

Preschool phonological, morphological and semantic skills explain it all: following reading development through a 9-year period

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Background: There is increasing recognition of the contribution of morphological skills to the development of reading fluency. However, theoretical models and recent research raise questions about how different language skills influence reading development.

Methods: The present study was designed to follow the reading development of a large sample of Norwegian children ($N = 323$) from preschool to Grade 9, assessing their performance on a wide range of language-related and reading skills including morphological awareness. We employed confirmatory factor analyses of the cognitive, linguistic and reading variables prior to modelling the contribution of the preschool language variables to reading comprehension in Grades 1, 2 and 9.

Results: Preschool measures of phonological, morphological and semantic skills were best represented by a single language latent variable. Reading in Grades 1 and 2, assessed by measures of both decoding and comprehension, was also best represented by a single latent variable. Preschool language skills have long-range direct and indirect effects on the development of reading comprehension. Overall, preschool language abilities accounted for 69.2% of the variance in reading comprehension 9 years later.

Conclusions: The results demonstrate the powerful influence of early language on later reading and suggest that language intervention programmes, combining phonological, morphological and semantic activities, may help to reduce the incidence of reading problems.

Keywords: longitudinal, phonological awareness, morphology, oral language skills, reading comprehension

Highlights

What is already known about this topic

- Reading comprehension builds on oral language.
- Language in preschool has a long-term effect on later reading comprehension.
- Training morphological awareness improves reading comprehension.

What this paper adds

- Phonological awareness, morphological awareness and language comprehension in preschool are best represented by a single variable.
- The findings confirm the key role of language skills as a foundation for learning to read and as a robust predictor of longer-term reading comprehension outcomes.
- Preschool language skills are direct predictors of reading comprehension in Grade 9 and have an indirect effect on reading comprehension mediated by reading skill measured in Grades 1 and 2.

Implications for theory, policy or practice

- Children in preschool and school should receive broad-based language programmes.
- Teachers can support children in detecting both the phonological and morphological structures of words as well as helping them to develop semantic knowledge about words and word parts.

As language development progresses through the early years of schooling, children become aware of the sound and meaning components of words. Precursors of phonological awareness can be seen in aspects of sound play, rhyme and alliteration, and there is evidence that this skill is a strong predictor of reading development (Melby-Lervåg, Lyster, & Hulme, 2012). In contrast, morphological awareness, explicit knowledge of the morphemes, which are the smallest units of meaning of words, has been much less studied. Morphological awareness, measured, for example, by the ability to identify and understand how prefixes and suffixes change word meanings and how words can go together to make compound words, is thought to play a significant role in the development of reading comprehension, and there is evidence that training such skills benefits reading comprehension (e.g., Deacon, Kieffer, & Laroche, 2014; Deacon & Kirby, 2004; Goodwin & Ahn, 2010; Kieffer, Petscher, Proctor, & Silverman, 2016; Lyster, Lervåg, & Hulme, 2016; Rueda-Sánchez & López-Bastida, 2016). However, a paucity of longitudinal data means that the mechanisms, which account for these relationships, are not understood; key questions are the extent to which morphological awareness differs from phonological awareness and from vocabulary in the prediction of reading outcomes.

A related question is the structure of oral language and how morphological awareness relates to this. While Tomblin and Zhang (2006) reported that vocabulary knowledge could be separated from sentence use when modelling the structure of oral language, a single factor model fit data from a cohort of preschool children well. Further, it was a better fit in

later grades. Similarly, although there is some evidence for the differentiation of language skills later on in development in relation to reading comprehension (e.g., Foorman et al., 2015; Ricketts et al., 2019), large-scale studies converge on the view that language can be considered a unitary factor (Bornstein et al., 2018; Hjetland et al., 2019). Furthermore, a number of studies suggest that phonological awareness is strongly related to oral language abilities in preschool, forming a single dimension of language (Foorman et al., 2015; Storch & Whitehurst, 2002), but few of these studies include measures of morphological awareness. It is plausible that awareness of morphemes has distinct effects on reading from that of other language skills (Borleffs, et al., 2019); indeed, Kieffer et al. (2016), in a study of children in Grades 3–5, found that morphological awareness made a substantial unique contribution to reading comprehension after variance in a latent measure of language comprehension (the strongest predictor) was taken into account. The present study was designed to follow the reading development of a large sample of Norwegian children from preschool to Grade 9, assessing their performance on a wide range of language and reading-related skills including phonological and morphological awareness. The study is novel in including multiple measures of preschool language skills and using latent constructs to model the development of reading over a 9-year developmental period. It sought to answer the following research questions: (i) to what extent do measures of morphological awareness in preschool correlate with other language abilities? (ii) are preschool measures of phonological, morphological and semantic skills best represented by a single language factor and do they have effects on the development of reading comprehension in Grade 9? (iii) are the effects of morphological awareness distinct from those of phoneme awareness?

