground-breaking intervention influenced all the children and particularly those at risk of reading disabilities. These children's abilities were raised to the level of the mainstream control children in phonemic awareness at the beginning of grade 1 (Lundberg et al., 1988). The impact was subsequently seen in their reading and spelling ability up to the third grade (Lundberg, 1994), suggesting that phonological awareness at the school start is crucial for the subsequent learning to read process (Frost, 1999). This phase is followed by a foundation period of alphabetic and phonological processing when strategies for subsequent reading are learned (Seymour, 1997). Bradley & Bryant (1983) had some years earlier shown the significance of phonological kindergarten interventions. The study of Lundberg and his colleagues was soon followed by replications worldwide: In Portugal by Cary and Verhaege (1994), in Israel by Kozminsky and Kozminsky (1995), in Germany by Schneider, Küspert, Roth, Visé, and Marx (1997), in Great Britain by Brennan and Ireson (1997) and in the United States by Foorman, Francis, Schaywitz, Schaywitz, and Fletcher (1997).

Already in 1980, Lundberg and his co-researchers found the training effects, in a smaller Swedish sample, produced similar results to those of the Bornholm study (Lundberg, Olofsson, & Wall, 1980). Olofsson and Lundberg (1985) continued the phonemic awareness training studies in kindergartens, which despite a relatively short eight-week training, yielded clear phonological improvements. Children enjoyed the playful and creative language games. It was found that phonological awareness could be developed in kindergarteners outside the contexts of formal reading instruction, enhancing their understanding of the relationship between spoken and written language (Olofsson & Lundberg, 1983, 1985). During these years, a collection of phonological language games were created and published in the volume *På tal om språk. Lekar och övningar* [Speaking about language. Games and exercises] (Tornéus, Hedström, & Lundberg, 1986), also presented in the Finnish version *Löytöretki kieleen, leikkejä ja harjoituksia* (Tornéus, Hedström, Lundberg, & Ahlbom, 1991). The collection of linguistic exercises made up the original basis for the Bornholm language games and was used in the Danish project *Sproglig opmærksomhed* in Bornholm kindergartens (Amtorp, Frost, & Troest, 1985, 1987), which finally resulted in the above-mentioned Bornholm study. The research input spread all over the Nordic countries. The Oslo-project (1986-

1992) of training linguistic awareness and stimulating invented writing, was conducted in Norwegian kindergartens (Hagtvet, 1989) and another project called Bilingualism and linguistic awareness (1988-1990) was conducted in Swedish speaking kindergartens in Finland (Østern,1991).

The Norwegian intervention study of Lie (1991) evaluated two different daily treatments for stimulating word analysis in first graders; these were phoneme isolation training and phoneme segmentation training. For control conditions illustration discussions were used. Both treatment forms of phonological training had effects on reading and spelling at the end of grades 1 and 2. However, the phoneme segmentation training had a significantly stronger effect than the phoneme isolation training on spelling than on reading at the end of grade 1, but these differences disappeared by the end of grade 2. Children with a lower general intelligence at the pretest gained most from the training. Another Norwegian intervention study conducted at kindergarten level comprised two different programs: one phonological training and the other of morphological training (Lyster 1995, 1997). These two groups were trained 10-15 minutes daily for 17 weeks. The results showed that different linguistic and cognitive factors operated at different times in the child's reading and spelling development. Children with poor initial linguistic awareness progressed first in phonological skills, which were subsequently associated with good spelling development in grade 1. On the other hand, those with high initial linguistic awareness proceeded immediately to more advanced morphemic awareness which was also seen as good reading development in grade 1 (Lyster 1995, 1997).

In a Danish study, non-reading kindergarteners of dyslexic parents were trained in phoneme awareness and letter-sound correspondences for the purpose of preventing reading difficulties at school (Elbro & Klint Petersen, 2004). The intervention group outperformed the control group with ordinary kindergarten training regarding the immediate effects on phonemic awareness and letter knowledge. Training effects were seen in all reading measurements in grades 2, 3 and 7 in favor of the trained at-risk group. The differences between the trained and the untrained at-risk children were apparently due to differences in phoneme awareness which was stimulated during the kindergarten year (Elbro & Klint Petersen, 2004). Finnish phonological intervention studies have been conducted in kindergarten- (Korkman & Peltomaa, 1993) and school-settings (Poskiparta, Niemi, & Vauras, 1999). When Korkman and Peltomaa (1993) trained kindergarteners with language impairments in phonological awareness and grapheme-phoneme conversions the positive effects on reading and spelling acquisition were seen in grade 1. The University of Turku and its Centre for

Learning Research contributed to reading research with over 30 articles. Some of them targeted intervention effects on early reading. Poskiparta, et al. (1999) trained 117 first grade students in linguistic awareness in a four-year longitudinal study. The intervention consisted of group games and exercises inspired by and modified according to the programs created by Tornéus et al. (1986, 1991) and Hagtvet and Palsdóttir (1992). Results from the end of grade 1 gave support to the relevance of phoneme synthesis ability when beginning to read and spell. It was shown that prospective children-at-risk in the intervention group performed at the level of other first graders. Even children with cognitive delays benefitted from training in linguistic awareness

2.3 Phonological interventions during 2001-2017

Nordic interventions conducted after the millennium shift extended the training programs by including additional components and study variables. Intervention studies featuring digital training programs increased as well. Lundberg, Larsman and Strid (2012) carried out a kindergarten intervention study of more than 2000 six-year-old children in Sweden. They used the phonological language games of the original Bornholm study, but now with an emphasis on games emphasizing the linkage between sounds and letters as was done in the American version of the program (Adams, Foorman, Lundberg, & Beeler, 1997). Before and after the training, phonological awareness was tested. Gender comparisons showed more boys with low scores and more girls with high scores in phonological awareness. Phonemic awareness at the end of the training period was significantly predicted by the initial phonemic awareness which, in turn, was associated with the family's socioeconomic status. In another Swedish longitudinal kindergarten study with 6-year-old children, phonological training was combined with articulation exercises (Fälth, Gustafson, & Svensson, 2017). The experimental group of 39 children was divided into two subgroups, those at risk for developing reading difficulties and those with no risk. Both subgroups outperformed the comparison group of 30 children on phonological awareness and word decoding (Fälth et al. 2017). A third Swedish remediation study was a multi-component one-to-one-tutoring program featuring phonics, comprehension strategies and fluency training among nine-year-old students with reading difficulties. The study showed the direct training effects of spelling, reading comprehension, reading speed and phonological awareness immediately after the intervention (Wolff, 2011). The indirect training effects one year after the intervention were seen in all variables; reading comprehension predicted spelling and phoneme

awareness predicted both spelling and reading comprehension one year later (Wolff, 2011).

A Finnish kindergarten training of phonological awareness in 6-year-old children supported reading and spelling ability in grade 1 (Mäkinen, 2002). The kindergarten exercises emphasized syllable and phoneme analysis and synthesis. Those phonological exercises that most promoted decoding skills were identifying, naming and manipulating syllables of words and naming the initial phoneme of words (Mäkinen, 2002). At the University of Jyväskylä and the Niilo Mäki Institute, Timo Ahonen and Heikki Lyytinen have conceived and led the Jyväskylä Longitudinal Study of Dyslexia (JLD). By the year 2015, the JLD Study has delivered more than 160 scientific articles and 13 doctoral dissertations. One PhD thesis was a phonological intervention designed according to ordinary clinical speech therapy and given to six children with a very clear risk for dyslexia. The children were followed from kindergarten to grade 7. Despite the careful training, they showed very poor literacy progress. For this exceptional group the phonological intervention was not enough (Ketonen, 2010) and the outcome can be viewed as an example of “treatment resisters” (e.g. Torgesen, 2000). In the JLD project the Finnish computerized reading intervention program Eka-Peli for first graders was developed (Lyytinen & Lyytinen, 2006), and this program was further modified into GraphoGame™, an internationally widespread computer-game based reading program to facilitate the development of phonemic decoding and literacy skills (Lyytinen, Ronimus, Alanko, Poikkeus, & Faanila, 2007; Richardson & Lyytinen, 2014; Ronimus & Richardson, 2014). The JLD has also inspired similar research in other countries, most notably in the Netherlands (The Dutch Dyslexia Programme; van der Kooy-Hofland et al., 2012; van der Leij, van Bergen, van Zuijen, de Jong, Maurits, & Maassen, 2013; van der Leij et al., 2013). In Sweden, computer-assisted interventions for 130 second-graders with reading disabilities showed the strongest literacy gains one year afterwards with a training program combining word decoding and phonological awareness with word and sentence reading skills (Fälth, Gustafson, Tjus, Heimann, & Svensson, 2013). Two Dutch two-year-long computer-assisted interventions, one in grade 1 (Regtvoort, Zijlstra, & van der Leij, 2013) and the other in kindergarten (Zijlstra, 2015) gave support for the effectiveness of a targeted intervention as an effective complement to classroom education for children with low literacy skills. In an Italian intervention study of kindergarteners (Goffredo et al., 2016), acquisition of phonological skills was supported by kinesthetic practice on a virtual platform called En Plein. In this playful environment, phonological games were

provided by a cartoon-avatar. The trained kindergarteners showed significant improvements compared to peers receiving a traditional kindergarten education.

2.4 Intervention characteristics

2.4.1 Intervention components

What are the important ingredients of effective kindergarten-interventions? Bradley and Bryant (1983, 1985) divided their cohort of 4- to 5-year-olds into three groups each receiving different training: sound categorizing, meaning-based, and sound categorizing using plastic letters. The last group gained the most in subsequent reading and spelling ability. The kindergarten interventions of Byrne and Fielding-Barnsley (1989, 1991, 1993, 1995), training phonemic awareness by combining sounds and letters, showed literacy effects several years after the training. Similar training components were used in the intervention study of Blachman, Ball, Black, and Tangel (1994), who trained low-income inner-city kindergarteners in phoneme segmentation and letter knowledge skills. This training program promoted the children's literacy skills in grade 1. The effects of sound-to-letter training have also been confirmed in meta-analyses (Bus & van IJzendoorn, 1999; Galuschka, Ise, Krick, & Schulte-Körne, 2014; Hulme et al., 2012). Both phoneme analysis and phoneme synthesis are necessary for a phonological training program to be effective (Torgesen, Morgan, & Davies, 1992). Besides the measurable variables of phonological awareness and other literacy stimulating elements also joy, play, fantasy, sensitivity and creativity facilitate learning processes in kindergarten (Häggström & Lundberg, 1994). These "soft" factors function as mortar in the brick building and have a value of their own for the participating children.

2.4.2 Training dose, length and starting point

The training dose, length and starting point of the intervention are measurable factors affecting intervention outcome. In the study of Lundberg et al. (1988), as well as in its subsequent replications, the program consisted of a daily training dose of language games. In the study of Kjeldsen, Olofsson, and Niemi (2003) a 60% dose of this training also produced significant effects when the program was carefully kept systematic and structured according to its model. In the study of Lundberg et al. (2012), a teacher-rated training dose showed a positive correlation between the amount of training and its subsequent outcome. Hindson, Byrne, Fielding-Barnsley, Newman, and Hine (2005) found that preschool children at familial risk for reading disabilities needed more sustained

teaching and more training sessions than their non-risk peers to reach grade-appropriate levels of reading and spelling. The same conclusion was made in the study of Hatcher, Hulme and Snowling (2004) with 4-to-5-year-old children at risk for reading delay. These children needed additional phonological awareness and letter-sound training. Certain length and intensity of training are necessary for literacy processes. Larger amounts of training and longer durations of treatment seem to produce more gains (Galuschka et al., 2014). In the longitudinal training study of Wise, Ring, & Olson (2000) the expected training effects were not found. The training program of 29 hours was considered too short.

