The effects of morphological versus phonological awareness training in kindergarten on reading development

Article *in* Reading and Writing · June 2002

DOI: 10.1023/A:1015272516220

1 author:

Solveig-Alma Lyster
University of Oslo
33 PUBLICATIONS **1,541** CITATIONS

SEE PROFILE

Reading and Writing: An Interdisciplinary Journal **15:** 261–294, 2002.

The effects of morphological versus phonological awareness training in kindergarten on reading development

SOLVEIG-ALMA HALAAS LYSTER
Department of Special Needs Education, University of Oslo, Oslo, Norway

Abstract. The aim of this study was to investigate the long-term effects of two different training programs in kindergarten on reading development. One group received a program focusing on the phonological structure of words, while a second group received a program focusing on morphology. Both groups also had some print exposure focusing on phonological or morphological elements respectively. During their last pre-school year, participants received training for 30 minutes per week for a total of 17 weeks. A control group received no intervention but was regularly visited by the researcher and had extensive print exposure. Both trained groups showed improvements in phonological, morphological and reading skills in comparison to the Control Group. The effects of training varied according to mother's educational level: Children of relatively highly educated mothers entered the pre-school training with better developed metalinguistic abilities than children of less well educated mothers. Significant interactions between the groups and the mother's educational level, for some of the school reading measures, indicated that different training programs had different effects on different groups of children. Children of poorly educated mothers profited the most from metaphonological training while children of highly educated mothers profited the most from metamorphological training.

Key words: Morphological awareness, Morphological awareness training, Mother's educational level, Phonemic awareness, Phonological awareness, Phonological awareness training, Reading development

Introduction

It is widely accepted that there is a strong relationship between reading development and linguistic awareness, the ability to reflect upon spoken language (Adams 1990; Bradley & Bryant 1983; Goswami & Bryant 1990; Hagtvet 1989; Olofsson & Lundberg 1985; Treiman & Baron 1983) and that measures of phonological awareness taken prior to reading instruction predict later reading skills (Mann 1991; Mann & Liberman 1984; Wagner & Torgesen 1987). The term linguistic awareness is used very broadly and covers many disparate tasks, such as rhyme judgement, the ability to segment words into sounds, counting words in sentences and syllables in words, detecting morphemes in words, and judgements of syntactic and grammatical correctness. Phonological awareness refers to children's ability to analyze the sound

structure of words while phonemic awareness refers specifically to awareness of the individual phonemes. Studies, which have tried to improve reading skills by giving the children phonological and phonemic training prior to, or alongside, reading instruction, have been successful (Bradley & Bryant 1983; Cunningham 1990; Hatcher, Hulme & Ellis 1994; Lundberg, Frost & Petersen 1988).

In comparison to phonological awareness, morphological awareness has received less attention in studies of reading acquisition and reading disability. A morpheme is the most basic element of meaning. Morphological awareness is the ability to be aware of and manipulate morphemes (the minimal, meaningful parts of words).

There is evidence that there is a relationship between morphological awareness and reading development (Carlisle 1995; Fowler & Liberman 1995; Tornéus 1987; see also Feldman & Andjelkovic 1992; Marslen-Wilson, Tyler, Waksler & Older 1994). Bryant and his colleagues (Bryant, Nunes & Bindman 1998; Nunes, Bryant & Bindman 1997) present empirical support for a connection between children's spelling and their morpho-syntactic awareness, and their results suggest that the connection is a causal one. They clearly state that their data apply to spelling only but it seems unlikely that there will be a clear separation between reading and writing.

To answer the question about causes, intervention studies are needed in addition to prediction studies. There are few experimental studies, however, which have followed the effects of morphological awareness training on reading development. Notable exceptions are the work of Henry (1989, 1993) and of Elbro & Arnbak (1996). Henry showed that 3rd and 5th grade students' knowledge of morphological patterns (and their decoding and spelling performance) benefited from instruction on language origin and morpheme patterns in English. Elbro & Arnbak reported promising results from a training study teaching morphology to 10- to 12-year-old Danish dyslexics.

Lyster (1997) reported effects of phonological and morphological awareness training in kindergarten on spelling development in grade 1. The effect of morphological training was most marked for the group of children who started the intervention with relatively well-developed phonological awareness. The results support the view that morphological knowledge and awareness play an important role in spelling development and that these skills do not develop independently of children's phonological level. Pre-school training aiming at developing morphological knowledge and awareness may therefore have a relatively small effect on reading development in the first school year if children's phonological abilities are weak (see Fowler & Liberman 1995 for a discussion). Byrne, Fielding-Barnsley, Ashley & Larsen (1997), however, suggest that children as young as four years of age are able

to identify and focus on the morphemic values of print elements, but that their first systematic encounters with print do not typically include phonology. On the other hand, morphemes have a phonological structure. Morphemic training might therefore also contribute to the development of phonological awareness.

Training of phonological skills seems to have the most powerful effects on reading when children are taught about the relationship between sounds and letters and when phonemic awareness training is linked explicitly to print (Ball & Blachman 1988; Blachman 1989; Bradley & Bryant 1983; Hatcher, Hulme & Ellis 1994). Morphological awareness training might also be more effective when oral activities are related to print. Alphabetic writing systems are usually described as morpho-phonemic, because the representations of the words are in accordance with a combination of a morphemic and a phonemic principle. In order to become a competent reader, the child will have to make use of these two principles (Adams 1990; Elbro 1990). The present study focuses on these two principles and compares the effects of phonological and morphological awareness training in kindergarten on reading development in grade 1. Sound–letter correspondences in Norwegian are relatively regular, much more regular, for instance, than two of the least regular languages English and Danish (Elley 1992; Hagtvet & Lyster, in press). The teaching of reading in all schools included in the present study focused more on phonics than on a whole language approach, but less systematically than seems to be the case in German schools. The effect of a pre-school phonological awareness program might therefore be moderate. The regularity of the written language and reading instruction focusing on phonics, might help the children to discover the phonemic principles of the written language whether they have attended a pre-school phonological awareness program or not. Very little attention, however, has been given the morphological patterns of words in the Norwegian schools. There is a persistent influence of morphology on the Norwegian orthography. Many morphemes in high frequency words change their sound structure when changing context and high frequent articles such as -en in "gutt**en**" (**the** boy) and **-et** in "hus**et**" (**the** house) have silent letters in the eastern Norwegian dialect.

The main questions addressed in the present study were as follows:

1. What effect does morphological awareness training in pre-school have on metalinguistic development compared to phonological awareness training when both training programs include some exposure to print?
2. Does morphological awareness training like phonological awareness training facilitate learning to read?

3. Will the two metalinguistic programs have different effects on reading acquisition in different sub-groups of children, such as groups of children with weak versus strong phonological skills?

The study seeks to answer these questions by following the metalinguistic and reading development of children in two experimental groups: one receiving phonological awareness and one receiving morphological awareness training and a control group, during their last pre-school year and until the end of grade 1. All groups had some exposure to print in pre-school, but in very different ways. A variety of cognitive, linguistic and metalinguistic tests were used to assess the children's skills when they entered the study and to evaluate the effects of the training programs. The children's reading abilities were assessed at the time of the pre-test, at the time of the post test, at school entrance and at the end of grade 1.

Method

Subjects

A total of 273 monolingual Norwegian children attending 25 different pre-school groups in two different communities outside Oslo participated in the study. The children were first seen 10 months before school entrance. Their age was then 5 years 10 months to 6 years 9 months. (Until 1997 Norwegian children did not enter school before August the year they reached the age of seven). No letter, reading or writing instruction is given in the Norwegian kindergarten or pre-school system. Children reading at the time of the pre-test were excluded from all analyses presented here. Sixteen children were identified as readers and 14 were identified as beginning readers. The beginning readers could read a few words correctly by using their very limited grapheme-phoneme correspondence knowledge and through their ability to identify some words logographically. To look for the impact of the children's social background, the mother's education was used as a central variable in some of the analyses. Information about the mother's education was not collected from 12 of the children. Results from these 12 children are excluded from the analyses when the mother's education is used as a variable. Six children moved to other communities before the end of first grade. The analyses presented here are partly run on the basis of results from the 237 non-reading children who were still available at the end of grade 1 and partly on the basis of the results from the 225 non-reading children about whom there was information about the mothers' education.

Design

Groups of children, and their pre-school teachers, were randomly assigned to two experimental groups 10 months before school entrance. The school authorities wanted all pre-school teachers to attend the course in development of linguistic awareness described below and there was high interest from the pre-school teachers themselves. Because of this it was not possible to assign an equal number of children to experimental and control groups. Children who acted as controls were those whose pre-school teachers were not able to attend the course and the meetings of the year prior to the intervention. But also the control group teachers were very eager to take part. In a field experiment like this we did not use the name control group, but told the teachers that we would like to look at how the children's language development before school entrance influenced their reading development in school. This procedure, however, might have given the teachers in the control group even more interest in focusing on language and linguistic elements in their teaching. This group of pre-school teachers was highly experienced, having more than ten years pre-school teaching experience. Younger and a few recently educated teachers were found in the experimental groups, but the base of their education was similar to that of the more experienced teachers. Thus, if experience, as well as interest, should be counted as factors influencing the results, the Control Group should, to some extent, be at an advantage.