Method

Participants

Three months prior to school entrance, 323 typically developing Norwegian-speaking children with no known special needs (mean age of 6 years 10 months; SD = 3.49) from 25 preschool groups were recruited to the study. None of the children had received reading instruction. Informed consent for participation in the study was obtained from parents. Educational information was collected for mothers at the time of the first data collection (see Lyster et al., 2016). The distribution of these data suggested that the sample was representative of the Norwegian population at the time. At the time of this study, children in Norway entered school and began phonically based reading instruction in the year they turned 7 years. The children proceeded to attend 18 different schools. Data were collected after two thirds of them had taken part in an experimental intervention study comparing the effects of phonological versus morphological awareness training (with no reading instruction) (Lyster et al., 2016). We took this into account in our data analysis.

Measures

Four constructs considered important predictors of reading were measured at t1, which spanned preschool shortly before school entry and early Grade 1: multiple measures of phonological awareness, morphological awareness and language comprehension. Word-level reading skills were measured at the end of Grade 1 (t2) and Grade 2 (t3),

respectively, 11 and 23 months after the first testing at t1. Reading comprehension was assessed in Grades 1, 2 and 9 (t4). All measures, except vocabulary, were administered to children in small groups. Brief details of measures are given below (for reliabilities, see Table 1; for further information, see Lyster, 2002; Lyster et al., 2016).

Phonological awareness

Rhyme recognition. The child was required to mark one of three pictures that rhymed with a target picture.

TABLE 1. Means (*SDs*) and reliabilities (α) for all measures in preschool and Grades 1, 2 and 9.

Measures	Max score	Mean	<i>SD</i>	Reliability
Preschool/early Grade 1 (t1)				
Rhyme recognition	9	8.28	1.42	.73
Phoneme deletion	10	6.14	2.12	.65
Phoneme segmentation	6	3.02	1.94	.72
Morph1 (understanding compound words)	11	9.93	1.42	.81
Morph2 (morphological blending)	7	5.90	1.57	.67
Morph3 (morphological analyses)	8	5.78	2.11	.59
Homophones	16	8.91	4.11	.88
Vocabulary	28	23.63	3.33	.73
Listening comprehension	34	23.63	3.33	.73
Raven	60	22.99	6.96	.85
Grade 1 (t2)				
Word–picture reading	36	22.72	8.52	.87 ^a
Phonological reading	20	8.50	5.58	.89
Orthographic reading	20	10.74	6.52	.93
Reading comprehension, RCa1	18	9.97	5.16	.92
Reading comprehension, RCb1	38	20.53	11.29	.86 ^a
Grade 2 (t3)				
Word–picture reading	400	200.19	71.44	.80
Phonological reading	20	10.67	5.38	.91
Orthographic reading	20	16.37	5.27	.94
Reading comprehension, RCa2	18	11.67	3.51	.92
Reading comprehension, RCb2	50	25.19	11.03	.86 ^a
Grade 9 (t4)				
Reading comprehension, RCa9	12	8.59	2.73	.93 ^a
Reading comprehension, RCb9	14	10.32	3.42	.86 ^a

^aReliability (α) data from Norwegian standardisation.

Initial phoneme deletion. A spoken word was presented, and the child had to indicate the picture out of three which matched the word with a sound deleted.

Phoneme segmentation. Each word was presented orally with accompanying picture. The child had to mark each phoneme in the word using a pencil stroke.

Morphological awareness

The tests used to measure morphological awareness tapped compounding (after Elbro,). Compounding of two or more words is common in Norwegian, the last part carrying the main meaning and the first part(s) adjusting or modifying the meaning of the word.

Knowledge of compound words. The child had to select the picture (from a set of four) corresponding to the compound word. The foils were drawings of words containing both word parts or one of them.

Word compounds. This test assessed children's ability to make a compound word from two given words by selecting the correct picture (from a set of four) (e.g., what word do you get if you put together 'spise' [eat] and 'bord' [table]).

Analysis of compound words. The child had to find the word (from a set of four) that was left when one of the words from a compound was deleted.