The best starting point seems to be close to the learning of the alphabet and early reading acquisition that is, when the child is 5-6 years of age (Adams, 1990; Lundberg et al., 1988; Suggate, 2010, 2016; Zijlstra, Koomen, Regtvoort, & van der Leij, 2014; van der Kooy-Hofland, Bus, & Roskos, 2012). It appears that preschool years play a critical role in the children's long-term literacy success (Neuman & Dickinson, 2002). Remediation studies starting in grades 2-3 (Torgesen, Alexander, Wagner, Rashotte, Voeller, & Conway, 2001; Wise, Ring & Olson, 2000) miss this crucial period indicating that interventions from grade 2 upwards produce relatively small effects for children with the most severe reading problems. Moreover, a phonological intervention given in grade 1 seemed to have less effect than the interventions starting in kindergarten (Poskiparta et al., 1999), van der Leij, 2013). However, an 8-month reading intervention with 2nd and 3rd graders with poor reading abilities showed moderate to small effect sizes in reading and spelling as late as ten years afterwards in Blachman's, Schatschneider's, Fletcher's, and Murray's study in 2014. On the other hand, the very early reading instruction given in the United States and United Kingdom seems to deliver no extra advantage in literacy development compared with children starting formal reading acquisition at the age of 7 (Lundberg, 1999).

Intervention effects of explicit training also depend on good teaching which underscores the importance of the teacher factor (Rupley, Blair, & Nichols, 2009); this is not so easily measured and is more seldom measured in studies. In the study of Schneider et.al. (1997), the preparatory period for the involved teachers seemed to be too short. Typical of successful teachers is that they will not just follow a certain method, but also realize the context and understand the idea behind, a sort of "teaching awareness". They will follow the development of the individual child in this integrated cultural context, which is apparent in the interaction between teacher qualification and treatment fidelity (Suggate, 2016).

Teacher quality is guaranteed by well-trained, skillful, relentless specialist teachers (Rack & Hatcher, 2002; Torgesen et al., 2001). Interventions led by the author of the study tend to show greater treatment effects than interventions led by others, which explains the importance of professional insight and knowledge about reading disabilities (Galuschka et al., 2014).

2.4.3 Social interaction, scaffolding and a self-teaching mechanism

The phonological kindergarten training introduced by Lundberg et al. (1988) and the replications owe certain elements to Vygotsky (1978). More specifically, interventions were inspired by a pedagogy focusing on sociocultural theory, where learning takes place in cooperation with the child and the teacher, who functions as the active role model and the responsible actor for explicit instruction. Social interaction is crucial for cognitive development. The student gains insight, knowledge and deeper understanding in a dialogue with others. These metacognitive processes take place in the zone of proximal development (ZPD), a zone of internalization, where the child participates in common activities and consequently develops relevant skills. Transition from social to individual contexts is the product of learning: cognitive skills developed in interaction with others will be applied in new individual settings (Säljö, 2000). In social interaction imitation, according to Vygotsky, is also an important pedagogical tool. “While imitating the elders in culturally patterned activities, children generate opportunities for intellectual development” (Vygotsky, 1978, 129). Close to imitation is the concept of scaffolding, which refers to the idea that the importance of teachers’ support for the child’s learning process is greater in the beginning than later on when the child manages to learn more independently (Wood, Bruner, & Ross, 1976), as self-teaching mechanisms also start to operate (Share, 1995).

2.4.4 The type of intervention

Why is there a need for targeted intervention when most children attend kindergarten and school? Ordinary teaching in general or special education classrooms are not enough for children with reading disabilities. A specific, systematic and structured intervention is needed to generate timely progress for these children (Brooks, 2003). This fact is consistent with the findings of Torgesen and colleagues (2001). Sixty children between 8 and 10 years of age with severe reading disabilities were randomly assigned to two instructional programs of phonemic awareness and phonemic decoding skills. These intense programs featuring one-to-one instruction were given daily in two 50 minute sessions for 8 weeks, a total 67,5 hours. Although the programs differed in depth

and extent of instruction, they nevertheless produced large effect sizes (4.4 and 3.9). One year after the intervention, 40% of the children studied without receiving special education and after two more years, improvements in word reading skills were still stable. The effects were interpreted as a result of intensive, explicit and structured instruction. In line with this, Foorman and associates (1998) found that first and second graders who received explicit as opposed to implicit instruction in sound-letter correspondences showed the largest gains in word recognition skills. Importantly, the outcome was pronounced for children-at-risk for reading failure.

2.4.5 Long-lasting intervention studies

The literacy development from early childhood to adolescence is a complex, multidimensional process with many components (Perfetti & Stafura, 2014) but still there is no broad theory of reading to explain it. Long-lasting follow-up studies are needed to clarify the order and reciprocal relationship of these literacy-related components both on a group and an individual level; for example, how kindergarten training affects the development of reading comprehension via word decoding. Unfortunately, intervention studies with a follow-up extending over three or more years are few. The proportion is shown in two meta-analyses and one review: Bus and van IJzendoorn (1999; 32/9), Ehri, Nunes, Willows, Valeska Schuster, Yaghoub-Zadeh, & Shanan (2001; 52/8) Schneider and Stengård (2000; 44/9). Very few long follow-up studies have been reported. The Australian preschool intervention of phoneme identity training promoted word reading ability six years later (Byrne, Fielding-Barnsley, & Ashley, 2000). The Danish study of kindergarten children with a familial risk of dyslexia showed training effects on non-word reading speed and a nonsignificant tendency for improved reading comprehension still functioning in grade 7 (Elbro & Klint Petersen, 2004). A British study followed school beginners at risk for poor spelling (Snowling & Hulme, 2011). Both immediately and 11 months after the intervention of phonological and reading-alone training the effects could be seen on word reading ability. Six years afterwards reading accuracy and reading comprehension were still at an average level. A Swedish study conducted on grade 3 with daily training over 12 weeks consisted of phoneme-grapheme mapping, reading comprehension and reading speed. At the immediate post-test, gains in spelling, reading speed, reading comprehension and phonological awareness were reported as well as sustained effects one year later. Five years later only word decoding showed significant training-related effects (Wolff, 2016).

2.5 Word decoding and spelling

Finnish researchers followed 61 children from 1 to 7 years of age testing their development of language acquisition and possible early reading before formal school instruction (Silvén, Poskiparta, & Niemi, 2004). Early vocabulary and word inflection skills were associated with phonological awareness during early childhood years. The increased awareness of sound patterns led to subsequent improvements of phoneme awareness during learning to read. Phonemic awareness was regarded as both a precursor and a consequence of reading. The process leading to competent reading and spelling ability passes through developmental stages requiring different cognitive skills at each stage (Ehri, 1991; Ellis, 1994). Stage models of reading development suggest four distinct stages: pseudo-reading, logographic reading, alphabetic-phonemic reading and orthographic-morphemic reading (Ehri, 2005; Høien & Lundberg, 1988; Seymour & McGregor, 1984). A more recent developmental model defines the stages as periods in children's reading and spelling development where certain strategies dominate (Treiman & Bourassa, 2000). The most crucial moment during these periods is the breaking of the alphabetic code, which functions as a starter and catalyzer for further literacy development of alphabetic-phonological and orthographic-morphological reading. Improved phonological representations function as the establishing factor for the connections between orthographic patterns and their oral correspondences (Elbro, Borström, & Petersen, 1998; Elbro & Jensen, 2005; Taube, 2007), a necessary pre-requisite for the quality of word representations in the mental lexicon (Perfetti, 2007).

In their meta-analysis, Melby-Lervåg et al., (2012) underscored the importance of phonemically structured phonological representations for good word reading skills. In a study with British school beginners, the predictive power of phoneme manipulation and letter knowledge at school entry was 54% of the variance in word reading ability a year afterwards (Muter, Hulme, Snowling & Stevenson, 2004). In a Norwegian longitudinal study, similar predictive evidence of phoneme awareness, letter-sound knowledge and non-alphanumeric rapid automatized naming were found for the development of early word recognition skills (Lervåg, Bråten, & Hulme, 2009). A meta-analysis of 52 studies evaluated the effects of phonemic awareness instruction on reading and spelling acquisition. A significant effect size (Cohen's d) of 0.86 revealed the impact of phonological awareness instruction on phonological awareness skills. The phonological awareness instruction also benefitted reading ($d = 0.53$), spelling ($d = 0.59$) and reading comprehension (Cohen's $d = 0.34$). The study showed

that all the children improved their literacy skills along with the training: normal, at-risk, and disabled readers; children in preschool, kindergarten and first grade; as well as children of different socio-economic status (Ehri et al., 2001). A two-year longitudinal study of 202 Italian children from kindergarten to primary school showed that emergent literacy skills, such as phonological awareness and numeracy awareness in kindergarten predicted reading, spelling and mathematical performances, the essential domain-specific skills in primary school (Pinto, Bigozzi, Tarchi, Vezzani, & Accorti Gamannossi, 2016). Each domain-specific skill in kindergarten predicted corresponding domain-specific skill in primary school. In addition, cross-domain relations occurred in phonological awareness contributing not only to reading but also to mathematical skills. Domain-general predictors had less impact on reading, spelling and mathematics (Pinto et al., 2016).

For skillful word decoding, accuracy and speed, in addition to letter-sound knowledge also have to be developed to full automatization. In an 8 year follow-up of reading fluency and spelling development in German-speaking students, Landerl and Wimmer (2008) found that the strongest predictors were rapid automatized naming for reading fluency and phonological awareness for spelling. The speed of word decoding was the only discriminating factor for different levels of reading skill in the phonologically transparent German orthography. The same pattern was found in the transparent Finnish orthography among children with a family risk for dyslexia who showed persistent deficiency in reading speed but less in reading and spelling accuracy (Eklund, Torppa, Aro, Leppänen, & Lyytinen, 2015).

Reading researchers have suggested theoretical models for word recognition. First, a two-path model with an indirect phonological path for reading of unknown and low-frequent words and a direct visual path for well-known and high-frequent words and sight-words (Coltheart, 1974). Second, an analogy model referring to the use of comparisons of similar word units in known and unknown words when reading by analogy (Goswami, 1991, Ziegler & Goswami, 2005). Third, a connectionist model, a “parallel distributed processing”, proposing that all kind of words can be processed in the same way by connection of phonological, orthographic and semantic knowledge (Baker, Croot, McLeod, & Paul, 2001; Seidenberg & McClelland, 1989), a model combining the two-path model and the connectionist model (Bjaalid, Høien, & Lundberg, 1997). Connectionist models explain both typical and diverging reading and spelling development and are thus useful as pedagogical tools in educational and special educational settings (Ehri, 2000). Decoding and recoding phonemes, syllables

and words is more of a linguistic process while the expressing or understanding the meaning of a text is based on a more cognitive process of comprehension. Along with more fluent and accurate decoding, a reader's general language comprehension gradually becomes more important for reading comprehension (e.g., Cutting & Scarborough, 2006; National Institute of Child Health and Human Development Early Child Care Research Network, 2005; Storch & Whitehurst, 2002).

In literacy development word decoding and spelling acquisition as well as reading and writing ability are closely linked, as the two sides of the same coin, promoting the development of each other and being enhanced by phonological processing abilities. These connections have been found from earlier to higher grades of education (e.g. Abbot & Berninger, 1993; Berninger, Cartwright, Yates, Swanson, & Abbot, 1994; Juel, 1988; Shankweiler, Lundquist, Dreyer, & Dickinson, 1996). The level of phonological awareness in the beginning of formal education promotes spelling acquisition and this effect is stronger on spelling than on reading during the first grades (Lundberg et al., 1988; Schneider et al., 1997). Spelling plays an important role for literacy development (Young-Suk, Petcher, Foorman, & Zhou, 2010; Pinto, Bigozzi, Tarchi, Accorti Gamannossi, & Canneti, 2015). Early spelling is learned by focusing on the explicit awareness of the phonological structure of words and to language-specific spelling rules (Cataldo & Ellis, 1988). Phonological segmentation skills, developed by spelling activities, facilitates early reading development and have a special impact on children with poor phonological awareness (Frost, 2001). Muter (1998) found that spelling is more dependent on phonology than reading and the need of phonological processing lasts longer for spelling. Orthographic and morphological knowledge in combination with phonological and letter-name knowledge are crucial for spelling development. Preschool children training letter-sound correspondences also show influences of orthographic abilities (Castles, Wilson, & Coltheart, 2011). Bourassa and Treiman (2001) found that children with spelling disorders had difficulties with the morphological structure in words, which was described as the “morphological deficit hypothesis”.