The first experimental group, the *Phonological Group*, received training in phonological awareness. The training used involved a combination of the training used by Bradley & Bryant (1983) and Lundberg et al. (1988). The children played the *Odd one out* games presented by Bradley & Bryant and participated in tasks requiring the use of rhyme, alliteration, syllable, sound blending, and sound segmentation. Ideas for phonological play-like activities were also collected from the work of Tornéus, Hedstrøm & Lundberg (1986). The children were exposed to letters or letter sequences corresponding to the sounds that they were working/playing with and some activities focussed on the way sounds were articulated. When playing "Odd one out" games finding the word with an odd rime or onset, the pre-school teacher wrote the words on a flip-chart so that the children could see the difference as well as hearing it. When the task was to "load the boat with words that start with /m/", the pre-school teacher drew a boat on a blackboard or flip-chart. The boat would have a flag with the letter m and the pre-school teacher wrote all the words given by the children inside the drawing of the boat. Phoneme blending, counting and deletion activities were not combined with print exposure. The children were not taught all sound–letter correspondences, but a selection of sound–

letter correspondences were taught to help the children discover connections between speech and print.

The second experimental group, the *Morphological Group*, learned about morphemes and received training in morphemic awareness. Compound words, grammatical elements and a variety of prefixes and suffixes were used. The children made compound words out of two words and found the different words in compound words. They learned about grammatical units expressing the noun's plural form and the verb's past tense and about different prefixes and suffixes, e.g. mis- in misunderstanding and -less in fearless. The children in this group were also exposed to the written forms of the words they were working/playing with to the same degree and amount as the children in the Phonological Group. Exposure to print activities focused on bound morphemes as described in the appendix. Even if whole words were presented, focus was on the morphemes in question. Exposure to free morphemes, whole words, was only included in activities focusing on the concepts of words and sentences.

In both experimental groups upper-case letters were used when words or letters were written on the blackboard or flip-over. Children in the experimental groups were exposed to no more than 30–35 different words during the experiment. Many of the metalinguistic activities were not combined with print exposure. The amount of print exposure in the two groups was controlled as strictly as possible to keep the influence of this variable at the same level in the two groups. The words the two groups were exposed to differed, however, in some ways. Both groups were exposed to relatively short words, but while the Phonological Group was exposed to one-syllable words, the Morphological group as part of the experiment was exposed to two-syllable words as well as a few three-syllable words. Many of these words were relatively short, however, such as *ulykke* (accident), *leie* (sad) and peier (a non-word created by some children and used when focusing on the plural ending -er). Different effects of the print exposure activities on reading development in the two experimental groups should on this background be attributed to the activities in the two groups: the morphological activities focusing on morphological elements in spoken and printed words or the phonological activities focusing on letters, onsets and rimes corresponding to the different sounds and letter sequences in question.

The *Control Group* children received no training, but were regularly visited by the researcher who wanted to get an overview of the activities they took part in. In this way the Control Group received more attention from people outside the pre-school setting than the experimental groups.

This study was intended to help children discover how phonology and morphology map onto print. Since the experimental groups were exposed to

print as well as linguistic awareness activities, a control group receiving no intervention, might be questionable. All control group children, however, but none of the experimental children, attended groups using grade 1 classrooms. They were therefore exposed to both the lower and upper case letters of the alphabet hanging around the walls throughout the entire year for two or three days a week. All letters were connected to a picture representing a noun beginning with the sound corresponding to the letter in question. They were also exposed to single words hanging on the walls and other written materials in the classrooms. No one identified the different words to the children if they did not ask for it. They could very easily learn the meanings of many orthographic strings, however, since the written words were connected to pictures. All words were regular, one-syllable nouns. Most of them were three-letter words such as APE (ape) and BIL (car). There also is a tradition for Norwegian pre-school teachers to focus attention on onsets and rimes in words through different language games and play activities and children may concentrate on play-write activities even if they are not initiated by the teacher. Of the 225 pre-readers about whom there were information about mother's education, 87 were in the Phonological Group, 107 were in the Morphological Group, and 31 in the Control Group.

Procedure

The pre-school teachers responsible for the experimental groups were instructed in reading and spelling development, language development and linguistic awareness once a month in the year before the children entered the experiment. They were given a theoretical framework to support the next year's teaching within the field of linguistic awareness. During the second year, when the intervention took place, the two groups of pre-school teachers had separate lectures and work-shops. The teachers of the children in the Phonological Group were taught about the linguistic elements to focus on in spoken and written forms and how to carry out phonological awareness training. The teachers of the children in the Morphological Group were taught about how to carry out the morphological awareness training and about the morphological elements to focus on. All the teachers met with the researcher once each month during the year of the intervention to develop and refine the skills necessary for the next month's instruction. Different teaching activities were introduced for the teachers to use in a graded sequence according to their difficulty. Onsets and rimes, for example, were introduced much earlier than phoneme deletion and phoneme counting activities in the Phonological Group, and in the Morphological Group free morphemes and compound words were used in teaching earlier than bound morphemes such

as plural endings and other affixes. The children's training period lasted from October/November to March/April, the amount of training being approximately 30–40 minutes once a week or 15–20 twice a week for 17 weeks. The number of children in the different groups was between 6 and 12, but in the larger groups the pre-school teachers had an assistant. When finishing pre-school the children entered 18 different schools. There were experimental children in 22 out of 24 classes and control children in 7 classes. Some classrooms had children from all pre-school groups and most classrooms had children from both experimental groups.

Measures

Pre-school measures

At the time of the pre-test the pre-school teachers observed and assessed whether the children could decode words they had not seen before or identify words they had been exposed to. Since there are no standardized Norwegian tests that can identify readers at the very initial levels of reading, using pre-school teachers to make such judgements was a valid way to proceed. The validity of this procedure is supported by findings by Lundberg and his colleagues (1988). In the Bornholm study they found only 1 child out of 187 who could read the year before school entrance. The social structures and the school systems are very similar in the Scandinavian countries and parents consider learning to read and write as matters for school. The age of the children entering the present study corresponds to the same age as the age of the children who entered the Bornholm study. The rejection of 30 children therefore seems very strict. This may be because children who could read some words because they knew a few letter–sound correspondences were considered beginning readers and therefore rejected.

Pre- and post-tests: Linguistic and metalinguistic knowledge

All children were given the same set of group-administered linguistic and metalinguistic tests before the intervention and six months later after the intervention ended. The test battery was standardized the year before the intervention (Lyster & Tingleff 1992). Sub-tests were developed to measure different metalinguistic abilities, as well as vocabulary, naming speed, syntactic knowledge and memory for word sequences.

For the tests pictures were used to represent the different items. The influence of short-term memory, which might be important if the tasks had been presented orally only, should therefore to some extent be controlled. The 6 phonological tasks are identical to the tasks used by Høien, Lundberg, Stanovich & Bjaalid (1995), who used part of the battery, except for the number of items on Rhyme Recognition. Two multi-syllabic items were

deleted from this task. The testing was ended if any of the children became inattentive. All groups needed three sessions, each lasting approximately 20–30 minutes, to complete the pre- and post-test battery. Reliability estimates for the tasks from the standardization procedure are reported below.

The following tasks were included in the pre-and post-test battery. All words and sentences, represented by pictures in the different tests, were given orally during the presentation with the exception of Homophones, which is a naming task. The children could give their responses by marking one of the different drawings for the different items presented or by drawing lines when number of words, syllables and phonemes were in question. The sub-tests were given in the same sequence as presented below, but to be sure that the concepts *words, syllables* and *sounds* should not be too confusing to the children, counting tasks including these concepts were presented on separate days.

I. Word length recognition. This task was constructed to test the children's ability to compare the length of words. After two practice trials, six items were presented orally. For each item the children had to decide which of two words sounded the longest and to mark the one of two pictures corresponding to the word they selected. The reliability (alpha) was 0.79.

II. Rhyme recognition. This task was constructed to test the children's ability to identify words that rhymed. For each item the children were presented with four pictures. The words corresponding to the pictures were also presented orally. The children's task was to mark the word (picture) that rhymed with the first word (picture) on the line. After two practice trials, nine items were presented. The reliability was 0.76 (alpha) for the 9-item version.

III. Syllable counting. The syllable counting test consisted of 16 items. For each item the children were presented an easily recognizable picture of a word that was also presented orally. The children were asked to count the syllables in the word and mark each one by a pencil stroke in an empty box below the picture. The number of syllables varied from one to four randomly distributed across the test. The reliability (split-half) was 0.91.

IV. Initial-phoneme matching. The children were presented with a row of three pictures and were asked to select the picture that started with the same sound that was pronounced by the tester. Two practice items and 10 test items were given. Both consonants and vowels were target phonemes. Reliability (split-half) was 0.76.

V. Phoneme blending. For each item the children were presented with a row of three pictures. The phonemes in the words in question were pronounced with an interval between them of about $^1/_2$ sec. The children were asked to mark the picture that matched the resulting word. The length

of the words varied from two to four sounds. Two practice trials and nine test items were given. Reliability (split-half) was 0.68.

VI. Phoneme counting. The format of this test was similar to the syllable test. Each word was presented orally together with an easily recognizable picture. The children's task was to count the phonemes in the word and mark each phoneme by a pencil stroke in an empty box next to the picture. The children were given one practice trial and six test items. The reliability (split-half) was 0.67.

VII. Deletion of initial phonemes. For each item the children were presented with a row of three pictures. A word was presented and the children were told that if the first sound of the word was deleted, one of the pictures in the row would match the resulting word. The sound to be deleted was given (What is left if you delete/take away the first sound /r/ in rice?). Two practice items followed by10 test items were given. The children were presented with both CV- and CCV-onsets. The reliability (split-half) was 0.70.

VIII. Knowledge of compound words. Compound words like "brannbil" and "bilbrann" (fire engine and engine fire), "blomsterpotte" and "potteblomst" (flower pot and pot flower) etc. are high frequency words in Norwegian. This task was constructed to assess the children's knowledge of compound words. For each item they had to select the picture (from a set of four) corresponding to a presented word. All the foils were compound words and one of the foils was composed of the same two words as the target word, only in different positions. The test consisted of one practice item and 13 test items. Reliability (split-half) was 0.70.