Language comprehension skills

Homophones. The child had to identify within 5 minutes two pictures (from four) with the same name (e.g., 'Christmas' and 'wheel' – homophones in Norwegian).

Vocabulary. The WISC-R vocabulary test was given. The child has to explain the meanings of the words.

Listening comprehension. The child had to identify one picture from four representing orally presented sentences with different grammatical and syntactic constructs.

Nonverbal IQ

Each child completed Raven's Progressive Matrices (Raven, Raven, & Court, 1988).

Reading grades 1 and 2

In each of the tasks involving real words (for decoding or comprehension), items were high-frequency words well known by children of the age in question.

Word-picture reading. For each item, the child saw a picture and had to choose from a number of words (4–8), the one which matched it. There were 36 items and a time limit of 4.5 minutes.

Word–picture reading. This task consisted of 400 words, each accompanied by four pictures in a row. The child had to match as many words and pictures as possible within 15 minutes.

Phonological reading. The child had to identify the pseudo-word that sounded like a real word in 20 nonword/nonword pairs within 120 seconds. Score was the number correct minus number incorrect.

Orthographic reading. The child had to identify the word in 20 word/pseudo-homophone pairs with the correct spelling. Score was the number correct minus number incorrect.

Reading comprehension (Grades 1 and 2). The child reads 18 sentences within 3 minutes, finding one picture among four that was the correct one for each sentence. The measure was the number of correctly read and understood sentences within the time limit.

Reading comprehension (Grade 1). The child reads passages of increasing length after which there was one question to be answered by putting a cross on one of four pictures representing the correct answer. Children completed as many of the 19 items as possible in 12 minutes. Two points were given for each correct answer.

Reading comprehension (Grade 2). After each of 25 passages to be read, there were two questions to be answered by putting a cross on the one of four alternative answers. Children completed as many items as possible in 15 minutes. Two points were given for each correct answer.

Reading Grade 9

Reading comprehension. This narrative reading task was followed by 14 multiple choice questions tapping literal information.

Expository text reading. This task consisted of a short text and a table with information about political parties (party standings) followed by 12 multiple choice questions. Children were given 4 minutes to complete the task.

Results

Descriptive statistics and reliabilities for all measures are shown in Table 1.

Table 2 shows the correlations between variables. The preschool and early Grade 1 ($t1$) measures correlated moderately. The Grade 1 ($t2$) reading measures correlated well with each other and with the Grade 2 ($t3$) and Grade 9 ($t4$) measures, suggesting considerable stability of reading over time. The two reading comprehension measures at $t4$ were also well correlated with listening comprehension and other measures at $t1$.

All further analyses were of models estimated in Mplus 8.0, using robust standard errors taking the preschools into account (MLR, complex in Mplus). Full information maximum likelihood was used to handle the missing values. In order to adjust for potential differences caused by the fact that children in the sample had participant in an intervention study in kindergarten, we regressed all of the indicators in the following models on two

TABLE 2. Correlations between all variables.

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
t1 measures																						
1 Rhyme	–																					
2 Deletion	.383	–																				
3	.323	.308	–																			
Segmentation																						
4 Morph 1	.269	.217	.232	–																		
5 Morph 2	.350	.391	.368	.330	–																	
6 Morph 3	.259	.391	.259	.275	.295	–																
7	.415	.391	.433	.406	.484	.430	–															
Homophones																						
8 Vocabulary	.244	.254	.280	.320	.230	.293	.453	–														
9 List. Compr.	.439	.368	.375	.407	.505	.382	.562	.362	–													
10 Raven	.221	.336	.305	.225	.351	.328	.415	.285	.424	–												
t2 measures																						
11 WordPict	.399	.358	.386	.331	.393	.369	.581	.390	.454	.335	–											
1																						
12 PhonRead	.287	.259	.338	.256	.328	.202	.447	.307	.413	.315	.640	–										
1																						
13 Orth. Read. 1	.332	.391	.419	.272	.398	.259	.525	.388	.437	.323	.763	.632	–									
14 ReadC a1	.377	.376	.439	.317	.412	.315	.586	.388	.485	.362	.772	.667	.770	–								
15 ReadC b1	.310	.384	.399	.308	.382	.333	.570	.381	.469	.325	.816	.662	.782	.813	–							

(Continues)

Table 2. (Continued)