2.5.1 Reading comprehension

Since reading comprehension is one of the strongest predictors of educational success in most school subjects (e.g., OECD, 2000), it is remarkable that studies concerning reading comprehension are fewer compared with studies of phonological awareness (Adams, 1990). The same is true of studies of reading

comprehension disabilities (Catts, Nielsen, Bridges, & Liu, 2016). One influential model, the Single View of Reading, describes reading comprehension as the product of word decoding and language comprehension (Gough & Tunmer, 1986; Hoover & Gough, 1990). Phoneme awareness is the oral correspondence of word decoding similar to listening comprehension being the oral counterpart of reading comprehension (e.g. Catts, Hogan, & Adlof, 2005; Kendeou, Bohn-Gettler, White, & van den Broek, 2008).

Which factors contribute to a functioning reading comprehension? Reading comprehension as well as word reading ability focus on different sizes of language units. The text units relevant to reading comprehension comprise words, sentences and discourse (Cain, 2010). In their study of four-to-six-year-olds, Cunningham and Carroll (2015) found that phonological awareness as well as phonological and morphological strategies predicted reading accuracy, whereas morphological awareness only predicted reading comprehension. Moreover, Carlisle (2000) found that morphological awareness promoted reading comprehension in children aged 9 and 11 years. Deacon and Kirby (2004) found in their 4-year longitudinal study starting in grade 2 a similar contribution of morphological awareness to reading comprehension. This relationship was sustained 3 years after the assessment of morphological awareness. The authors argued that the significance of morphological awareness extends longer and wider than that of phonological awareness in the course of reading development. Roth, Spence, and Cooper (2002) showed that semantic knowledge together with print awareness were stronger predictors of reading comprehension than phonological awareness which predicted word decoding in early grades. According to the lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002), high quality lexical representations based on phonology, orthography, morphology and semantics promote word recognition thus playing a pivotal role for reading comprehension. In a longitudinal Finnish study from kindergarten to grade 3, listening comprehension was the strongest predictor for reading comprehension in grade 3, while reading fluency affected reading comprehension in grade 1 but ceased thereafter. Reading fluency and listening comprehension accounted for 37% of the variance in grade 2 reading comprehension and 28% in grade 3 reading comprehension (Torppa, Georgiou, Lerkkanen, & Nurmi, 2016). In another Finnish study, letter knowledge at kindergarten entry was the strongest predictor of reading ability and reading comprehension in grade 4 (Leppänen, Aunola, Niemi, & Nurmi, 2008). Vocabulary knowledge during the first school years is a further predictor of reading comprehension development several years later (e.g. de Jong & van der

Leij, 2002; Perfetti & Stafura, 2014). However, reciprocal relationships also exist. Reading comprehension in young readers predicts vocabulary knowledge some years later (Cain & Oakhill, 2011; Seigneuric & Ehrlich, 2005). The mere reading and understanding words correctly is not enough; knowledge of sentence and text structures, inferences, monitoring and general knowledge is needed for a full understanding of the text when reading (Cain, 2010; Kendeou, van der Broeck, White, & Lynch, 2007; Oakhill & Cain, 2007, 2012; Oakhill, Cain, & Bryant, 2003; Oakhill, Cain, & Elbro, 2015). Finnish researchers stimulated inference-making skills in four-year-old children by means of shared picture book reading. Results showed that inference-making skills both directly and indirectly promoted later narrative listening comprehension via vocabulary knowledge (Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012). A review of interventions of reading comprehension and the underlying components suggests that interventions targeting skills directly related to reading comprehension through strategy training show moderate to large effects, while training of word decoding as an underlying component shows small to moderate effects (Melby-Lervåg & Lervåg, 2015). In a state of poor literacy stimulation, the opposite occurs: Poor reading comprehension causes poor text production (Cain & Oakhill, 2007), as poor word decoding leads to poor spelling.

It is a tempting idea that children, after having broken the alphabetic code and learned to read, are ready for the literacy world. As it often happens, many of them are left to decide by themselves what and how much to read with little incentive to read other texts than school books. As they grow older, children tend to show less enthusiasm about reading activities (Wigfield, 2000), being aware of their own reading level (Wigfield, Eccles, Fredricks, Simpkins, Roeser, & Schiefele, 2015), which for struggling readers is devastating in terms of motivation, academic self-esteem (Taube, 2007), self-efficacy (Bandura, 1986) and educational outcome, and finally likely to result in the negative spiral called the “Matthew effect” (Stanovich, 1986). Finnish researchers have also highlighted the predictive value of motivation for reading disorder (Lepola et al., 2000, 2004, 2005; Poskiparta et al., 2003). The consequences of frequent experiences of reading failure result in a lack of reading motivation (Aunola, Nurmi, Niemi, Lerkkanen, & Rasku-Puttonen, 2002). Motivation and learning reciprocally impact on each other – motivation feeds into learning and learning feeds into motivation. In a German study, altogether 1051 second and third graders were followed up and examined on the effects of reading motivation on reading comprehension. A significant relationship was confirmed (Schiefele, Stutz, & Schaffner, 2016). An even broader set of cognitive and motivational

tasks were assessed in an Italian study of 155 students in grades 7 and 8 in order to clarify the contribution of different cognitive and motivational factors for reading comprehension. The inference-making ability and self-efficacy contributed to reading comprehension and in this process the intrinsic motivation played a moderating role (Tarchi, 2016).

2.5.2 Reading disabilities

Children lacking phonological awareness and letter knowledge in the pre-reading period in kindergarten are at risk for long-term reading difficulties (Ferrer, Shaywitz, Holahan, Marchione, Michaels, & Shaywitz, 2015; Melby-Lervåg, et al., 2012; van der Leij et al., 2013), including both word decoding and reading comprehension disabilities (Catts, Nielsen, Bridges, & Liu, 2016). In an American study, tests of language ability in kindergarten predicted reading comprehension difficulties in grade 3, while early language intervention for the same 366 kindergarteners predicted a good reading comprehension outcome in grade 3 (Catts et al., 2016). The authors emphasized the importance of early identification. Both genetic risk factors and impaired phonological processing influence the probability of developing dyslexia. Prevalence estimates for children with familial risk vary between 30-60% depending on consistency of orthography (Elbro et al., 1998; Snowling & Melby-Lervåg, 2016; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010; van Bergen, de Jong, Maassen, & van der Leij, 2014). A recent meta-analysis based on 21 independent samples of children with a family risk of reading disorders concluded that these children had delayed language development as infants and toddlers (Snowling & Melby-Lervåg, 2016). As preschoolers they had difficulties in phonological processing, letter knowledge, phonological awareness and rapid automatized naming. Children developing dyslexia had more impairments in their preschool language than those developing a good reading ability, albeit not as good as the more skillful readers had. School age children with familial risk showed poor phonological awareness and literacy skills. Their parents tended to have lower educational level and they also read less (Snowling & Melby-Lervåg, 2016). These findings underscore the phonological processing deficit of dyslexia as being a core risk factor for reading difficulties (Samuelsson & Lundberg, 2003). Children with the so-called double deficit, that is, poor phonological and rapid naming skills (Denckla & Rudel, 1976), show even greater difficulties than those with deficits in only one ability (Kirby, Georgiou, Martinussen, & Parrila, 2010; Wolf & Bowers, 2000). The comorbidity rate of reading and spelling disorders and other disorders such as specific language impairment, psychiatric and neuro-psychiatric disorders have a prevalence rate of 9%-20% (e.g., Galuschka

et al., 2014; Melby-Lervåg & Lervåg, 2012). The co-occurrence of dyslexia and specific arithmetical disorders, dyscalculia, is increasing and has a prevalence rate of 20%-40% (Galuschka et al., 2014). The longer a child has struggled with reading, the more difficult it is to remediate (Ehri et al., 2001). In these circumstances students encounter academic frustration with increasing symptoms of low self-esteem, anxiety and depression (Carroll, Maughan, Goosman, & Meltzer, 2005; Willcut & Pennington, 2000). In the Jyväskylä Longitudinal Study of Dyslexia (JLD), about 200 children with and without familial risk for dyslexia were followed from birth. As early as at six months of age differences in speech sounds related to responses in brain were detected between familial risk children and the control group (Lyytinen et al., 2001; 2006). Subsequent yearly follow-ups revealed that children with both familial risk of dyslexia and a late talking debut ran the risk of delayed language acquisition. This subgroup requires careful assessment and intervention (Lyytinen, Poikkeus, Laakso, Eklund, & Lyytinen, 2001). The longitudinal Danish study of kindergarten children of dyslexic parents showed three predictive measures of dyslexia which were letter naming, phoneme identification and distinctiveness of phonological representations. It was suggested that the quality of phonological representations of lexical items is of great relevance in the development of phoneme awareness and phonological decoding skills during reading acquisition (Elbro, Borstrøm, & Petersen, 1998).

3 AIMS

The aims of the present study were to replicate in Swedish the intervention carried out in the Danish island of Bornholm, evaluate its effects in kindergarten and follow the children's literacy development throughout the comprehensive school from grade 1 to grade 9, thus amounting to a 10-year follow-up. A special focus was placed on reading difficulties among children-at-risk at the age of 6 years, who were identified at the beginning of the kindergarten year. The overarching goal was to find support for an evidence-based method which could serve as a pedagogical guideline as well as Good Practice in kindergartens and schools in ordinary educational settings. The specific aims of the present thesis are as follows:

Study I: Evaluating the effects of a 60% training dose of the Bornholm phonological kindergarten intervention from kindergarten to grade 2 for the whole experimental group as well as separately for children-at-risk for reading failure.

Study II: Evaluating the effects of the phonological kindergarten training on the development of word decoding in the grades 3-6 and subsequent reading comprehension in grade 9 for the whole experimental group.

Study III: Evaluating the effects of the phonological kindergarten training on the development of word decoding, spelling and reading comprehension during grades 1-9, specifically for children-at-risk at the beginning of the study.

4 METHOD

4.1 Participants

When planning the intervention and control groups to be used in the study different options were discussed. The first option was to have the intervention group in Åland comprising of all the kindergartens that would strictly follow the phonological intervention of the Bornholm language games. Similar to previous studies (Lundberg et al., 1988; Schneider et al., 1997), where the geographical distance between the intervention and control groups was used as a means against contagion of treatment effects, the control group of this study was then planned to be recruited from the archipelago district close to the Finnish mainland, but at a distance from Åland. Unfortunately, SES and the Swedish language comparability were difficult to obtain using this option. The second option was to recruit the control group in Åland kindergartens the year following the intervention year. However, a risk of contagion from the intervention carried out in the previous year was identified. Finally, as the best option at hand, albeit with relatively small groups, it was decided to recruit both the intervention and control group in Åland kindergartens. By this time in 1997-1998, knowledge of phonological awareness had penetrated Åland kindergarten and school staff were, to some extent, familiar with the exercises. The teachers of the control groups were informed about the design and content of the study. They were free to use any linguistic games or other language awareness moments in their kindergarten groups as well as given a promise of supervision in the Bornholm phonological intervention after the intervention year. The main difference between the intervention and control group was the degree of systematicity and the quantity of phonological elements in the intervention, which were much more pronounced in the intervention group. Regarding the intervention, this arrangement makes it harder to show training-related gains in literacy, because even kindergarteners in the control group were expected to participate in different kinds of language stimulating activities.

At the beginning of the study in September 1997, the original sample comprised 209 participants (100 girls and 109 boys), who represented two-thirds of an age group in Åland.. The kindergarteners were then on average 6 years and two months old. The original intervention group consisted of 108 kindergarteners (50 girls and 58 boys) attending nine different kindergarten classes located in the Southern Junior High School District of Åland. The control group consisted of 101 kindergarteners (50 girls and 51 boys) attending 13 different kindergarten

classes. Two kindergartens located in the town of Mariehamn could not be included in the control group because they were already practicing teaching based on phonological awareness. Forty-four percent of the control children came from the capital of Åland situated in the south and 19% from rural kindergartens, and the remaining 37% came from municipalities in the north of the main island and in the Åland archipelago. The intervention and control groups were located geographically close and the average distance between home and school was equal for both groups. Eighty-eight percent of the population of about 29.000 inhabitants in Åland have Swedish as their mother tongue (Ålands statistik- och utredningsbyrå [Statistics and Research Åland], 2016) and in general show the same high level of literacy as Finland (Elley, 1992; Harju-Luukkainen & Nissinen, 2011). All the children were fluent speakers of the Swedish language, which has an orthography that can be placed in between the shallow and deep variants. All classes belonged to the Swedish-speaking public kindergartens and primary schools of Åland.