IX. Word compounds. This test was constructed to test the children's ability to make a compound word from two given words and to test their knowledge of the word they had created. For each item the correct word had to be identified from among four drawings. When the words "brann" (fire) and "bil" (car) were to be blended, the foil "bilbrann" (car fire) were among the other foils in addition to the target word "brannbil". One practice item and eight test items were given. Reliability (split-half) was 0.78.

X. Analyses of compound words. The children were asked to find the word that was left in a compound word when one of the words in it was deleted (e.g. what is left in the word "bilbrann" if you delete "bil"). For each item the target word was presented in a row of four pictures. Among the foils was a picture representing the compound word and also a picture representing the part to be deleted. One practice item was followed by eight test items. Reliability (split-half) was 0.67.

XI. Segmentation of sentences into words. The children had to find the number of words in sentences. Sentence length ranged from two-word to five-word sentences. The sentences were presented orally at a normal speed. The

children marked the number of words by pencil strokes in an empty box next to the picture representing the item. The test consisted of one practice item and six test items. Reliability (split-half) was 0.83.

XII. Syntactic awareness. This test was constructed to test the children's ability to detect syntactic irregularities in sentences. The children had to decide whether a presented sentence was correct or not. If the children identified the sentence to be correct, they marked the picture of a mother. If the children identified the sentence to be incorrect, they marked the picture of a little child. The test consisted of one practice item and 10 test items. Reliability (split-half) was 0.90.

XIII. Memory for word sequences. The children's ability to remember word sequences was tested. They were given sequences of three to five unrelated words. The most difficult items consisted of five three-syllable words. The target sequence was represented as a row of pictures representing the presented words. This target sequence was one of three possible rows to choose for each item. The foils consisted of sequences of the same words in the wrong order. The test consisted of one practice trial and nine test items. Reliability (split-half) was 0.69.

XIV. Homophones. This task was created to test the children's naming ability. The children had to identify the two pictures (from four) representing items with the same name (homophones) (e.g. CHRISTMAS and WHEEL which are homophones in Norwegian). There was a time limit of 5 minutes for this task. The test consisted of one practice item and 16 test items. Reliability (split-half) was 0.84.

XV. Listening comprehension. This task was constructed to test the children's ability to understand the meaning of sentences. The children were given sentences with different morphemic elements and syntactic constructions. For each item the children had to identify one picture out of four representing the orally presented sentence. The test consisted of one trial item and 28 test items. Reliability (alpha) was 0.75.

Word reading five months before school entrance

When the intervention ended, 5 months before school entrance, the children were given a word reading test. They were presented with 4 words printed in upper-case letters and 17 words printed in lower-case letters. The task was to draw a line from each word to a picture representing it. All the words were high-frequency nouns with regularly spelling patterns. To avoid guessing from the first letter or letters, groups of words had the same onset, which could be a single consonant or a more complex consonant cluster. The 4 upper-case letter words were presented on one page and the 17 lower-case letter words were presented on two pages. There was no time limit. The

children were urged to try to find the correct drawing for the different words. Scores were the numbers of correct picture matchings. Reliability (alpha) was 0.96.

Word reading at school entrance
This test was given to the children at school entrance. They were given 5 words printed in upper-case letters and 29 words printed in lower-case letters. The task was to match each written word with the picture representing it. All words were high frequency nouns with regularly spelling patterns, but many of the words contained complex consonant clusters. To avoid guessing from the first letter or first groups of letters, groups of words had similar onsets and some of the words just differed by one or two letters. The 5 upper-case letter words were presented on one page and the lower-case letter words on three pages. The children were given a time limit of 8 minutes to read the words. Scores were the number of correct items. Reliability (alpha) was 0.98.

School measures

IQ-measures and socio-economic status

To control for the children's verbal intelligence Vocabulary, Digit Span and Similarities from WISC-R (Undheim 1978; Wechsler 1974) were administered to the children 3–4 months after they entered school. Data on covariates should be gathered before treatment is administered. However, even if the children in the Morphological Group to some extent focused on word meaning and concepts, the training programs were not expected to influence the children's verbal abilities as measured by the WISC-R sub-tests. Information about the mother's educational level was collected before school entrance or in the beginning of first grade. In the present study a dichotomous variable was created. The mothers were ranked as poorly educated if they had less than 3 years of schooling after the 9 obligatory years and as highly educated if they had 3 years or more of education after the obligatory years.

Reading measures
Until recently there were few standardized reading and spelling tests in Norway. Most of the tests necessary for the present study had to be developed before the study started.

I. Phonological coding. Phonological coding was measured by having the children designate the pseudo-word that sounded like (was a phonetic equivalent to) a real word in 20 non-word/non-word pairs. In the pair spo/sgo the second letter sequence is an exact phonetic equivalent of the Norwegian word *sko* (shoe). [See also Olson, Kliegel, Davidson & Foltz (1985), for discussions

about the use of phonological coding tasks.] The non-words were presented to the children on paper and they had to underline the one non-word in each pair that sounded like a real word. There was a time limit of 120 seconds. Scores were the number of correct minus the number of incorrect items. Reliability (alpha) was 0.89.

II. Orthographic coding. The orthographic coding task required the children to identify the word in 20 word/pseudo-homophone pairs. In the pair sko/sgo both the word and the non-word sounds like the Norwegian word for shoe, but *sko* represent the correct spelling. The task is similar to the task described by Olson, Wise, Connors & Rack (1990) and to one used by Baron & Strawson (1976). The word/pseudo-homophone pairs were presented to the children on paper, and they had to underline the word in each pair. There was a time limit of 120 seconds on this task. Scores were the number of correct minus the number of incorrect items. Reliability (alpha) was 0.93.

III. Word Identification. The children were presented with three lines containing a total of 25 words. There was no space between the words and the children had to draw a vertical line between them. There was a time limit of 120 seconds. Scores were the number of words correctly identified. Reliability (alpha) was 0.94.

IV. Word reading (Gjessing 1958). This is part of an old standardized test, consisting of word reading and text reading items, which has been widely used in Norway. For each item in the word reading part the children were presented with an easily recognized picture and a varying number (4–8) of words to match the picture. The children had to mark the word corresponding to the picture. There was a time limit to the task. There were 36 test items. The test-retest reliability is reported to be 0.87 for the total word and text reading task.

V. Sentence reading. The children were given 18 sentences to read within a limit of 3 minutes. They had to find one picture among four that was the correct one for each sentence. The sentences and pictures were all chosen from the Listening Comprehension test in the pre- and post-test battery. The measure was the number of correctly read and understood sentences within the time limit. Reliability (alpha) was 0.92.

VI. Text reading. A cloze procedure was used in constructing this task. At intervals throughout the text the children had to choose one out of three words to complete a sentence. One alternative was correct and fitted both the sentence and the story; one distractor fitted the sentence but not the story context, while the other distractor fitted neither the story nor the sentence context (see Snowling & Frith 1986). The children were given 3 minutes to respond to as many of the seven items as possible. The number of the correct responses was the measure. Reliability (alpha) was 0.88.

Mathematics

Goswami and Bryant (1990) emphasize the need to show that children's phonological skills are related to reading and not to their mathematical skills. To look more closely at the specific link between the pre-school metalinguistic training and reading development, the children were also presented with a mathematical test (Tornes 1968) at the end of first grade. The standardization data for this test were reported in 1968. The internal reliability (alpha) for the addition part is reported to be 0.96, for the subtraction part to be 0.96, and for the practical, mathematical part to be 0.88.

All testing was done by following the standardized procedures. No information was given to the teachers in school about the content of the pre-school training until after the children were tested at the end of grade 1. As described above the teaching of reading and spelling in all classes used mainly phonic methods, but all teachers combined, to some extent, this approach with elements from a language experience method (Leimar 1974). The language experience method stresses the importance of language experience and the use of texts composed by the children and dictated to the teachers as material for reading.

Results

Missing data for some pre- and post-tests for some of the children were due to illness among two of the pre-school teachers before finishing the pre-test or the post-test and to absence of a few children for part of the testing. Missing data for the school measures were due to absence among the pupils for the days of testing. The number of subjects reported will therefore differ somewhat for the different tasks. Because of the large number of analyses conducted per experiment, an alpha of 0.01 was set as the minimal acceptable level of significance to minimize the experiment-wise error rate. A Bonferroni procedure was used to adjust for the number of comparisons made when running general factorial procedures.

Table 1 shows the pre-test results. With few exceptions no differences were found between the groups. Significant differences, however, were found on Phoneme Counting, $F(2,213) = 6.82$, $P < 0.01$, and Syntactic Awareness, $F(2,222) = 4.85$, $P < 0.01$, and post hoc tests (Scheffé) showed that the Phonological Group performed significantly higher than the Morphological Group on both tests.