There were 14 single-parent families in the intervention group and nine in the control group. The mothers' educational background was similar in both groups: compulsory education (50.5% vs. 50.3%), secondary education (41.4% vs. 40.4%), and college/university education (8.0% vs 8.9%). The levels of parental education and SES were balanced between the intervention and control groups. Parents were asked to sign informed consent; no parent refused. Ethical approval for the research project was applied for from the Åland Government, municipalities, leading administrators of schools and kindergartens.

Table 1. Numbers of participants in different stages of the study from kindergarten to grade 9

Groups	K_a	K_b	G1a	G1b	G2	G3	G4	G6	G9
Total sample	209	208	203	193	193	192	192	191	191
Total intervention group	108	107	103	99	99	99	99	96	97
100% training dose	85	84	80	77					
60% training dose	23	23	23	22					
Total control group	101	101	100	94	94	93	93	95	94
K All-day	83	83	82	76					
K Half-day	18	18	18	18					
Intervention children-at-risk	30	29 (33)	27 (25)	22 (26)	22 (26)	22	22	21	20
Control children-at-risk	22	22 (25)	21 (24)	20 (21)	20 (21)	20	20	20	19
Intervention children not at-risk	78	78	76	77	77	77	77	74	77
Control children not at-risk	79	79	79	74	74	74	74	75	75
Intervention drop-outs	-	1	4	4	-	-	-	12	-
Control drop-outs	-	-	1	6	-	1	-	-	-
Change of group, Int.gr.to contr.gr.	-	-	-	-	-	-	-	2	-
Study	I-III	I-III	I	I-III	I	II-III	II-III	II-III	II-III

Notes. Ka=Kindergarten pretest, Kb=Kindergarten posttest. G1 a= grade 1 autumn testing, G1 b= grade 1 spring testing. G2-G9= grades 2-9. Frequencies within parenthesis refer to the 28% estimate of children-at-risk in Study I. Int.gr= Intervention group. Contr.gr=Control group.

All participating kindergartens were all-day kindergartens, except for two half-day kindergartens in the intervention group as well as two in the control group. In Study I, the two half-day kindergartens in the intervention group, which followed a training dose of 60% of the Bornholm intervention program, were compared to the corresponding two half-day kindergartens of the control group. The difference between the two levels in the intervention kindergartens was purely quantitative, i.e. the type of training provided to the children was similar. For Study I, children-at-risk of reading difficulties were defined as the ones belonging to the lowest quartile of the sum of z-scores for letter knowledge and

phonological ability at the beginning of kindergarten³. The children at-risk in the intervention group numbered 33 and those in the control group 25 at the beginning of the study.

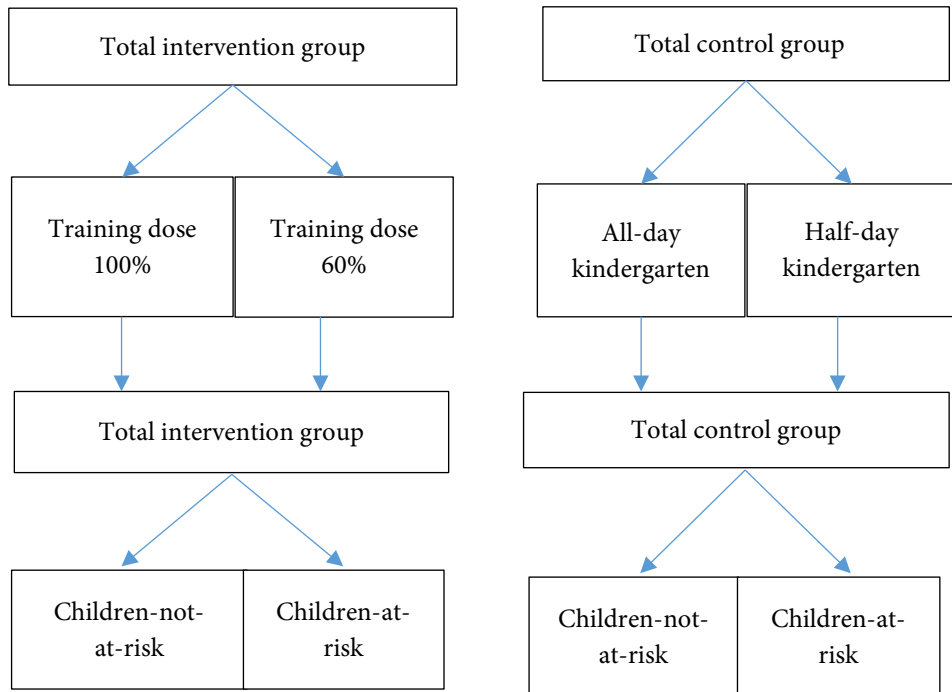


Figure 1. Intervention and control groups and their different subgroups.

For Studies II and III, the status of children-at-risk was again defined as the lowest quartile (25%) of phonological awareness and letter knowledge at the beginning of the kindergarten year were 30 children-at-risk in the experimental group and 22 children-at-risk in the control group. In grades 1, 3 and 4, the numbers were 22 versus 20, in grade 6 21 versus 20 and in grade 9 20 versus 19. The rest of the sample belonged to the not-at-risk group. In kindergarten the intervention group and control group consisted of 78 and 79 not-at-risk participants, respectively. In grade 9 the corresponding numbers were 77 versus 75.

By the end of the study in grade 9 the participants were on average 15 years and 9 months old. By that time the sample was reduced to 191 adolescents. The

³ In fact, as it was discovered afterwards, the number of at-risk children in Study I represented 28% of the participants with the lowest scores.

attrition of 18 participants was due to 9 children who remained for an additional year in kindergarten based on prognostic data suggesting that an additional year in kindergarten would be beneficial to their school debut. These children still participated in the phonological transfer tests in the beginning of grade 1. Further, seven children moved away from Åland and two children moved within Åland from a control group class to an intervention group class during their school years. Two participants moved from an intervention group class to a control group class in grade 6 and could remain in the study. Missing values were due to illness or administrative failures in test procedure. The percentages of missing values in the intervention and control groups at school age ranged from 6.9 to 21.3, depending on the study group and outcome. The rate of the missing data was, at most, 10% and the missing values were clearly associated with the kindergarten measures. Children with missing data in both groups scored lower in letter knowledge and phonological awareness. In general, there was somewhat more attrition among low-scoring intervention students in the pre-reading skills measured in kindergarten.

4.2 Test procedures and materials

The school system in Åland is homogenous and even the kindergartens are regulated by a master plan of the Åland Government as well as by local plans. The master plan from 1997 prescribes language awareness activities, but gives no precise direction concerning any specific training content. These decisions are made with support of the local plans and in the individual kindergartens. The only criterion when choosing control kindergarten classes was that they had other language activities than the specific and intensive Bornholm language games. The content of the local plans in kindergartens in the control group was assessed by questionnaires given to the teachers. They indicated language-stimulating activities for 10 of the 13 classes. On average, such training sessions were arranged once or twice a week. The exercises typically included rhyming, some letter recognition, syllable and phoneme segmentation and general language production. Regrettably, it was not possible to have daily notations of the exact amount of phonological activities in these control classes.

To ensure treatment fidelity in the intervention groups, kindergarten teachers were carefully instructed both in groups and individually as to how to carry out the program. This factor is important. For example, an extensive analysis of German intervention studies a defective preparation as the main cause of unreliable training results (Schneider, 2018). The intervention teachers met regularly once a month at in-service training given by the author, sharing experiences of how to administer the phonological language games. The teachers also participated in theoretical

background lectures given by one of the co-writers of the Swedish “Bornholmsmodellen” (Häggström, 1996). Since the program extended eight weeks into the autumn term of grade 1 at school, primary school teachers were also invited to participate in the in-service training. Before the study began, a pilot program with kindergarteners not participating in the study was implemented to familiarize the teachers of the intervention group with the program and the tests. During the intervention, fidelity was assessed by questionnaires to kindergarten teachers who also wrote diaries about their work. All the tests during the study were administered by the children’s ordinary teachers, who were carefully briefed by the author and also had detailed written instructions.

Speech therapists, child healthcare workers and librarians were also informed and invited to a cooperating network. Parents, politicians, school administrators and school principals participated in information meetings. The municipalities of the participating kindergartens showed excellent co-operation and the Government of Åland supported the intervention project financially.

Study I:

In the beginning of the kindergarten year (1997), one year before school start, all the children in the intervention and control groups were individually pre-tested with a set of eight tests of phonological awareness as well as letter knowledge, early reading and vocabulary, (Table 2; for further details see Kjeldsen et al., 2003). A group test of language comprehension was also administered (KTI. Krogh, 1977). From September to April the children in the intervention group were given daily 15-20 minutes sessions of phonological awareness exercises and games. These were highly structured to follow a strict progression from easy to more complicated tasks. The control group followed the ordinary kindergarten program, also including phonological awareness exercises, but training in these skills was much less structured and frequent. The total training time was less than in either of the experimental groups (60% = 3 days/week and 100% = 5 days/week). By the end of April, both groups were given the same tests as in pre-testing. For the intervention group a condensed version of the phonological awareness training was repeated during the first eight weeks of grade 1. When the intervention was finished in October in grade 1, a phonological awareness transfer test was administered (Table 3) as well as tests of non-verbal cognitive ability and perceptual-motor skill (Table 4). The phonological transfer test consisted of a set of group tasks that were different from the tests used at pre- and post-test during the kindergarten year. At the end of grade 1, in April-May, reading, spelling and mathematics skills were assessed in group tests. At the end of grade 2, in April-May, reading and spelling were assessed in group tests (Table 4).

Table 2. Phonological tests. Kindergarten pre-testing autumn, post-testing spring

Subtest	Max Score
1. Rhyme test	18
2. Word segmentation	2
3. Syllable blending	3
4. Syllable segmentation	3
5. Initial phoneme identification	8
6. Initial phoneme deletion	8
7. Phoneme blending	8
8. Phoneme segmentation	8
Sum score phonological tests 1-8	58

Note. Swedish versions of the same phonological tests as in Lundberg et al. (1988) were used. All phonological tests were conducted individually. For descriptions, see Kjeldsen et al., 2003.

Table 3. Phonological transfer tests. Grade 1, autumn

Subtest	Max Score
1. Rhyme test	5
2. Word length analysis	9
3. Initial sound analysis	9
4. Phoneme segmentation	9
Sum score phonological transfer tests 1-4	39

Note. Swedish versions of the same phonological tests as in Lundberg et al. (1988) were used. All phonological transfer tests were group-administered. For descriptions, see Kjeldsen et al., 2003.

Study II:

Study 2 was a continuation of Study 1 that is, a follow-up of the children's reading progress after grades 1 and 2. In grades 3, 4 and 6 decoding was assessed by a word chain test which taps word attack skills in the absence of contextual support. However, the grade 3 test differed from the grade 4 test in terms of the number of words in each chain. For the data analysis and model testing, the grade 3 data had to be equated with those of grades 4 and 6. This was done by means of a linear equating procedure using a new sample of grade 3 students randomized into two groups, who received the tests in different orders (Crocker & Algina, 2008, 459-460). Based on these data, the grade 3 measurements were transformed to grade 4 equivalent measurements. Reading comprehension was assessed in grade 9.

Table 4. Test batteries in kindergarten and at school

Subtest	K	G1	G2	G3	G4	G6	G9	Study
Early reading (4)	X							I, II, III
Letter knowledge (56)	X							I, II, III
Language comprehension (5)	x							I
Vocabulary (66)	x							I, II
Total phonological tests (58)	x							I, II, III
Total phonological transfer tests (59)		x						I
Raven progressive matrices (35)		x						I
Perceptual-motor speed (80)		x						I
Mathematics G1 (40)		x						I
Reading ability G1 (400)		x	x					I
Decoding G1 (120)		x						I
Spelling G1 (30)		x						I, III
Decoding G3 (60)				x				II
Decoding G4 (64)					x			II
Decoding G6 (64)						x		II
Reading comprehension G4 (35)					x			III
Reading comprehension G6 (35)						x		III
Reading comprehension G9 (36)							x	II, III

Note. Maximum scores in parenthesis. K=Kindergarten, G1-G9 = Grade 1-9.