The better performance of the Phonological Group on these two measures might give the children in this group an advantage compared to the children in the Morphological Group in developing reading competence. However, these initial differences will be controlled for in the analyses to be presented. There

Table 1. Pre-test means for treatment and control groups and comparisons of group means

Measure	Phonological group		Morphological group		Control group		df	F	*P*	Post hoc comparisons
	Mean	SD	Mean	SD	Mean	SD				
Identification of word length (max = 6)	4.54	1.50	4.69	1.55	4.13	1.36	2,225	1.70	ns	–
Rhyme recognition (max = 9)	7.84	1.92	7.42	2.24	7.13	1.78	2,231	1.82	ns	–
Syllable identification (max = 16)	10.89	4.17	11.62	3.82	9.68	4.56	2,228	2.87	ns	–
Initial phoneme matching (max = 10)	8.35	1.71	7.89	2.05	7.81	2.21	2,225	1.70	ns	–
Phoneme blending (max = 10)	6.84	1.55	6.77	2.03	6.97	1.61	2,221	0.15	ns	–
Phoneme counting (max = 6)	2.38	1.43	1.63	1.45	2.17	1.14	2,213	6.82	<0.001	p > m*
Deletion of initial phonemes (max = 10)	4.71	2.09	4.64	1.96	4.80	1.99	2,223	0.08	ns	–
Knowledge of compound words (max = 11)	8.96	1.93	8.60	2.10	9.13	1.76	2,228	1.28	ns	–
Word compounds (max = 7)	4.54	1.86	5.08	1.65	4.86	1.77	2,224	2.33	ns	–
Analysis of compound words (max = 8)	4.77	2.21	4.37	2.18	4.23	2.16	2,226	1.10	ns	–
Segmentation of sentences into words (max = 6)	2.32	1.88	1.92	1.45	1.93	1.44	2,221	1.62	ns	–
Syntactic awareness (max = 10)	6.28	2.34	5.15	2.72	5.93	2.64	2,222	4.85	<0.01	p > m
Memory for word sequences (max = 8)	4.83	2.06	4.98	2.15	5.03	1.84	2,226	0.19	ns	–
Homophones (max = 16)	5.41	3.75	5.64	3.93	5.31	3.40	2,226	0.13	ns	–
Listening comprehension (max = 28)	21.68	3.84	21.37	4.02	22.10	3.74	2,223	0.45	ns	–

*p = the phonological group, m = the morphological group.

Table 2. Pre-test results in groups of children with highly and poorly educated mothers

Measure	Low education*		High education**		F***	df	*P*
	Mean	SD	Mean	SD			
Identification of word length	4.30	1.62	4.88	1.33	8.28	1,218	ns
Rhyme recognition	7.00	2.41	8.20	1.31	20.70	1,218	<0.01
Syllable counting	10.42	4.11	11.95	3.88	7.98	1,215	<0.05
Initial phoneme matching	7.83	2.05	8.35	1.80	3.92	1,215	ns
Phoneme blending	6.49	2.00	7.22	1.48	9.13	1,213	<0.05
Phoneme counting	2.01	1.43	2.02	1.47	0.00	1,209	ns
Deletion of initial phonemes	4.49	2.00	4.92	2.03	2.48	1,211	ns
Knowledge of compound words	8.46	1.96	9.18	1.96	7.23	1,216	ns
Word compounds	4.59	1.81	5.18	1.66	6.26	1,212	ns
Analyses of compound words	4.04	2.17	5.08	2.15	12.65	1,214	<0.05
Segmentation of sentences into words	1.88	1.59	2.31	1.69	3.62	1,210	ns
Syntactic awareness	5.33	2.77	6.19	2.32	6.12	1,212	ns
Memory for word sequences	4.64	2.21	5.29	1.92	5.33	1,216	ns
Homophones	5.19	3.72	6.05	3.89	2.78	1,216	ns
Listening comprehension	20.90	4.51	22.36	3.02	7.73	1,213	ns

*Mother's education less than 3 years of schooling after 9 obligatory years.
**Mother's education 3 years of schooling or more after 9 obligatory years.
***With a composite score of the scaled scores from the WISC-R sub-tests Vocabulary, Similarities and Digit Span as covariates.

were no differences between the groups on the WISC-R sub-tests Vocabulary, $F(2,221) = 1.03$, Similarities, $F(2,221) = 1.05$, or Digit Span, $F(2,221) = 2.81$.

Table 2 shows the mean scores (and standard deviations) for children of highly and poorly educated mothers.

Children of highly educated mothers outperformed children of poorly educated mothers on Rhyme Recognition, Syllable Counting, Phoneme Blending, and Analyses of Compound Words. These results may be caused by genetic differences, but genetic factors are partly controlled for by using the children's verbal IQ as covariate. The differences therefore suggest that the segmentation and blending abilities, which are necessary for these tasks, are dependent to some extent on environmental factors. No differences were found, however, between these two groups of non-reading children on Phoneme Counting and Deletion of Initial Phonemes, the more advanced and more reading related phonemic awareness tasks. These results indicate that mother's educational level should be accounted for when the results of training are analyzed.

The post-test mean scores of the two experimental groups and the Control Group are shown in Table 3, together with the significance of group differences and follow-up pairwise comparisons based on the estimated marginal

means. A series of covariance analyses were conducted to compare the results in the three groups. To control for individual differences at the outset of the study and the impact verbal IQ might have on linguistic and metalinguistic development, verbal IQ was used as covariate alongside the pre-test results for the different post-tests.

As the table shows both the Phonological Group and the Morphological Group had made very good progress compared to the Control Group. Both experimental groups performed significantly better than the Control Group on most tests. The phonological awareness training had also facilitated the development of morphological awareness. The Phonological Group had, from the test results obtained, developed their morphological awareness to an even higher level than the morphological Group. The morphological awareness training, on the other hand, had fostered growth in phonological awareness. The Morphological Group had developed their phonological and phonemic awareness to significantly higher levels than the Control Group and within some areas developed their phonological awareness to the same level as the Phonological Group. The Phonological Group, however, performed significantly better than the Morphological Group on two phonemic awareness tasks: Phoneme Counting and Deletion of Initial Phonemes. Lack of significant differences between the groups on Phoneme Blending is somewhat difficult to explain. One explanation might be that most of the variance is accounted for by including Digit Span as part of verbal IQ which is used as covariate and that the ability to blend sounds develops even if no training is conducted. The fact that there were ceiling effects for this variable in all groups also limits the conclusions that can be drawn.

The two experimental groups also outperformed the Control Group on Listening Comprehension and the Phonological Group outperformed the Morphological Group on this test. This is another result that is difficult to explain. One naive, but plausible, explanation might be that the focus on phonological details that has taken place in the Phonological Group has developed the children's awareness of linguistic details to an even higher level than is the case of the Morphological Group. The result of the Listening Comprehension is at odds with results from other studies. Lundberg et al. (1988) found no effect of phonological awareness training on a listening comprehension task.

Some elements from the training, for example the grammatical emphasis in the Morphological Group (see Appendix), are not covered in the test battery. Development due to the training might for some linguistic areas be underestimated by the post-test results. Possible effects of the training that have remained uncovered by the post-test battery may, however, affect word recognition and reading development.

Table 3. Post-test means for treatment and control groups and analyses of treatment effects

Measure	Phonological group		Morphological group		Control group		df	F*	*P*	Post hoc comparisons**
	Mean	SD	Mean	SD	Mean	SD				
Identification of word length (max = 6)	5.48	0.95	5.24	1.29	4.42	1.26	2,221	9.39	<.0001	p > c, m > c
Rhyme recognition (max = 9)	8.48	1.37	8.21	1.45	7.39	1.71	2,221	6.46	<.01	p > c, m > c
Syllable counting (max = 16)	13.06	3.40	13.06	3.15	11.19	3.79	2,218	2.01	ns***	p > c
Initial phoneme matching (max = 10)	9.23	1.26	8.96	1.61	8.32	1.96	2,212	4.36	<.05	p > c, m > c
Phoneme blending (max = 10)	7.76	2.71	7.54	2.51	8.42	1.91	2,231	0.67	ns	–
Phoneme counting (max = 6)	3.45	1.84	2.71	1.87	2.00	1.44	2,198	8.64	<.0001	p > c, m > c, p > m
Deletion of initial phonemes (max = 10)	6.85	2.91	6.09	2.22	5.47	2.03	2,220	4.59	<.05	p > c
Knowledge of compound words (max = 11)	9.83	1.40	9.91	1.37	10.10	1.63	2,211	1.19	ns	–
Word compounds (max = 7)	6.20	1.12	5.73	1.65	5.55	1.88	2,209	4.33	<.05	p > c, p > m
Analysis of compound words (max = 8)	6.32	1.94	5.63	2.16	3.90	1.47	2,207	19.04	<.0001	p > c, m > c
Segmentation of sentences into words (max = 6)	3.56	1.82	3.27	1.62	2.26	1.21	2,182	7.35	<.001	p > c, m > c
Syntactic awareness (max = 10)	8.00	1.72	6.85	2.42	6.43	2.21	2,205	7.57	<.001	p > c, p > m
Memory for word sequences (max = 8)	5.95	2.04	5.91	2.17	5.71	2.16	2,213	1.15	ns	–
Homophones (max = 16)	8.98	4.04	8.41	4.15	8.34	3.53	2,211	0.91	ns	–
Listening comprehension (max = 28)	24.23	2.70	23.08	3.54	22.60	3.35	2,206	7.50	<.001	p > c, m > c, p > m

*With the pre-test results and the composite score of the scaled scores from the WISC-R subtests Vocabulary, Similarities and Digit Span as covariates.

**p = the phonological group, m = the morphological group, c = the control group.

***The post hoc comparisons showed significant differences between the groups.

Table 4 shows the pre-school and school reading results and the results from the test of mathematics. As the table shows children in both experimental groups benefited immediately in terms of their reading development.

Significant differences between the groups were found on Word Reading at post-test, $F(2,231) = 10.60$, $P < 0.0001$, and on Word Reading at school entrance, $F(2,226) = 11.06$, $P < 0.0001$. Follow-up pairwise comparisons based on estimated, marginal means showed that both the Phonological Group and the Morphological Group had significantly higher scores than the Control Group. Significant differences were also found on Orthographic Coding, $F(2,232) = 3.32$, $P < 0.05$, and Word Identification, $F(2,231) = 3.15$, $P < 0.05$. The follow-up comparison procedure showed that the Morphological Group had a significantly higher mean than the Control Group on these two tasks that probably depend more on the use of an orthographic strategy than any of the other measures. Significant group differences were also found on Word Reading (Gjessing 1958), $F(2,226) = 4.78$, $P < 0.01$, and Text Reading (the close task), $F(2,231) = 3.61$, $P < 0.05$. The comparison procedure showed that the Morphological Group outperformed both the other groups on Word Reading and that both experimental groups had significantly better performances on Text reading than the Control Group. Group differences were close to being significant for Sentence Reading, $F(2,232) = 2.90$, $P = 0.57$. No significant differences were found between the groups on Phonological Coding, $F(2,332) = 1.63$. The stress on phonics in most classrooms and the relatively regular orthographic structure of the Norwegian language might, to some extent, explain this result. No group differences were found on mathematics, a result supporting earlier findings that growth in metalinguistic awareness seems to support reading development, not mathematical development. An analysis of covariance was also conducted using a composite of the z-scores from the reading measures. There was a significant group effect, $F(2,226) = 4.26$, $P < 0.05$. The multiple comparison procedure showed that this effect was due to the performance of the Morphological Group versus the Control Group only. This finding supports the results from the single tests: The effect of the phonological training is quite small while the effect of the morphological training is more substantial.

Since mother's educational level had an influence on some of the pre-school tests a series of 2 (mothers' educational levels) X 3 (training groups) analyses of covariance were conducted to evaluate the effects of mother's educational level and possible interactions with group. The composite Verbal IQ score used in the above analyses was used as a covariate. A main effect of mothers' educational level was only found for Word Identification, $F(6,216) = 4.09$, $P < 0.05$. Several significant interactions between training groups and mothers' educational levels, however, were found. These were found

Table 4. Results in reading and mathematics for the treatment and control groups and analyses of the effect of pre-school training

Measure	Phonological group		Morphological group		Control group		df	F*	*P*	Post hoc comparisons**
	Mean	SD	Mean	SD	Mean	SD				
Pre-school measures:										
Reading 5 months before school entrance (max = 21)	6.77	6.30	6.71	6.06	2.39	2.85	2,231	10.60	<0.0001	p > c, m > c
Reading at school entrance (max = 20)	12.78	11.52	11.56	10.94	4.52	3.74	2,226	11.06	<0.0001	p > c, m > c
Measures end of first grade:										
Phonological coding (max = 20)	8.00	5.27	8.16	5.68	7.10	4.79	2,232	1.63	ns	–
Orthographic coding (max = 20)	9.85	6.13	10.13	6.17	8.19	5.68	2,232	3.32	<0.05	m > c
Word identification (max = 25)	12.87	7.20	12.89	6.98	10.74	5.34	2,231	3.16	<.05	m > c
Word reading (max = 36)	20.50	7.86	22.38	8.65	19.97	6.20	2,226	4.78	<.01	m > c, m > p
Sentence reading (max = 18)	9.90	5.12	9.30	5.22	8.10	3.56	2,232	2.90	ns***	p > c, m > c
Text reading (max = 7)	2.58	2.35	2.44	2.43	1.71	1.64	2,231	3.61	<0.05	p > c, m > c
Mathematics	62.67	24.96	61.11	25.22	68.73	25.39	2,199	0.40	ns	–

*With the composite score of the scaled scores from the WISC-R sub-tests Vocabulary, Similarities and Digit Span.
**p = the phonological group, m = the morphological group, c = the control group.
***p close to being significant and post hoc comparisons show significant differences between groups.

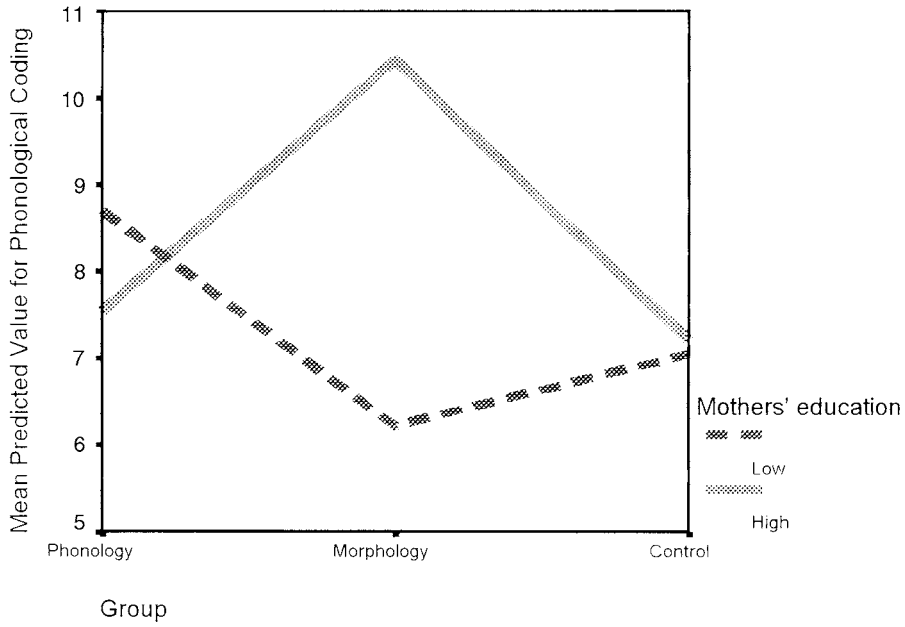

Figure 1. Mean predicted value for phonological coding. Covariate is verbal IQ. Number of children in the phonological group is 36 (low) + 50 (high), in the morphological group 59 + 48 and in the control group 22 + 9.

for Phonological Coding, $F(2,217) = 5.51$, $P < 0.01$, Orthographic Coding, $F(2,217) = 3.95$, $P < 0.05$, and Sentence Reading, $F(2,217) = 3.71$, $P < 0.05$. These interactions make the group effect on Orthographic Coding somewhat difficult to interpret and indicate that different kinds of training has had different effects on different subgroups of children. A series of L matrix procedures were run to conduct pairwise interaction comparisons and simple main effect analyses. The results on Phonological Coding showed that the difference between children of poorly and highly educated mothers in the Morphological group differed significantly from the difference between these two groups of children in the Phonological group, $F(2,217) = 10.76$, $P < 0.01$. The results for children of poorly and highly educated mothers in the different groups are shown in Figure 1.

Children of highly educated mothers in the Morphological Group performed significantly better than children of highly educated mothers in the Phonological group, $F(2,217) = 8.33$, $P < 0.01$. Children of highly educated mothers in the Control Group had the lowest predicted score, but, probably due to the small number of children in this group, no significant differences were found between this group of children and the other subgroups. The difference between children of highly educated mothers in the Control

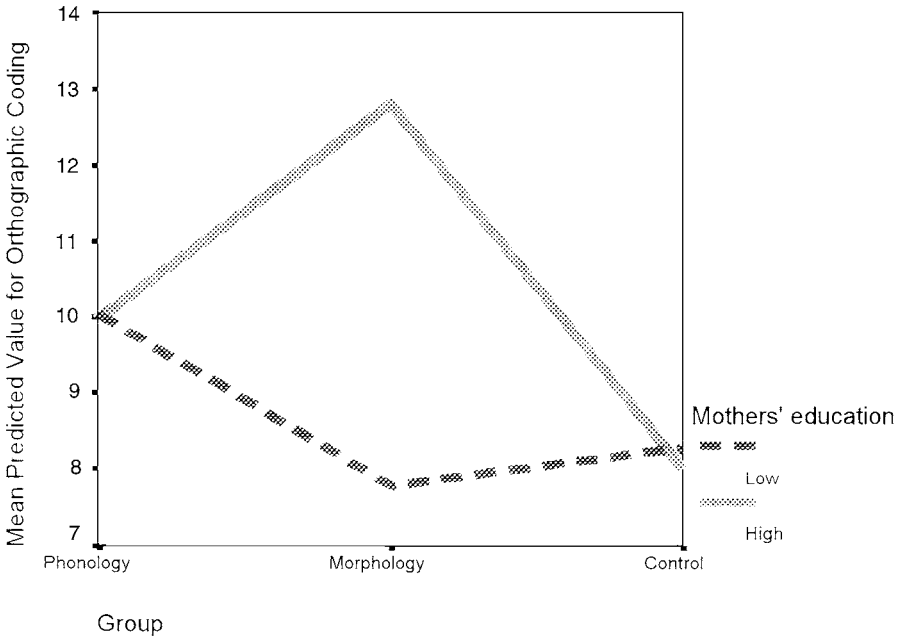

Figure 2. Mean predicted value for orthographic coding.

Group and the Morphological Group was, however, close to being significant, $F(2,217) = 3.79$, $P = 0.53$. As the figure shows there also was a tendency for children of poorly educated mothers in the Phonological Group to perform better than this subgroup of children in the other groups. Pairwise comparisons, however, did not reveal any significant differences between these groups of children, $F(2,217) = 1.98$, $P = 0.14$.

The test results on Orthographic Coding and Sentence Reading tended to be very similar to the results on Phonological Coding. Significant interactions were found between the Morphological Group and the Phonological Group on both Orthographic Coding, $F(2,217) = 6.95$, $P < 0.01$, and Sentence Reading, $F(2,217) = 6.94$, $P < 0.01$. The results on Orthographic Coding for children of poorly and highly educated mothers in the different groups are shown in Figure 2.