Measures: Kindergarten reading (Lundberg et al., 1980, 1988), Letter knowledge (Lundberg et al., 1988), Language comprehension (KTI, Krogh, 1977), Vocabulary (Sproglig test 1, Ege, 1985), Raven progressive matrices (Raven, 1960), Perceptual-motor speed (Figure-chains, Olofsson, 1995). Mathematics (MAKEKO, Ikäheimo, Putkonen, & Voutilainen, 1989), Reading ability (OS400, Soegaard & Boarding Petersen, 1974), Decoding G1 (Word-chains, Olofsson, 1997), Decoding G3–G6 (Reading chains, Jacobson, 1995; 2001), Reading comprehension G4-G6 (DLS 4-6, Järpsten & Taube, 1997), Reading comprehension G9 (Classroom diagnoses of reading, Johansson, 1992)

Study III

As in Studies I and II, a sum score of eight tests of phonological awareness was computed for kindergarten pre- and post-tests. Spelling in grade 1, word decoding in grades 1 and 3 and reading comprehension in the grades 4, 6, and 9

were assessed. The main objective was to study possible differences between not-at-risk children and at-risk children.

4.3 Intervention

The language games of the Bornholm study (Lundberg et al., 1988) were originally written in Swedish and translated into Danish when used in the kindergartens of Bornholm (Lundberg et al., 1988). The present study was the first to be carried out in Swedish, which is also spoken in certain regions in Finland, including Åland. The Åland study also differed from that of Bornholm in that, according to the pretest scores, it was carried out in a context with more literate kindergarteners as well as with kindergartens using language activities more extensively. Moreover, the Åland kindergarten teachers were more acquainted with the concept of phonological awareness. To be able to compare the two studies, similar tests were used. "Bornholmsmodellen", the Swedish version of the intervention was used (Häggström & Lundberg, 1994). A pilot year of systematic training with different kindergarteners was carried out in 1996-1997, the year before the study started, in order to allow all involved teachers of the intervention group to become familiar with the program and the tests.

The training period was introduced in the beginning of the kindergarten year and lasted for 8 months. The program of the 100% training dose consisted of daily 15-20 minute sessions. The 60% training dose group followed the same training but only three days a week. The intervention program consisted of six basic sets of tasks and each set had seven to twelve different tasks or games. The program started with rather simple listening games based on non-verbal and verbal sounds followed by a group of rhyme tasks. The focus of the third set was on sentence and word awareness while the fourth was about syllable awareness. After three months of training, the smallest units of phonological awareness were introduced featuring identification of the initial phoneme. Finally, in the fifth month, the sessions included phoneme blending and phoneme analysis. Following this structure, each kindergarten teacher could select among the tasks and games for each session. The teachers also carefully planned the sessions in advance and made notes afterwards to revise the subsequent training schedule. A typical training session consisted of five to nine tasks. Some of them were repetitions from previous sessions while others introduced a new concept or procedure. The format was playful and multi-sensory. Pictures, toys, singing, dancing and hand-clapping were frequently included in the language games.

Plastic and wooden markers and letters were used at later stages to represent whole words and word parts.

4.4 Data analyses

In Study I, a repeated measures multivariate analysis of variance of an SPSS software package was carried out involving all kindergarten pre-reading measures. Interactions were analyzed by univariate tests. Post hoc tests were done on post-test group differences. The effect of training dose was analyzed by a series of t-tests. The statistical procedure was repeated for grade 1 and grade 2 literacy outcomes as well as for an analysis of at-risk children belonging to either the intervention or control group. Children at risk for reading failure were defined as those whose individual sum z-score for letter knowledge and phonological awareness belonged to the lowest quartile at the beginning of the kindergarten year.

In Studies II and III, the longitudinal analyses were based on modern multivariate methods. In Study II, the individual developmental trajectories from grade 3 through grades 4, 6 and 9 were analyzed by means of latent curve models of an Mplus 7.11 software package. Because the intervention aimed at producing interaction effects with trained children showing a faster literacy development over the years, a nonlinear trajectory was specified for decoding development. The analysis target was on predicting growth in decoding through grades 3 to 6, as well as the final outcome, that is, reading comprehension in grade 9.

In Study III, the focus was on the reading development of children at risk for reading failure. The analyses were performed within the structural equation modeling framework which allows the specification of more complex models and provides more information on model fit. Multiple-group path models were estimated with a software package Mplus 7.4 using a maximum likelihood estimation with robust standard errors (MLR).

The hypothesized multiple-group path model comprised a series of regressions including the measures of reading ability regressed on themselves (i.e., autoregressive paths) or on an analogous measure at a previous time point. The change in phonological awareness was regressed on the treatment variable (i.e., intervention or control). The effects of gender and baseline phonological awareness on all the study variables were also controlled for. The model was evaluated according to χ^2 goodness-of-fit statistics and several fit indices following conventional criteria for acceptable model fit. We followed up the

composition of the lowest quartile group to see whether their reading development could be predicted by the membership in the intervention or control group. These analyses were based on the whole sample, also including the few students who already could read when the intervention began. Cross-tabulations were produced to illustrate the relative standing of at-risk children in the whole group in terms of selected measures of later reading ability.

5 RESULTS

5.1 Study I: Training phonological awareness in kindergarten level children: consistency is more important than quantity

The purpose of the study was to find out whether a smaller 60% dose of the original program of Lundberg et al., (1988) would give similar results in reading and spelling skills as the 100% training dose. Another purpose was to study the intervention effects in children-at-risk for reading disabilities defined as those children belonging to the lowest quartile of phonological awareness and letter knowledge in the beginning of the study. The original 209 participants showed no statistically significant differences between the intervention and control group on initial kindergarten measurements of phonological awareness, pre-school reading ability, letter knowledge, language comprehension and vocabulary. The only exception was phonological segmenting ability with the control group outperforming the experimental group.

Firstly, the kindergarten post-tests showed that the two intervention groups with the 60% and 100% training dose outperformed the respective control groups in all eight subtests of phonological ability (Table 2). The only difference was in the vocabulary test which failed to reach significance and the largest effect was found for the tests of phonological ability. The difference between the intervention group with a 60% dose of training and the larger control group of all-day kindergartens was close to significance ($p = 0.077$). The effect of the training dose showed no differences between the 100% and 60% dose of training on either kindergarten or grade 1 measures. Because of similar test performances, the groups with different training doses were combined to one intervention group, which was compared to the combined control group of all-day and half-day kindergartens in all subsequent analyses. The phonological training also stimulated early reading ability although no explicit teaching in it was given. At the kindergarten pre-test of reading, 78% of the children in the intervention group and 85% in the control group showed no sign of reading. In the post-test the figures were 44% vs. 61% for non-reading, and 20% vs. 8% for fluent reading.

At the beginning of grade 1 there was a significant overall difference between the intervention and control groups (combined) in all phonological transfer tests (Table 3). At the end of grade 1 there was a significant difference in mathematics, reading, decoding, and spelling (Table 4). In grade 2 word reading ability

showed a significant difference whereas spelling did not. The specific effects of the phonological training are underscored by the fact that measurements of general cognitive ability and perceptual-motor speed did not show any difference between the groups.

Secondly, the kindergarten training in phonological awareness improved the at-risk children's word reading ability in the grades 1 and 2 and their spelling ability only in grade 1. For these children, similar training-induced gains were found with both training doses (60% vs. 100%). In fact, the children-at-risk with a 60% training dose reached the same level as the total control group in all measures except reading ability in grade 1. Their reading developed somewhat more slowly and showed no reading gains until grade 2 comparable to those of mainstream readers. The findings were discussed in terms of metacognitive insights into reading, which are obtained through strictly systematic phonological kindergarten training. It is suggested that also a smaller 60% training dose of the phonological kindergarten intervention gives positive training results. The gains were most obvious for the group of children-at-risk for reading disabilities.

5.2 Study II: Gains from training in phonological awareness in kindergarten predict reading comprehension in grade 9

The purpose of the second study was to explore whether phonological training in kindergarten would result in better decoding in grades 3, 4 and 6 as well as in improved reading comprehension in grade 9. The results showed small but significant effects with the intervention group scoring two points higher than the control group in decoding in grade 3. Boys as a group scored on average two points lower than girls. The reading readiness, including both kindergarten phonological awareness and letter knowledge, predicted the level of decoding as well as reading comprehension in grade 9. Moreover, the level of decoding had a direct effect on grade 9 reading comprehension. The total effect of the intervention on grade 9 reading comprehension was 3.7 points. Twenty-two percent of the total effect of the intervention on reading comprehension was direct, whereas seventy-eight percent was an indirect intervention effect mainly passing through the level of decoding. However, the effect size (*d*) for the total indirect effect was 0.31 indicating a small effect; for effects via the level 0.21 and for effects via growth rate 0.10.

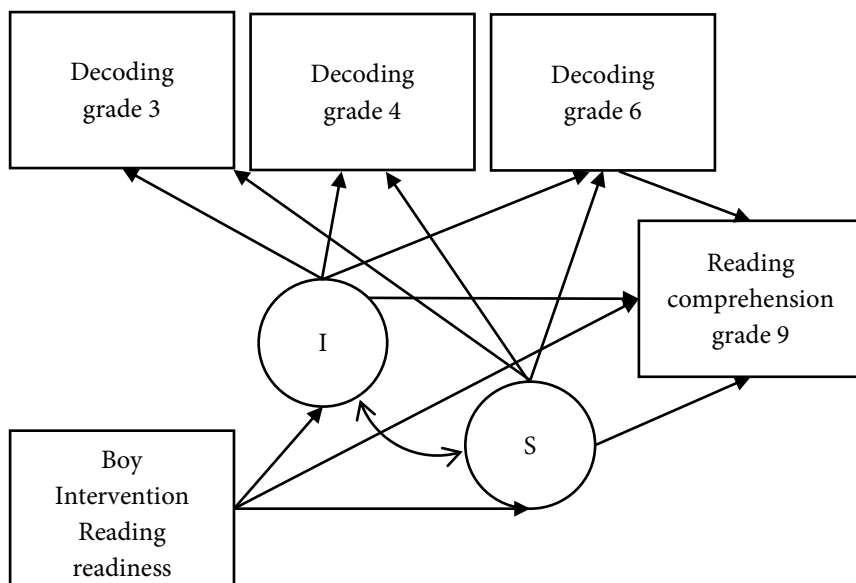


Figure 2. A latent curve model for testing intervention effects on decoding in grades 3, 4, and 6. I=Intercept (level); S=Slope (growth).

The results also confirm the finding from Study I that the difference in word reading between the intervention and control group was already in place in grade 1. This difference remained stable through primary grades and generalized to reading comprehension in grade 9. The results, even if they are modest, lend support to the usefulness of an early phonological training before formal reading instruction at school. As an implication it is suggested that the early starting point of a systematic phonological training should be combined with exact knowledge of which literacy-related activities take place during the subsequent grades.

5.3 Study III: Kindergarten training in phonological awareness: fluency and comprehension gains are largest for readers-at-risk through grades 1 to 9

The first aim was to investigate a hypothesized theoretical model of chain-link processes of reading development following the phonological kindergarten intervention. The second aim was to examine suggested differences in the intervention effects on phonological awareness and on the subsequent ability of word decoding and reading comprehension between children at-risk for reading failure and those not at-risk. As a complement to this, the third purpose was to

examine the proportion of children-at-risk remaining in the group of at-risk readers through all school years.

The results showed that the direct effect of the intervention on the increase in phonological awareness during the kindergarten year was significantly higher in the intervention group relative to the control group for both children at-risk and children not at-risk (Figure 3). The improvement was 1.50 times higher for the at-risk group with the intervention compared to the at-risk group in the control group with no intervention.

In terms of gender effects, the results for the not at-risk group indicated that boys had lower phonological awareness, $b = -4.371$, $p = .012$, and word decoding skills in grade 1, $b = -3.403$, $p = .001$, compared to girls. In the at-risk group there were no gender differences except for spelling in grade 1, $b = -2.189$, $p = .001$, with boys scoring lower than girls. Phonological awareness performance was positively associated with both at-risk and not at-risk kindergarteners' spelling skills in grade 1, $b = 0.307$, $p = .017$, and both at-risk and not at-risk kindergarteners' reading comprehension in grade 4, $b = 0.128$, $p = .005$.

The increase in phonological awareness during the intervention predicted word decoding and spelling in grade 1 for both at-risk and not at-risk readers. The same pattern held true for grade 1 word decoding and spelling which, in turn, predicted word decoding in grade 3. Of these outcomes, word decoding in grade 3 predicted reading comprehension in grade 4 for both groups. This autoregressive path was continued through grade 6 until grade 9 reading comprehension.

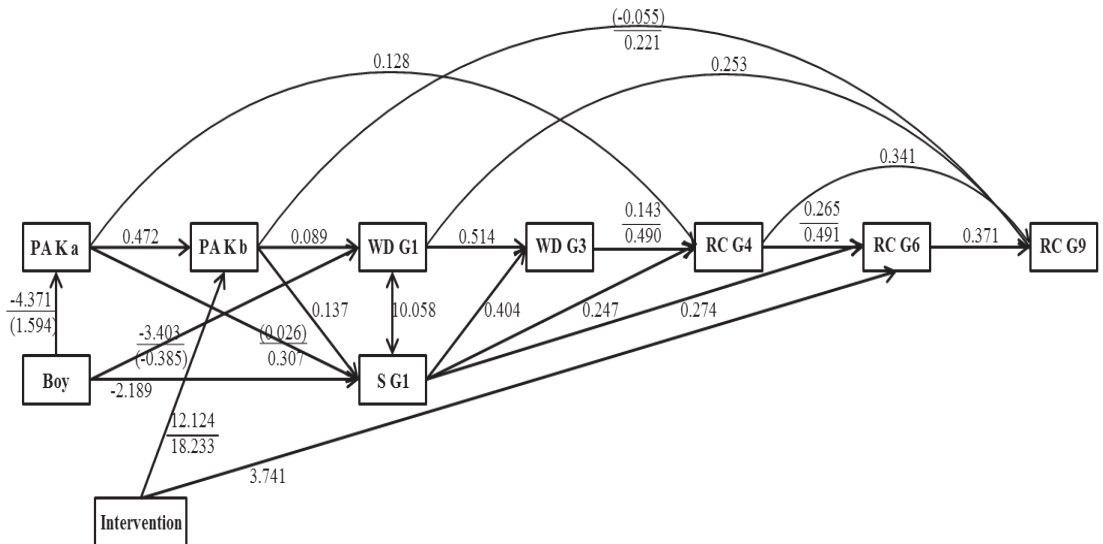


Figure 3. Multiple-group path model for the development of reading ability following the kindergarten phonological training intervention (PA = phonological awareness, S = spelling, WD = word decoding, RC = reading comprehension, K = kindergarten, a = pretest, b = post-test, G1-9 = Grade 1-9). Reported are the unstandardized parameter estimates. The estimates in parentheses are not statistically significant ($p > .10$). For associations that differ across the two groups, the estimates above the line are for children not at risk and those below the line are for at-risk children.

The results also showed a direct intervention effect on reading comprehension in grade 6. Participation in the intervention and prior ability were somewhat more predictive of later word reading ability for the at-risk children as compared to the not at-risk children. The results showed that 32% of the at-risk children in the intervention group as opposed to 60% of the at-risk children in the control group still belonged to the at-risk group in grade 1. Regarding the not at-risk children in the intervention condition, 13% had become members of the at-risk group in grade 1. The corresponding percentage for the not at-risk children in the control condition was 31%. The grade 1 risk status results indicated gains from the intervention for both at-risk and not at-risk children. To summarize, approximately twice (60% vs 32%) the number of children in the control group, as compared to children in the intervention group, were defined at-risk for reading failure in grade 1. In grade 6 reading comprehension 24% of the at-risk children in the intervention group still belonged to the at-risk group, as opposed to 60% of the at-risk children in the control group. The corresponding percentages for the not at-risk children were 9% for the intervention group vs.

35% for the control group. In grade 9 reading comprehension, 25% of the original at-risk children of the intervention group still had the same status as opposed to approximately twice the proportion, 53% of their peers. The corresponding percentages for the not at-risk children were 17% for the intervention group and 27% for the control group, that is 1.6 times higher.

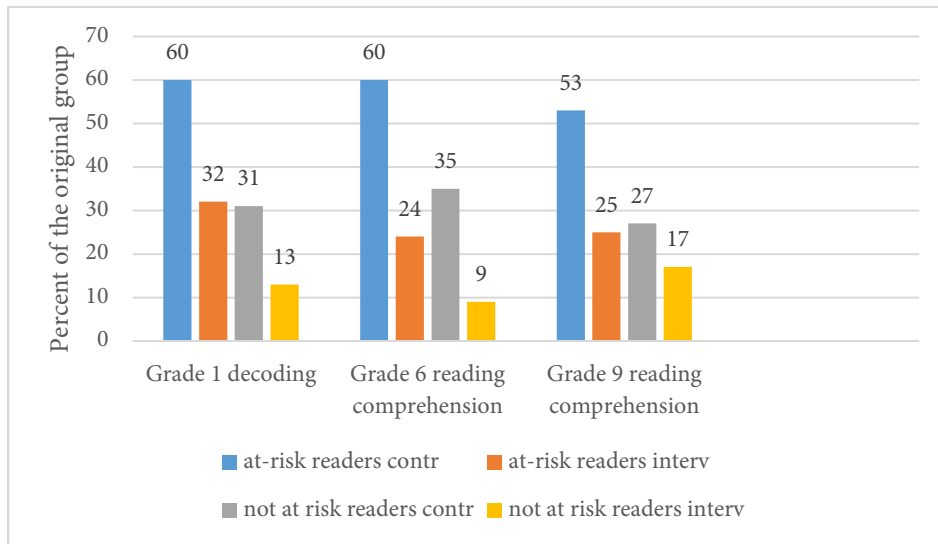


Figure 4. The proportions of kindergarten at-risk and not at-risk children belonging to the lowest quartile (25%) in decoding (grade1) and reading comprehension (grades 6 and 9)

5.4 After the fact: descriptive analyses.

When Ingvar Lundberg conceived the original Bornholm study, the issue of gender differences was not of immediate interest in contrast with the situation about 15 years later. Several recent studies point to the tendency of increasing differences between boys and girls (e.g. Price-Mohr & Price, 2017; Torppa, Eklund, Sulkunen, Niemi, & Ahonen, 2018; Voyer & Voyer, 2014). In the present study, the same pattern of gender differences was found. An after the fact analysis of gender-related effects revealed that both boys and girls benefitted from the training. However, there were consistent gender differences in the whole cohort in favor of girls on virtually all measurements throughout the school years. Intriguingly, both boys and girls at-risk performed at an approximately similar level; sometimes boys even outperforming the girls. When comparing boys at-risk with the whole cohort of boys, the mean scores were close to each other with no statistically significant differences. A caveat is that these analyses are mainly descriptive because of lacking statistical power.

6 DISCUSSION

6.1 Key findings and their implications

The aims of the present study were threefold. First, to replicate in Swedish the intervention conducted with Danish kindergarteners on the island of Bornholm by varying the training dose. Second, to evaluate the immediate effects as well as to follow the students' literacy development from kindergarten until the end of the comprehensive school, resulting in a 10-year follow-up. Third, to compare the reading development of readers-at-risk with and without training through grades 1 to 9.

The overarching goal was to find support for an evidence-based working model which could serve as a pedagogical guideline and Good Practice in kindergartens and schools for the entire class and especially for children-at-risk for reading difficulties.

6.1.1 The Åland study

Lundberg et al. (1988) set a standard for a Nordic model of early phonological kindergarten intervention. Their so-called Bornholm study was designed for the whole kindergarten classes with an emphasis on, in addition to cognitive and linguistic training, peer influence and group dynamics. The daily language games followed a systematic structure in pre-defined target skills and were conducted in the course of the last kindergarten year before school start at seven years. Understandably, these features of the intervention were known to the kindergarten teachers whereas the children thought that they were just playing attractive games.

Inspired by the Nordic model, a modified replication was developed in the present Åland study with certain characteristics differing from the original Danish intervention. First, as opposed to the study of Lundberg et al. (1988), the geographic proximity of the intervention and control groups was pronounced in Åland. Second, in all Åland kindergartens language stimulating activities were already in use to some extent before the present study started, among them some phonological exercises. This means that the control group also received phonological stimulation to a certain extent. Third, unlike the Danish peers, there were a number of precocious readers among Åland kindergarteners. Fourth, because of feasibility issues, a smaller part of the intervention group received only a 60% dosage of the training program instead of a 100% dosage, although in original proportions. These differences from the Lundberg's et al.

(1988) study were likely to make a successful replication more difficult to achieve. As it transpired, however, this was eventually accomplished. The key findings of the present study are as follows:

1. Both training doses, that is 60% and 100%, yielded significant training effects on word decoding and spelling.
2. Word decoding gains sustained until grade 6. Text comprehension gains sustained until grade 9.
3. Children at-risk for reading difficulties in kindergarten age benefitted most from the training with the effects on word reading ability and text comprehension sustaining until grade 9.

The relatively high initial levels of letter knowledge and early reading ability suggest that the present phonological awareness training was implemented in a context of ubiquitous informal letter teaching and learning, typically taking place in the home environment. Despite this, the kindergarten training had a large effect on phonological awareness, which is an important pre-requisite for being able to “crack the letter-to-sound code” that is, learning to decode grapheme strings. The fact that training exerted an effect under such circumstances is in line with the phonological linkage hypothesis (Hatcher, Hulme, & Ellis, 1994; Lundberg, et al., 2012) and the findings of Schneider, et al. (2000), showing that the effect of phonological training is considerably strengthened when the training is carried out in concert with the teaching of letter-sound correspondences. It appears that phonological training yields particularly strong positive transfer effects when given before children have learned to read. Moreover, in line with our third finding above, Galuschka et al. (2014) found in their meta-analysis of randomized controlled trials strong positive effects when phonological training was given to preschool children at risk for reading difficulties.

Stable positions and long-lasting gains

The training gains of the present intervention were cemented in grade 1 and remained stable through grade 9 as regards both word decoding and reading comprehension. Spelling ability was measured in grades 1 and 2, and the results were perfectly in line with those obtained for word decoding (Kjeldsen et al., 2003). In accordance with this, stable individual differences were seen in phonological decoding abilities in a Swedish follow-up study of reading-retarded children through grades 3 and 12 (Svensson & Jacobson, 2006). It seems likely that gains in phonological awareness functioned as a catalyst for the

subsequent reading development. Interestingly, no trace of the so-called Matthew effects on reading (Stanovich, 1986) could be seen because the pupils' relative position in grade 1 already determined their subsequent rank.

After the initial gain was established, the question was for how long it would last. For the intervention group, the results showed improved word decoding until grade 6 as well as better reading comprehension through grade 9 as compared with pupils without the intervention. It is noteworthy that reading comprehension was not trained in the program but instead was obviously built on the early phonological gains brought about by the intervention. The results lend support to the notion that training in phonological awareness can have long-lasting beneficial effects on word reading, which then generalize to reading comprehension. This is a novel result. Previously only Elbro and Klint Petersen (2004) have reported a nonsignificant tendency towards improved reading comprehension among seventh graders, following a phonological intervention carried out in grade 3.

Both mainstream readers and readers at-risk benefitted from the training, as was also found by Schneider, Ennemoser and Roth (1999). However, it should be noted that in the present study, even the control group was offered language stimulating activities, albeit in an unstructured and more spontaneous fashion. It is of importance that the program given to the intervention group featured planning, systematicity, hierarchical structure and continuity. Therefore, even the 60% training dose was powerful enough to produce positive effects comparable to those brought about by the full dose. This outcome suggests that when training is given, its structure and continuity are more important than the quantity that is, number of repetitions per training unit as such. Obviously, although the question of the sufficient training dose and intensity remains open, it can be speculated that a certain amount suffices to give rise to metacognitive and motivational processes which stimulate early reading development. This possibility is dealt with in some detail later in Discussion.

A further question is about the optimal total length of the training. Should an intensive program, for instance, lasting for four to six weeks be preferred to one extending over the whole kindergarten year or even longer? Unfortunately, the present study cannot give an answer. For example, it can be assumed that a sufficient length of the intervention would be crucial for the establishment of the transfer effects on literacy development. In fact, after the present study had ended, most of the kindergartens and preschools in Åland began to practice systematic Bornholm language games so that the later cohorts of children

received training over several years. Children three to four years of age started with the easiest language games which were followed by more advanced exercises at the age of five to six years. The intended outcome of this long-lasting intervention, albeit still untested, is to offer more time-on-task for children-at-risk of reading difficulties. In addition, the revised Swedish version of the Bornholm language games recommend an earlier start of the phonological training in preschool preceding the kindergarten year (Hägström, 2017).