Comparisons revealed no significant difference between children of poorly educated mothers in the three groups, $F(2,217) = 1.46$, but significant differences were found between children of highly educated mothers, $F(2,217) = 5.00$, $P < 01$. The comparisons showed that the group of children with highly educated mothers in the Morphological Group had significantly higher scores than the two other groups of highly educated mothers. Figure 3 shows the results on Sentence Reading for the different groups of children.

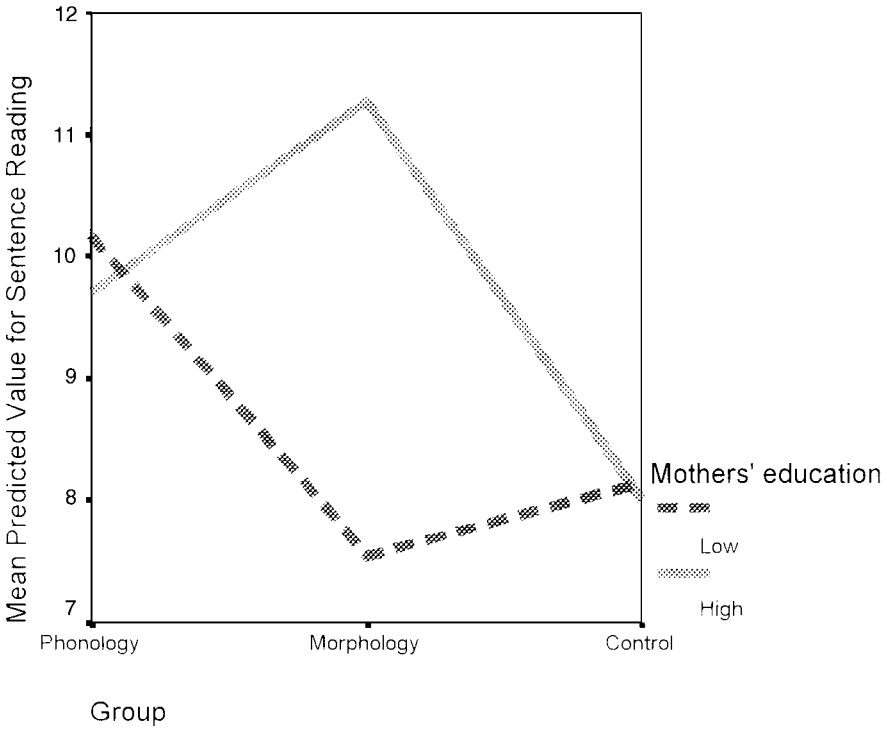

Figure 3. Mean predicted value for sentence reading.

Comparisons revealed a significant difference between children of highly educated mothers in the three groups, $F(2,217) = 3.10$, $P < 0.05$. Children of highly educated mothers in the Morphological Group were ahead of this subgroup of children in the Control Group. The difference between the subgroups of children of poorly educated mothers was also close to being significant, $F(2,217) = 3.08$, $P = 0.52$, with children in the Phonological Group clearly ahead of this group of children in the Control Group. A 2 (mothers' educational level) X 3 (training groups) analysis of covariance was also conducted to evaluate the results on the composite reading score. There was a main effect of group, $F(2,217) = 3.20$, $P < 0.05$ as well as a significant interaction effect, $F(2,217) = 3.85$, $P < 0.05$. Follow-up comparisons showed the same pattern as for the analyses presented above.

Discussion

Children in the experimental groups did not receive metalinguistic awareness training in isolation. They also, to some degree, had exposure to printed

elements. The Control Group had extensive exposure to print, but the experimental groups learned explicitly about some of the links between the spoken and the written language. The training in the experimental groups could in no way be compared to the way literacy teaching is conducted in the Norwegian schools, but the growing understanding of the principles that rule the written language may have triggered the development of metalinguistic awareness as well as reading. These facts, as well as the age of the children at school entrance, should be taken into consideration when interpreting the results from the present study. As pointed out by Lundberg et al. (1988) and Blachman, Ball, Black & Tangel (1994) there are limitations to research conducted in natural settings. But even if the problems discussed above represent a limitation on interpretation of some of the results, other questions and interpretations should be less influenced by the design of the present field experiment.

After completing the training program children in both the Phonological Group and the Morphological Group significantly outperformed controls on Identification of Word Length, Rhyme Identification, Initial Phoneme Matching, Phoneme Counting, Segmentation of Sentences into Words, Analyses of Compound Words and Listening Comprehension. The first four measures are related to the ability to identify and manipulate the phonological and phonemic structures in words. The next two measures are related to the children's awareness of words in addition to the phonological abilities that are implicit in these tasks. Listening Comprehension is supposed to be a measure of more general linguistic abilities, but focuses a variety of morphological elements that should be mastered to succeed.

The post-test results support the view that phonological processing plays a vital role in morphological learning [see Carlisle (1995), for a discussion]. The development of phonological and morphological awareness may be reciprocal (Carlisle 1995). This view is supported by the fact that children in the Phonological Group developed their morphological knowledge and awareness to a significantly higher level than children in the Control Group. This view is further supported by the fact that children in the Morphological Group also developed their phonological skills and awareness to significantly higher levels than the controls. The ability to manipulate the sound segments of words might have facilitated the development of morphological awareness and the development of morphological awareness might have fostered growth in phonological awareness. Another explanation may be, however, at least partly, the reading abilities in the experimental groups at post-test.

The Phonological Group did outperform the Morphological Group on one of the post-test's phonological tasks, however, namely on Phoneme Counting. It was no surprise that the phonological training, more so than the morpholog-

ical training, had been effective for the development of phonemic awareness. This result was supported by the results on the Deletion of Initial Phoneme task showing that only the Phonological Group outperformed the Control Group. Some of the post-test results are somewhat difficult to interpret. The Phonological Group outperformed not only the Control Group but also the Morphological Group on Word Compounds, Syntactic Awareness and Listening Comprehension. These results are surprising, and the significantly better performance on Listening Comprehension in the Phonological Group and the Morphological Group than in the Control Group is not in line with results from previous studies (Lundberg et al. 1988). The fact that the Phonological Group outperformed the Morphological Group on these measures is also difficult to understand. One explanation might be that the phonological awareness training to an even greater extent than the morphological awareness training helped the children develop better attention and awareness for linguistic structures. The morphological training, more than the phonological training, focused the children's attention on meaning. The main focus in the Phonological Group was the form of the language. The explicit focus on phonological elements, together with their growing morphological awareness, might have given these children an advantage when small phonological elements are to be identified and the exact meaning of a sentence is to be understood.

No differences were found between the groups on the measures Phoneme Blending, Knowledge of Compound Words, Memory for Word Sequences and Homophones. The ability to handle the demands of these tasks seems to have been little affected by the different intervention programs. These tests represent measures of phonological processing. One important factor in this process is the children's ability to activate stored phonological identities in their lexicon [see Bishop (1997); Torgesen, Wagner & Rashotte (1994) for discussions of children's phonological processing capacity and access to phonological information]. The metalinguistic activities in this study have had an effect on the children's metalinguistic development, but according to the results they had less effect on other phonological processing factors. The results for Phoneme Blending and Knowledge of Compound Words, however, may result from ceiling effects. The lack of differences might also be explained by using Digit Span as one component of the covariate, and by the fact that memory plays an important role in phoneme blending tasks.

Even if ceiling effects may explain the lack of significant differences between the groups for some of the tests, no such effect was found on Homophones. This result supports the view that linguistic awareness training in pre-school primarily has an impact on the development of linguistic awareness abilities, but scarcely has any effect on more general linguistic

and cognitive abilities. The results for Syntactic Awareness and Listening Comprehension, however, suggest that better metalinguistic abilities generalize to an overall better linguistic attention towards syntactic processing. A conclusion to the first main question of this study would be that morphological awareness training in pre-school is effective for the development of metalinguistic awareness. Children of five and six years of age can easily detect the morphological structures in words, especially when the awareness training is combined with some exposure to the written elements in question. Not surprisingly, phonological awareness training seemed to be more effective for developing awareness of the single sounds in words, but the effects of both types of awareness training seemed to be reciprocal.

The most important question, however, was not how the pre-school training affected the development of linguistic awareness alone, but if the different intervention programs also had effects on reading development immediately and later on in school. The ultimate goal of the study was to study the effect of morphological and phonological awareness training on reading development when the training programs included some exposure to print. The results from this study do in some ways confirm the results of previous research which found that training kindergarten children in phonological awareness has a positive influence on early reading skills (Bradley & Bryant 1983; Lundberg et al. 1988). The results confirm those from previous studies, which found that morphological awareness training clearly benefits development of linguistic awareness and reading development (Elbro & Arnbak 1996; Henry 1989, 1993; Tornéus 1987). Such training clearly also has effects on metalinguistic awareness and reading development even if it takes place as early as pre-school. The immediate effect, not surprisingly, of the pre-school training on reading was clear. After completing the training program children in both experimental groups outperformed the controls on the two reading tasks given to the children at the time of the post-test and at school entrance. Both types of metalinguistic training also seemed to have had long lasting effects. The two experimental groups outperformed the Control Group on two of the reading tasks given to the children at the end of Grade 1. The effect of the morphological training, however, clearly showed the strongest effect. The Morphological Group outperformed the Control Group on three more reading tasks and also on the composite reading variable. This group also outperformed the Phonological Group on Word reading. Phonological Coding was the only task on which no differences were found between the groups. This result and the overall small effect of the phonological awareness training might be due to the transparency of the Norwegian language and to the fact that all classrooms to quite a large extent focused on phonics. This fact may also explain why the better performance of

the Phonological Group on Phoneme Segmentation tasks did not give them a higher score than the other groups on Phonological Coding. The relatively regular Norwegian language and the focus on phonics in all classrooms did, in the long run, not necessarily give children in the Phonological Group a great advantage in cracking the code and learning the grapheme–phoneme correspondences. Most children from the Morphological Group, as well as from the Control Group, would be expected to crack the reading code quite easily in the Norwegian school system. Norwegian children, even children at risk, seem to learn phoneme–grapheme correspondences and crack the reading code quite rapidly and easily in grade 1 (Hagtvet & Lyster, in press).