The original phonological kindergarten intervention by Lundberg et al. (1988) already underscored the value of playfulness, joy and pleasure for children involved in the training. Moreover, the title of the program, 'Språklekar enligt Bornholmsmodellen' (Language games according to the Bornholm model), refers to this focus. Indeed, the theory of the role of play in child development (Vygotsky, 1978) has been a source of inspiration in educational settings. For example, McInnes, Howard, Miles and Crowley (2009), drew on children's own definition of play to create both formal and playful practice conditions. It was shown that in playful practice conditions, children outperformed peers participating in formal practice conditions across a range of activities. They also reported a better quality of learning experiences. Playful activities within educational contexts are likely to lead to effortful, deliberate and intentional learning (e.g. Whitebread et al., 2005; Whitebread, Coltman, Jameson, & Lander, 2009). Although the language games of the Bornholm model feature structure and systematicity, they also create room for children's own spontaneous discoveries when manipulating rhymes, syllables and sounds. For this purpose, the games and exercises include multi-sensory activities such as singing, dancing, using toys and pictures for the children's enjoyment.

An important aspect is that the obtained training effects were specific to literacy. This was underscored by the non-significant differences in the performance IQ and visual motor speed which are in accordance with the findings of Lundberg et al. (1988) and Schneider et al. (1997). An analysis of gender-related effects revealed that both boys and girls benefitted from the training. However, there were overall consistent gender effects in the whole cohort in favor of girls on virtually all measurements from the very beginning and extending through the school years. Interestingly, both boys and girls initially at-risk of reading failure performed at approximately the same level; sometimes boys performed even better than girls. When boys at-risk were later compared with the whole cohort of boys (including boys at-risk), the means of all tests were close to each other with no statistically significant differences. To conclude, the intervention did not eliminate gender differences at the level of the whole cohort, but it did so

among children-at-risk for reading difficulties. In other words, the intervention raised the group of at-risk boys to the same level as all the other boys in the cohort, while the corresponding pattern was not observed in the group of at-risk girls. This is a promising outcome because the tendency towards lower literacy skills of boys is already clearly marked in the early PISA studies (for a review, see Harju-Luukkainen & Nissinen, 2009), with Åland having the largest gender differences among 15-year-old students in the participating countries. However, the present Åland study was ended two years before the PISA 2009 study in question was conducted with another cohort. The development of boys' literacy skills will be one of the greatest challenges in future. There is a risk that a gender-related imbalance based on initial gender differences in literacy performance will create new social classes of educated and uneducated people. Those who fail in school are at risk of losing their self-confidence and lacking the crucial abilities to function in everyday life as adults (e.g. Taube, 1988).

6.2 The role of metacognition and self-teaching mechanisms

So-called pre-reading abilities that is, letter knowledge, phonological and rapid naming ability, are not the only skills to facilitate reading acquisition. A further auxiliary skill is the ability to reflect upon one's own cognitive processes, for example thinking. This metacognitive ability consists of knowledge about and monitoring of cognition. The prefix 'meta' refers to the cognitive ability of shifting one's attention from a concrete strategy to an abstract strategy. Metacognitive monitoring involves the guiding of one's learning processes by self-regulation (e.g. Schraw, Crippen, & Hartley, 2006), an essential motivational asset in learning to read (Whitebread et al., 2009). During play children are in control of their own (vicarious) learning (Vygotsky, 1978). Therefore, playful contexts are crucial for the development of self-regulatory skills or self-teaching mechanisms in young children. Whitebread et al. (2009) showed that the role of play, especially the pretend or symbolic play (Bornstein, 2006), significantly contributed to young children's learning development by supporting their metacognitive and self-regulatory skills, which are vital for children's thinking, problem-solving and creativity.

Once acquired, early metacognitive and self-regulatory skills are both profound and stable (e.g. Blair & Razza, 2007; Schweinhart & Weikart, 1998; Veenman & Spans, 2005). It appears reasonable to assume that the development of these two skills require pedagogic effort extending over several years. Metacognition can

be promoted by modeling by teachers, for example by “thinking aloud” (Kramarski & Mavarech, 2003). Whitebread et al. (2009) also highlighted the role of adults’ interaction in young children’s play as well as the adults’ understanding of the importance of self-regulation in young children’s learning processes. This involvement should take place in a sensitive and skillful way by, for instance, moving the play on, increasing the cognitive challenge, and providing new ideas and vocabulary. When a particular learning strategy is taught, metacognition helps to transfer it to a new, usually analogous context (Kuhn & Dean, 2004). In this vein, a successful transfer of pre-reading skills to subsequent reading acquisition can be interpreted in a context which is related to metacognition (Share, 1995; Share & Stanovich, 1995). Metacognitive and thereby phonological insights create a resource for the child, boosting a willingness to initiate self-teaching processes (Whitebread et al, 2009; Whitebread, 2010).

Is it possible that self-teaching already plays a role before learning to read? During the Åland intervention, a frequent experience reported by kindergarten staff as well as parents was that the structured language games proved socially contagious, instigating spontaneous repetition outside the kindergarten and school contexts. For example, kindergarten teachers noticed children embedding language games in their free play. Once a girl told her teacher: “Today, I will have my birthday party and then we will play the Bornholm language games!”. In addition, parents reported that children sometimes played the language games at the breakfast table or in the taxi on the way home from kindergarten.

The concept of metacognition helps to understand how children use linguistic processes in the context of reading by controlling their thinking and learning processes. There is a link between metacognition and phonological awareness where metacognition is the tool for developing phonological awareness, an ability of sound manipulation beyond what is immediately obvious. This is not a novel thought. Some decades ago, the concepts of metalinguistic awareness and metaphonological awareness were frequently used in research on learning to read. The implication, intended or not, was that they can be subsumed under the more general concept of metacognition. Perhaps the best-known presentation of the idea is Gombert’s (1993) model of metalinguistic development. (Meta)-linguistic awareness is gradually building up when the child uses spoken language for manipulating and analyzing words and sounds, usually spontaneously but sometimes also as a part of phonologically based language games prompted by others. Thereby the connections between sounds,

words, and even letters are gradually solved and implemented in memory as functional units. Such metacognitive insights are fundamental for the development of a functioning letter knowledge (Frost, 1999), awareness of meaning and understanding the relation between letter forms, letter sounds and the construction of words. The dynamic moment of cracking the alphabetic code thus becomes possible.

6.2.1 Does the concept of metacognition help to understand the present results?

Several empirical studies in Scandinavia and elsewhere have identified both metacognitive knowledge and metacognitive experiences as crucial factors for skillful reading (Lundberg, 1991; Olofsson, 1985; Pressley & Gaskins, 2006). In a Finnish intervention study, Vauras, Kinnunen and Rauhanummi (1999) showed that metacognitive differences in grade 1 predicted subsequent problem solving ability as well as reading comprehension strategies. Intervention effects could be seen in grade 3 pupils' increased metacognitive awareness and insights as well as self-regulation. In another follow-up study, a positive developmental trend was found between children's metacognitive knowledge and their reading comprehension from preschool to grade 3 (Annevirta, Laakkonen, Kinnunen, & Vauras, 2007; Annevirta & Vauras, 2001). Poskiparta et al. (1999) found that students who progressed very slowly, so-called resistant learners, had the lowest metacognitive skills. Hence, a reasonable assumption is that metacognitive training would be beneficial for initial reading. Following suit, Kärnä (2005) studied the impact of kindergarteners' metacognitive skills on the development of their word decoding ability through grades 1, 2 and 3. No association was found in grades 1 and 2. Interestingly, a clear effect emerged among third graders who read continuous text in a context. The role of metacognition was also highlighted in a Swedish longitudinal intervention study of reading comprehension in grades 6 to 9 when teaching linguistic strategies promoted pupils' subsequent metacognitive skills (Varga, 2017).

The ability to manipulate even small phonemic units (e.g. segmenting and blending; Ziegler & Goswami, 2005) is typical for phonological exercises. It is justifiable to assume that such a skill also includes a metacognitive component because children must distance themselves from what the words under study stand for. Such insights promote the acquisition of so-called bottom-up strategies that pave the way for accurate and fluent word reading. Finally, well-functioning reading comprehension is reached when word reading strategies act in concert with top-down strategies of text comprehension which have a

pronounced metacognitive flavor. Since the 1980s, models of competent reading typically include both components (Stanovich, 1984; Rumelhart, 1977). However, during more recent years, research on metacognition has received less attention. Even the present Åland study lacks direct measurements of metacognitive skills. Consequently, the link outlined here between phonological skills and metacognitive insights remains speculative rather than being evidence-based.

In conclusion, it seems plausible that the kindergarten training presented has promoted, in addition to phonological awareness, also children's metacognitive ability. Whilst the targeted phonological awareness is a restricted skill, and beyond all dispute of pivotal importance to learning to read, metacognitive ability is a more profound resource steering learning in general. An attractive albeit speculative interpretation is that the presented long-term reading gains are in part due to an unplanned improvement of metacognitive skills during the training.

6.3 Is there a right way to teach beginning reading?

Although preschool and kindergarten education aim at reducing the variation in literacy skills among school entrants, the gap between the highest and lowest performing pupils is still considerable. The quality of the home literacy environment also differs and rather increases than decreases initial differences in pre-reading skills. This is a challenge for the teacher and a burden for those children who see their peers succeeding in early reading. Unsurprisingly, there have been heated debates about how to invite school entrants into the world of literacy. For example in the United States, the "Right Method" for reading instruction has given rise to a "reading war", starting in the middle of last century, and involving camps preferring either the "phonics" or "whole language" method of teaching beginning readers (Fredriksson & Taube, 2012). In Sweden a similar debate was highlighted during 1970-80 (Hjälme, 1999; Kullberg, 2006), with opinion divided between synthetically inspired teaching based on the smallest grapheme-phoneme correspondences as in phonics, or the analytically based method starting with the meaning and content of a text as in the whole language method. In Sweden, this theoretical division was reflected in two opposing ideas of the teaching of reading; the phonetic method of Witting (Witting, 1985) and the whole-word method of LTG (Läsning på talets grund; [Reading based on speech]; Leimar, 1984). These two methods also had an impact on the Finland-Swedish school system, but not in the same polarized way as in Sweden. Instead, the main method of reading instruction has been based

on knowledge of letters and their sound correspondences, as well as blending that particular skill with general language skills. Be that as it may, the phonological kindergarten training according to the Bornholm model is a practical example of a training method that includes both oral synthetic and analytic strategies in preparation for written literacy strategies, thus avoiding polarized views of teaching beginning readers.

6.4 The real target group: Children-at-risk of reading difficulties

In the present study, the children-at-risk for reading difficulties also improved their phonological awareness by the end of the kindergarten year. What is more, the gain was 1.5 times greater than that among kindergarteners-not-at-risk. The training helped the at-risk-kindergarteners to reach an average level of early reading ability at the beginning of their school career, which in this study was defined as performing above the lowest quartile of early reading ability. On a group level, this was true for about 2/3 of the trained at-risk children but only about 1/3 of the at-risk children in the control group who did not receive systematic training. The difference was maintained until the end of grade 9. A similar longitudinal pattern was found by Partanen and Siegel (2014): about 1/3 of the trained children-at-risk in kindergarten were still in the at-risk group in grade 7. These results corroborate, in a reversed order, that of Landerl and Wimmer (2008) who found that 70% of the at-risk readers in grade 1 were still at-risk readers in grade 8. In line with the study of Schneider et al. (1999), the difference between the trained at-risk group and the untrained at-risk group was 1.5 standard deviations in the phonological posttest in kindergarten as well as in phonological transfer test in grade 1. For the at-risk children in the present study, their relative positions among their peers were almost identical on all measurement points through grades 1, 6 and 9.