Wimmer and Goswami (1994) stress that "[i]n order to achieve fast reading for meaning, children learning to read in any alphabetic orthography need to develop direct word recognition strategies and stop assembling pronunciations via grapheme–phoneme translations" (p. 102). The children in the two experimental groups cracked the reading code earlier than the controls. This probably means that they, more than the controls, had developed direct word recognition strategies. This fact can explain that significant differences were found between the groups on different word and text reading tasks but not on Phonological Coding. Both experimental groups were exposed to print. The Morphological Group, however, was exposed to morphological structures and larger orthographic structures than the Phonological Group, which to a larger extent focused on letters. Children from the Morphological Group developed some understanding of the second main principle of alphabetic languages, the morphological principle. The awareness of this principle may be important for rapid word identification. Children learning about the morphological principle of the written language may have an extra advantage when identifying written words, at least if they have learned the letter–sound correspondences. They may be able to identify larger structures, for example structures representing grammatical elements, more easily and rapidly than children in the other groups. The better results for the Morphological group on most reading tasks were unexpected, however, when taking the post-test results into account. All aspects of morphology focussed on in the morphological training sessions (see Appendix) were not tested, however. The grammatical elements, for example, as they were presented, gave children in the Morphological Group explicit morphological knowledge that probably provided them with knowledge they could use to identify word parts easily and rapidly. The large amount of exposure to print in the Control Group did not seem to have had an effect on the children's reading compared to the development in the experimental groups.

The second main question can not easily be answered by comparing the effects of the two training programs. The effects of the training programs

should be viewed against the background of the Norwegian orthography and the methods of instruction in the schools. The results, however, support findings from research, which have shown a close relationship between morphological knowledge and awareness and reading ability, as well as extending our knowledge about the effect of morphological training.

One of the most interesting results from the study is that different kinds of training seem to have different effects depending on the children's linguistic abilities and their mother's educational level. The interaction effects that were found between training and mother's educational level for some reading tasks makes the interpretations of the main effects of groups complicated. Significant interactions were found for Phonological Coding, Orthographic Coding and Sentence reading. There was a clear tendency for children of poorly educated mothers who entered the training with poorly developed phonological awareness to profit the most from phonological awareness training. Children of poorly educated mothers did not benefit from morphological awareness training in terms of their reading development in grade 1. Children of highly educated mothers, on the other hand, clearly benefited the most from morphological awareness training. This group of children, who entered the study with relatively well developed phonological awareness, did not seem to benefit much from phonological awareness training in terms of their reading development. The results and the conclusions drawn from them seem to be at odds with some previous findings. According to Byrne (1998, see also Byrne et al. 1997), children seem to develop awareness of the morphemes in written words more easily than the alphabetic structure. The children in Byrne's experiments, however, were quite young and the results from the present study converge with claims put forward by Tunmer & Rohl (1991) that training effects cannot be considered independently of the cognitive level when children are older than 6 years. Cary & Verhaeghe (1994) have also suggested that children from poor social backgrounds may gain particular advantage from phoneme analysis training (which was part of the phonological training given in this study).

The answer to the third main question seems very clear. We can conclude that neither phonologically, nor morphologically, based linguistic training in pre-school is generally superior. Each of them, however, seems to be superior to the other when viewing sub-groups in the different experimental groups. The findings in this study support the theory that different metalinguistic knowledge has different importance at different stages of reading development (Tunmer & Bowey 1984) – or rather, different linguistic elements should be focused on at different stages of development if reading progress is to be supported and reading failure is to be prevented. The children with highly educated mothers who entered the last pre-school year with a relatively

high level of phonological awareness, clearly profited from metamorphological training. These children needed less explicit phonemic instruction, which seemed to be important for children with less developed phonological awareness. Morphological training, however, probably helped children of highly educated mothers to discover and use the morphological principle of the written language and gave them an additional strategy to identify words. The results seem to indicate that morphological awareness should rest on a basic level of phonological abilities before it can be an important element in an orthographic or morphemic reading strategy. It remains to be seen, however, if morphological training in the long run can help children with weak phonological skills to compensate for their problems with phonological decoding and help them to develop better reading abilities.

Mothers' education seems to be an important predictor of reading development, even when controlling for IQ. Since genetic influence to some extent was controlled for, this suggests that mother's education might partly be a measure of the linguistic context they have created for their children. How do highly educated mothers communicate linguistically with their children compared to poorly educated mothers? Do they read books to their children more often or differently from poorly educated mothers? Does the prevention of reading disabilities start indirectly by educating parents? Studies by Whitehurst, Epstein, Angell, Payne, Crone & Fischel (1994) show that educating parents in lower socio-economic communities about how to interact with their children, while reading to them, had a positive effect on the children's literacy development.

The effects of the training presented here, when focusing on the subgroups in the different training groups, seem to have had more effect than the training given by Lundberg and his colleagues (1988) if we consider the amount of intervention time in the two studies. In their study the difference between the experimental group and the control group on reading in grade 1 was only marginally significant ($P < 0.10$). Lundberg et al. did, however, only considered the total group and not different sub-groups in the sample. The exposure to print activities in the Phonological Group, which otherwise received training in line with the children in the Lundberg et al. study, might also explain differences in the size of effect obtained. There is now strong support for the view that phonological awareness training is most effective when run alongside reading instruction or is presented to the children alongside information about letters and print (Hatcher et al. 1994).

It remains to be seen if children of poorly educated mothers in this study, who needed more time than children of highly educated mothers to crack the alphabetic code, in the long run can take advantage of the morphological knowledge they developed during the study. The work reported, however,

suggests that morphological awareness, like phonological awareness, may bear a close relation to reading achievement even in pre-school and the early school years. The work also suggest that print exposure in a natural way can and should be included in linguistic awareness training to help children creating links between the spoken and the written language. Based on the results from this study, teachers should be encouraged to emphasize the teaching of morphological awareness and knowledge as soon as the children have developed a phonological base that helps them to handle morphemes. Further, given the important role of morphological awareness in acquiring new vocabulary it should be very important for weaker readers to receive explicit instruction within different areas of morphology (see for example Stemberger 1995; Stolz & Feldman 1995). On a practical level, it should be possible to combine the two types of metalinguistic awareness training presented here in a way that gives support to children at different developmental levels in the same classroom.

Acknowledgement

This study was supported by grant 571.92/007 from The Norwegian Research Council.

Appendix

Play and training activities in the Morphological Group

The children had play activities with words. They were finding words that consisted of two words. If they presented the word *skoeske* (shoebox), they had to find the two words shoe and box. They also had to delete one word at the time to find what was then left, and they had to move the last word in the compound word to the front of the word to create the word *eskesko (boxshoe)*. Then they had to decide whether the new word was a real word and what meaning it had.

Other activities were focusing on prefixes and suffixes. An example is that the pre-school teacher puts a drawing (made by one of the children) on the board and says "Look here is a pei." Pei is a non-word with an acceptable Norwegian orthography. "Look", the teacher goes on, "the pei is happy (glad is the Norwegian word). Can you see that he is smiling?" Then the teacher places the two written words under the drawing and says: "Look here is the word pei (points), and here is the word glad." Then the teacher puts another pei (even more happy than the first one) besides the first one and asks the children if it is correct to say only pei and glad now. Then the children alone or with help from the pre-school teacher find out that there are two pei*er* (plural is expressed with -er in Norwegian) and they are glad*e* (adjective plural). The teacher and the children listen to the sound structure of pei and glad and

find out that these words are not correct any more. They lack sounds in the "tail", the ending -er and the ending -e. The children find with help from the teacher the pieces of paper (among several) with -er and -e and place them at the end of the non-word pei and at the end of glad. The teacher says: "Look, we still have the word pei here, but we have added -er which tells us that we have more than one pei." The teacher goes on pointing to the pei that is smiling the most and says: "What do you think about this pei? Is it as happy as the first pei?" Together the children the pre-school teacher find the answer that this one is even happier, – it is the happiest of the two peis. Then the superlative -est has to be added to glad instead of the -e (glad*est*).

The same procedures were used for many of the morphemic presentations. But presentations were also done presenting only words and no drawings. One example is the following: The teacher asks the children if they know what the word *lykkelig* (happy) means. The children and the teacher talk about the meaning of the word and the children are presented with the printed word on the board. Then the teacher asks if the children know a word that means the opposite of happy. When they have found the word *ulykkelig (unhappy)*, the teacher asks if they can hear any difference between lykkelig (happy) and *u*lykkelig (*un*happy). Then they end up adding the prefix u- to lykkelig and focus on the part of the word that makes happy a word with opposite meaning.

References

Adams, M.J. (1990). *Beginning to read: Learning and thinking about print*. Cambridge, Massachusetts: MIT Press.

Ball, E.W. & Blachman, B.A. (1988). Phoneme segmentation training: Effect on reading readiness, *Annals of Dyslexia* 38: 208–225.

Baron, J. & Strawson, C. (1976). Orthographic and word-specific mechanisms in reading words aloud, *Journal of Experimental Psychology: Human Perception and Performance* 2: 386–393.

Bishop, D.V.M. (1997). *Uncommon understanding. Development and disorders of language comprehension in children*. Hove, East Sussex: Psychology Press.