In conclusion, the principal winners from the intervention were the readers-at-risk. But who are they? A review of longitudinal behavior-genetic twin studies in the United States, Australia, Scandinavia, and the United Kingdom has emphasized the role of hereditary factors influencing individual deficits in reading. A strong genetic influence on reading ability has been shown by the end of the first year of formal reading instruction and as continuing through to the end of the second and fourth grade (Olson, Keenan, Byrne, & Samuelsson, 2014). The role played by the genetic factor has also been supported in studies on the effects of familial risk of dyslexia in which readers-at-risk are defined as those

with dyslexic parents and close relatives (e.g., Elbro et al., 1998; Lyytinen et al., 2001). Probably children of dyslectic parents in those studies were closer to so-called treatment resisters than readers-at-risk of the present study, who were identified on the basis of low scores in pre-reading skills. In the present study, there was no information about possible dyslexia among the parents. It should be noted, however, that in the present low-performing group there were also those who did not develop reading difficulties (for a related finding, see Lepola, Salonen, & Vauras, 2000). On the other hand, despite a high phonological awareness in kindergarten, some children will become slow decoders in later grades that is, after grade 5 (Catts et al., 2003; Lepola et al., 2000). Finally, among the not-at-risk kindergarteners there are children who remain on the lowest levels of reading skills through primary school and show poor response to intervention, the so-called treatment resisters (Niemi et al., 2011). These children are characterized by a general learning difficulty rather than a specific reading disability.

6.4.1 Predicting reading difficulties

Although predicting the occurrence of reading difficulties from pre-reading skills has convincingly been proved and the outcome is statistically significant beyond doubt at a group level, the prognosis is not perfect. Perhaps the most intriguing counter-evidence is produced by studies focusing on late-emerging poor readers. Partanen and Siegel (2014) found that some children with not-at-risk status in kindergarten showed reading difficulties in grade 7. In another study of an 11-year-follow-up from kindergarten through tenth grade 66 (13%) of the 493 participants transpired to be late-emerging poor readers, defined as belonging to the lowest quartile of word decoding and reading comprehension in grades 5 to 8 (Catts, Compton, Tomblin, & Bridges, 2012). They showed no manifest reading difficulties in earlier grades. Interestingly, both main components of reading played a role. Among these pupils, there were poor readers with only comprehension problems (52%), only word decoding problems (36%) and with both difficulties (12%). In an international longitudinal twin study conducted in Norway, Sweden, the United States and Australia, poor decoders ($N = 85$) and poor oral comprehenders ($N = 99$) were identified among ten-year-old twins in grade 4 (Elwér, Keenan, Olson, & Samuelsson, 2013). Five years earlier, when the participants were at the age of five, the prospective poor decoders had low scores in rapid automatized naming, whereas poor oral comprehenders had low scores in vocabulary. Other cognitive and literacy-related predictors showed no difference between the groups. Children at-risk for both poor decoding and poor oral comprehension, the so-

called garden-variety poor readers (Stanovich, 1988), are in an even worse position.

At the same time, it has to be noted that the school curricula of Finland and Åland stipulate yearly screenings of the pupils' reading and spelling ability throughout the comprehensive school. Despite this, the prognostic uncertainty also points to the usefulness of phonological kindergarten interventions offered to whole groups. At the time of an intervention in kindergarten, it will not be possible to identify all the children who in the future will need special training and will gain the most from kindergarten training. The present results show that all children find phonological exercises stimulating and make progress regardless of their initial competence. Moreover, ethical reasons speak for phonological kindergarten training to be offered indiscriminately to all children instead of only selecting certain children with likely future reading difficulties.

6.4.2 Functional illiteracy

Poor literacy skills, often coined as functional illiteracy, among the population between the ages 15 and 65 are obvious and increasing (www.literacy-and-vocation.eu, 2012). In European countries, decades of compulsory education have eliminated basic illiteracy or analphabetism, defined as the total inability to read and write. However, presently around 20% of the pupils leave school as functionally illiterate that is, lacking the literacy skills needed to function in private life and society (OECD, PISA, 2009). This is becoming a major concern because basic competence in reading, writing, numeracy, telecommunication and information technologies is a prerequisite for lifelong learning, vocational participation and in many aspects of managing with everyday life. Poor literacy skills expose individuals to school failure and later marginalization in the labor market. Consequently, individuals as well as society incur huge losses. According to a report from the World Literacy Foundation, the estimated annual price tag for the world's illiterate or functionally illiterate people is about 1 billion U.S. dollars for society (www.worldliteracyfoundation.org, 2015). On an individual level, people with poor literacy skills usually have poorly paid jobs or suffer from poverty caused by unemployment (Chapman, Tunmer, & Allen, 2003). The human costs of seeing oneself in a worthlessness state in private life as well as in society are immeasurable (Miller, Esposito, & McCardle, 2011).

Even in the Nordic countries, functional illiteracy is an essential challenge for the educational system, although its occurrence is much less than in the rest of the world. However, the question still arises: Why is this handicap presently becoming more common? The comprehensive educational system has been an

important brand for Finland and its favored status in society has made a high literacy standard possible. Nevertheless, studies have shown that the educational system does not sufficiently live up to the standards of equality concerning all students regardless their possibilities of or circumstances for successful learning. Pupils with learning difficulties are at risk for dropping out of further education as well as remaining unemployed for longer periods during their lives (Hakkarainen, 2016).

The phonological training of the Åland kindergarten intervention has proved to be a pedagogical tool with considerable potential to fight functional illiteracy which, in fact, was one of its aims. We could show that after training, twice as many initial children-at-risk of reading difficulties moved into the broadly defined category of mainstream readers that is, those readers consistently performing above the 25th percentile through the comprehensive school. It thus seems justifiable to conclude that the just about average word decoding ability achieved was sufficient for a successful literacy development including reading comprehension. As regards the economics, the Bornholm intervention model is cost-effective. It can easily be integrated into the ordinary curricula and delivered to all children by kindergarten and school teachers.

6.5 Strengths and limitations of the study

In addition to fulfilling its scientific and pedagogical purpose, the Åland study exerted some valuable spin-off effects which had not been planned for in advance. The study was conducted by ordinary kindergarten staff in rural kindergartens. All kindergarten classes in the same school district participated in the intervention and in the follow-up study. The key factor for achieving the implementation and establishment of the intervention was the functioning co-operation. To assure treatment fidelity, the kindergarten teachers shared experiences and were supervised in monthly meetings. Spin-off effects could be seen in the emerging network of parents, school administrators, principals, school teachers, librarians, speech therapists, as well as child health personnel who were informed about the intervention and supported the project within their respective professional fields. This motivated the kindergarten teachers to do their very best. Moreover, the first-grade teachers also appreciated the cooperation with the kindergarten staff as the phonological intervention covered the first two months of school. In other words, the intervention functioned as an important bridge between kindergarten and school (e.g. Ahtola et al., 2010). First grade teachers continued on with the language games which were already familiar to their pupils. They noticed that the trained children were better

prepared for the first reading exercises than earlier school entrants who had not undergone a structured phonological kindergarten intervention. This information was delivered by the teachers at regular staff meetings and it was valuable feedback to the kindergarten teachers. Moreover, the cooperation included transmission of information about children in need of additional literacy support. Parents who themselves had encountered reading difficulties in school, expressed their relief when their children received early help. As for the professional staff as well as for the researchers involved, the study is a good example of an interdisciplinary co-operation between the scientific fields of Education, Logopedics and Psychology.

The study also has some important limitations. In Åland kindergartens, language activities were already practiced to a varying extent when the study started. For this reason, obtaining a positive intervention outcome was uncertain. The attrition rate was moderate, a result of the minimal emigration of families from Åland. Nevertheless, the total number of participants was too small for more advanced and detailed analyses. All six-year-old kindergarteners participated who suited either the intervention or the control group. The principle of random group assignment could not be followed which is a limitation (Snowling & Lervåg, 2016). For the same reason it was impossible to estimate classroom effects on training outcome and later reading development.

When the study was planned, the first intention was only a replication of the original Danish intervention in Swedish-speaking Åland kindergartens and primary schools until the end of grade 2. A longitudinal option lasting for the whole comprehensive school was not considered at the beginning of the study. Only later, when the follow-up study was being conducted, did different alternatives emerge, which now appear to be limitations of the study. First, a better recommendation would have been to use active control groups with another type of intervention, such as vocabulary training. Second, since the fluency factor is important for word decoding, testing of rapid naming ability would have been appropriate at the beginning of the study. Third, no direct test of metacognition was used to measure an unplanned generalized effect like that found by Poskiparta et al. (1999). Fourth, treatment fidelity was assured by methods deemed appropriate in the late 1990s which, however, do not fulfill current standards. No quantitative data on treatment fidelity were collected which, for example, precludes a comparison of intervention and control kindergarten teachers.

A further limitation concerns the content and quality of teaching during the grades 2–9. The curriculum stipulates the number of Swedish language lessons, the screening of literacy skills, and the remedial teaching given in each grade through compulsory school. In practice, the targeted educational equality could be jeopardized, for example, by shortage of professionals and re-occurring change of teachers. Moreover, very little is known about what occurred in children’s reading development between the measurement points, and there are neither theoretical models explaining this development, nor relevant longitudinal studies lasting for several years. A log of matters of concern could have been created with each participating teacher making notes of in-between-facts in the course of intervention (e.g. change of teachers, special education needs, pupils’ voluntary reading of books etc.). The participants’ choices and performance in upper secondary school education is a further relevant issue not studied in the present thesis. Although it does not call the present results into question, paying attention to these limitations in future studies would promote the interpretation of the results.

6.6 Conclusions and suggestions for further research

The present study has shown that early phonological training provides a good head start to literacy development. When offered to kindergarten groups before formal reading instruction, the training generates more positive reading-related effects than remediation following reading failure. For a successful intervention, the instruction has to be administered by trained professionals in a systematic and structured way. The training preferably includes all the children in kindergartens and is given by the ordinary teachers within the kindergarten schedule. It is thus cost-effective for the municipality. It is also plausible that gains may extend beyond adolescence considering all those whose reading failures at school may result in a negative self-image and dropping-out from society later in life.

The present results also showed that although an early intervention had long-lasting effects on word decoding as well as subsequent reading comprehension, this is not enough to secure a minimum needed level of literacy. Namely, 24% of the trained at-risk kindergarteners still belonged to the at-risk group in grade 6, as opposed to 9% of the trained not at-risk kindergarteners. Furthermore, 25% of the trained at-risk kindergarteners still belonged to the at-risk group in grade 9, as opposed to 17% of the trained not at-risk kindergartners. School education is duly expected to do its best, but it is not responsible alone for children’s

literacy development. Home environment and society are also actors in setting a standard for how literacy will be valued and promoted.

The type of literacy training should be in line with the phase of the child's reading development. Along with literacy stimulating training, attention should be paid to the training of metacognitive skills because teaching-induced strategies have an influence on the next stage in literacy development. For a teacher, it is crucial to be aware of the stages in this development, which dictate appropriate literacy stimulation and timely intervention (e.g. the zone of proximal development by Vygotsky, 1978).

Unfortunately, tests developed for kindergarten also miss some children who are at risk for later reading difficulties (e.g. Catts et al., 2012). This indicates the need for more valid screening materials for non-readers. Gellert and Elbro (2017) studied the predictive value of a dynamic testing of phonological awareness among Danish kindergarteners by comparing it with traditional tests of phonological awareness and letter knowledge. The test was administered in a mutual interaction with the tester and child. The failed items on the static tests were administered again with a series of prompts until the child answered correctly or the prompts were exhausted. The dynamic version showed more sensitivity to individual differences in phonological ability and proved a better predictor of children's reading ability at the end of kindergarten and in the first half of grade 1. In a previous study by Cunningham and Carroll (2011), the dynamic phonological awareness test added 9% to the prediction of children's early word reading ability over and above a traditional test. This perspective is particularly promising regarding readers-at-risk who comprise a heterogeneous group, and therefore powerful and novel diagnostics are in high demand for them. A special focus should be on the study of resistant learners and motivating efforts to benefit their reading development.

To conclude, it is of vital importance that responsible actors in schools secure a continuous, evidence-based and good-practice pedagogy to create the best learning environments through national, district and local school curricula. Ultimately, this goal is reached when co-operating networks consisting of researchers, school administrators, principals and teachers at all levels directly working with children are in place. The best investment for future is education, where an early literacy development is vigorously targeted. The results of the present longitudinal study highlight the importance of a systematic, structured and playful kindergarten intervention of phonological awareness delivered to the whole group of kindergarten classes. The children-at-risk who through

training were raised as a group to an average level of reading and spelling ability, were the victors. The phonological language games of the original Bornholm study developed by Ingvar Lundberg and colleagues (1988) were still, 20 years later, able to significantly contribute to the positive literacy development of children.

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