Blachman, B. (1989). Phonological awareness and word recognition: Assessment and intervention. In: A.G. Kahmi & H.W. Catts (eds.), *Reading disabilities: A developmental language perspective* (pp. 133–156). Boston: College-Hill Press.

Blachman, B.A., Ball, E.W., Black, R.S. & Tangel, D.M. (1994). Kindergarten teachers develop phoneme awareness in low-income, inner-city classrooms. Does it make a difference?, *Reading and Writing: An Interdisciplinary Journal* 6: 1–18.

Bradley, L. & Bryant, P.E. (1983). Categorizing sounds and learning to read: A causal connection, *Nature* 301: 419–421.

Bryant, P., Nunes, T. & Bindman, M. (1998). Awareness of language in children who have reading difficulties: Historical comparisons in a longitudinal study, *Journal of Child Psychology and Psychiatry* 39: 501–510.

Byrne, B. (1998). *The foundation of literacy*. East Sussex, UK: Psychology Press.

Byrne, B., Fielding-Barnsley, R. Ashley, L. & Larsen, K. (1997). Assessing the child's and the environment's contribution to reading acquisition: what we know and what we don't know.

In: B. Blackman (ed.), *Foundations of Reading Acquisition and Dyslexia. Implications for Early Intervention* (pp. 265–286). Mahwah, New Jersey: Lawrence Erlbaum.

Carlisle, J.F. (1995). Morphological awareness and early reading achievement. In: L.B. Feldman (ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cary, L. & Verhaeghe, A. (1994). Promoting phonemic analysis ability among kindergarteners. Effects of different training programs, *Reading and Writing. An Interdisciplinary Journal* 6: 251–28.

Cunningham, A.E. (1990). Explicit versus implicit instruction in phonemic awareness, *Journal of Experimental Child Psychology* 50: 429–444.

Elbro, C. (1990). *Differences in dyslexia*. Munksgaard, København.

Elbro, C. & Arnbak, E. (1996). The role of morpheme recognition and morphological awareness in dyslexia, *Annals of Dyslexia* 46: 209–240.

Elley, W.B. (1992). *How in the world do students read?* Hague: The international Association for the Evaluation of Educational Achievement Headquarters.

Feldman, L.B. & Andjelkovic (1992). Morphological analysis in word recognition. In: L. Katz & R. Frost (eds.), *Orthography, phonology, morphology, and meaning: An overview*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Fowler. A.E. & Liberman, I.Y. (1995). The role of phonology and orthography in morphological awareness. In: L.B. Feldman (ed.), *Morphological aspects of language processing* (pp. 157–188). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Gjessing, H.J. (1958). *Standpunktprøver i skolen. Stillelesning, 1. Klasse* [Standardized tests in the schools. Reading, grade 1]. Oslo: University Press.

Goswami, U. & Bryant, P. (1990). *Phonological skills and learning to read*. London: Lawrence Erlbaum.

Hagtvet, B.E. (1989). Emergent literacy in Norwegian 6-year olds. From pretend writing to phonemic awareness to invented writing. In: F. Biglmaier (ed.), *Reading at the crossroads*. Conference report, The 6th European Conference on reading. Berlin, July 31st–August 3rd.

Hagtvet, B.E. & Lyster, S.A.H. (in press). The spelling errors of Norwegian good and poor decoders: A developmental cross-linguistic perspective. In: N. Goulandris (ed.), *Dyslexia: Cross linguistic comparisons*. London: Whurr Publishers.

Hatcher, P., Hulme, C. & Ellis, A. (1994). Ameliorating early reading by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis, *Child Development* 65: 41–57.

Henry, M.K. (1989). Beyond phonics: Integrated decoding and spelling instruction based on word origin and structure, *Annals of Dyslexia* 38: 258–275.

Henry, M.K. (1993). Morphological structure: Latin and Greek roots and affixes as upper grade code strategies, *Reading and Writing. An Interdisciplinary Journal* 5: 227–241.

Høien, T., Lundberg, I., Stanovich, K.E. & Bjaalid, I.K. (1995). Components of phonological awareness, *Reading and Writing: An Interdisciplinary Journal* 7: 171–166.

Leimar, U. (1974). *Läsning på talets grund* [Reading based on the spoken language]. Stockholm: Liber.

Lundberg, I., Frost, J. & Petersen, O.-P. (1988). Effects of an extensive program for stimulating phonological awareness in preschool children, *Reading Research Quarterly* 23: 263–284.

Lyster, S.A.H. (1997). Spelling development and metalinguistic training before school entrance. The effects of different metalinguistic training on spelling development in first grade. In: C.K. Leong & R.M. Joshi (eds.), *Cross-language studies of learning to read and spell* (pp. 305–330). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Lyster, S.A.H. & Tingleff, H. (1992). *Ringeriksmaterialet. Kartlegging av språklig oppmerksomhet hos barn i alderen 5–7 år* [The Ringerike battery. Testing metalinguistic awareness in the age group 5–7 year]. Hønefoss: Tingleff forlag.

Mann, V.A. (1991). Are we taking too narrow a view of the conditions for development of phonological awareness? In: S.A. Brady & D. P. Shankweiler (eds.), *Phonological processes in literacy. A tribute to Isabelle Y Liberman* (pp. 55–64). Hillsdale, New Jersey: Lawrence Erlbaum.

Mann, V.A. & Liberman, I.Y. (1984). Phonological awareness and verbal short term memory: Can they presage early reading problems? *Journal of Learning Disabilities* 17: 592–599.

Marslen-Wilson, W., Tyler, L.K., Waksler, R. & Older, E. (1994). Morphology and meaning in the English mental lexicon, *Psychological Review* 101: 3–33.

Nunes, T., Bryant, P & Bindman, M. (1997). Morphological spelling strategies: Developmental stages and processes, *Developmental Psychology* 33: 637–649.

Olofsson, Å. & Lundberg, I. (1985). Can phonemic awareness be trained in kindergarten? *Scandinavian Journal of Psychology* 24: 35–44.

Olson, R., Kliegel, R., Davidson, B.J. & Foltz, G. (1985). Individual developmental differences in reading disability. In: T.G. Waller (ed.), *Reading research: Advances in theory and practice*, Vol. 4 (pp. 1–64). New York: Academic Press.

Olson, R.K., Wise, B., Conners, F. & Rack, J. (1990). Organization, heritability, and remediation of component word recognition and language skills in disabled readers. In: T.H. Carr & B.A. Levy (eds.), *Reading and its development* (pp. 261–322). San Diego, California: Academic Press.

Snowling, M.J. & Frith, U. (1986). Comprehension in 'hyperlexic' readers, *Journal of Experimental Child Psychology* 42: 392–415.

Stemberger, J.P. (1995). Phonological and lexical constraints on morphological processing. In: L.B. Feldman (ed.), *Morphological aspects of language processing* (pp. 247–267). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Stolz, J.A. & Feldman, L.B. (1995). The role of orthographic and semantic transparency of the base morpheme in morphological processing. In: L.B. Feldman (ed.), *Morphological aspects of language processing* (pp. 109–129). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Torgesen. J.K., Wagner, R.K. & Rashotte, C.A. (1994). Longitudinal studies of phonological processing and reading, *Journal of Learning Disabilities* 27: 276–286.

Tornes, J. (1968). *Standpunktprøver i skolen. Matematikk. 1., 2. og 3. Klasse* [Standardized tests in the schools. Mathematics for grade 1, 2 and 3]. Seksjon for skolepsykologi, NPF, Oslo: Universitetsforlaget.

Tornéus, M. (1987). *The importance of metaphonological and metamorphological abilities for different phases of reading development*. Paper presented at the 3. world congress of dyslexia, Crete.

Tornéus, M., Hedström, G. & Lundberg, I. (1986). *På tal om språk. Lekar och övningar* [Focusing language. Games and training]. Uppsala: Almqvist & Wiksell.

Treiman, R.A. & Baron, J. (1983). Phonemic-analysis training helps children benefit from spelling-sound rules, *Memory and Cognition* 11: 382–389.

Tunmer, W.E. & Bowey, J. (1984). Metalinguistic awareness and reading acquisition. In: W.E. Tunmer, C. Pratt & M.L. Herriman (eds.), *Metalinguistic awareness in children: Theory, research and implications* (pp. 144–168). Berlin: Springer-Verlag.

Tunmer, W.E. & Rohl, M. (1991). Phonological awareness and reading acquisition: Convergent findings on theoretical foundations of code-oriented versus whole-language approach in reading acquisition, *Journal of Educational Psychology* 83, 437–443.

Undheim, J.O. (1978). *Manual for Wechsler Intelligence Scale for children – revised*. Translated and adapted by permission from the Psychological Corporation, New York.

Wagner, R.K. & Torgesen, J.K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills, *Psychological Bulletin* 101: 192–212.

Wechler, D. (1974). *Wechsler Intelligence Scale for children – revised*. New York: The Psychological Corporation.

Whitehurst, G.J., Epstein, J.N., Angell, A.L., Payne, A.P. Crone, D.A. & Fischel, J.E. (1994). Outcomes of an emergent literacy intervention in Head Start, *Journal of Educational Psychology* 30: 79–89.

Wimmer, H. & Goswami, U. (1994). The influence of orthographic consistency on reading development: Word recognition in English and German children, *Cognition* 51: 91–103.

Address for correspondence: Dr. Solveig-Alma Halaas Lyster, Department of Special Needs Education, University of Oslo, P.O. Box 1140, Blindern, 0317, Oslo, Norway
Phone: +47-22858049; Fax: +47-22858021; E-mail: sol.lyster@isp.uio.no