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
t3 measures																					
16 WordPic 2	.293	.237	.212	.350	.368	.362	.489	.276	.425	.347	.605	.475	.568	.640	.619	–					
17 PhonRead 2	.138	.181	.214	.243	.183	.228	.291	.265	.302	.305	.453	.442	.462	.472	.470	.456	–				
18 Orth. Read. 2	.330	.220	.245	.363	.370	.346	.461	.320	.376	.309	.610	.428	.636	.604	.596	.649	.346	–			
19 ReadC a2	.232	.182	.249	.227	.250	.297	.473	.299	.435	.270	.525	.367	.475	.518	.525	.656	.407	.560	–		
20 ReadC b2	.327	.322	.296	.307	.328	.305	.516	.407	.485	.281	.724	.508	.670	.714	.755	.738	.475	.681	.602	–	
t4 measures																					
21 ReadC a9	.374	.215	.242	.332	.436	.339	.477	.309	.518	.312	.498	.387	.504	.516	.494	.591	.393	.547	.530	.560	–
22 ReadC b9	.224	.314	.159	.212	.184	.264	.354	.375	.302	.283	.441	.265	.381	.410	.442	.448	.323	.477	.397	.555	.499

Notes: Two-tailed correlations. All correlations are significant at the .001 level, with the exception of the correlations between rhyme and phonological reading Grade 2 and between segmentation and reading comprehension b9, which were significant at the .01 level. Orth.Read., orthographic reading; PhonRead, phonological reading; ReadC, reading comprehension; WordPic, word-picture reading.

dummy variables reflecting the assignment to intervention groups: phonological intervention versus morphological intervention versus control. For reasons of simplicity, these regressions are not shown in the figures.

Confirmatory factor analyses

First, we assessed whether the cognitive and linguistic variables measured in preschool were best described by a single latent factor rather than by distinct constructs describing phonological awareness, morphological awareness, language comprehension and nonverbal ability. Phonological awareness was defined by measures of rhyme, phoneme deletion and segmentation, morphological awareness by the three compound word measures and language comprehension by measures of homophones, vocabulary and listening comprehension. In addition, Raven Matrices reflected a nonverbal abilities factor. This two-factor model (language comprehension and nonverbal abilities) had an excellent fit to the data (Figure 1), $\chi^2(35) = 30.578$, $p = .682$, RMSEA = .000 (10% CI = .000–.033), CFI = 1.00, TIL = 1.01, SRMR = .024. Moreover, a Wald test showed no significant difference from a nested four-factor model with distinct factors describing the four constructs, $\chi^2(5) = 2.788$, $p = .733$; this was also supported by a lower Bayesian information criteria (BIC) for the two-factor model (BIC = 12,444.061) compared with the four-factor model (BIC = 12,468.454).

We followed the same procedure to estimate single factor models of reading from the five reading measures in Grade 1 and Grade 2 (word–picture reading, phonological coding, orthographic coding and the two reading comprehension tests). In Grade 1, this model (Figure 1) had an excellent fit to the data, $\chi^2(5) = 4.071$, $p = .539$, RMSEA = .000 (10% CI = .000–.070), CFI = 1.00, TIL = 1.00, SRMR = .005, and did not differ from a model with separate latent factors of word reading and reading comprehension, $\chi^2(1) = .045$, $p = .832$, something that was supported by a lower BIC for the one-factor model (9,535.395 vs. 9,541.102).

A similar pattern was evident for the reading variables measured in Grade 2 (Figure 1). The one-factor model had an excellent fit to the data, $\chi^2(5) = 8.314$, $p = .140$, RMSEA = .048 (10% CI = .000–.103), CFI = .990, TIL = .962, SRMR = .014, but did differ from a model with separate latent factors of word reading and reading comprehension, $\chi^2(1) = 4.356$, $p = .037$. However, the one-factor model was supported by a lower BIC (8,838.829) compared with the two-factor model (8,840.153), and the BIC is to be preferred in these models as the Wald test is testing at the border of permissible space (i.e., $r = 1$).

Predicting reading comprehension in Grade 9

To estimate the degree to which preschool language skills predicted reading comprehension skills in Grade 9, we estimated the full structural equation model shown in Figure 2. Here, we regressed a reading comprehension factor (reflecting both the narrative and expository comprehension tests) on reading in Grade 2, language in preschool and nonverbal abilities. Similarly, reading in Grade 2 was regressed on reading in Grade 1, language and nonverbal abilities in preschool; and reading in Grade 1 was predicted by earlier language and nonverbal abilities in preschool. This model, shown in Figure 2, had an excellent fit to

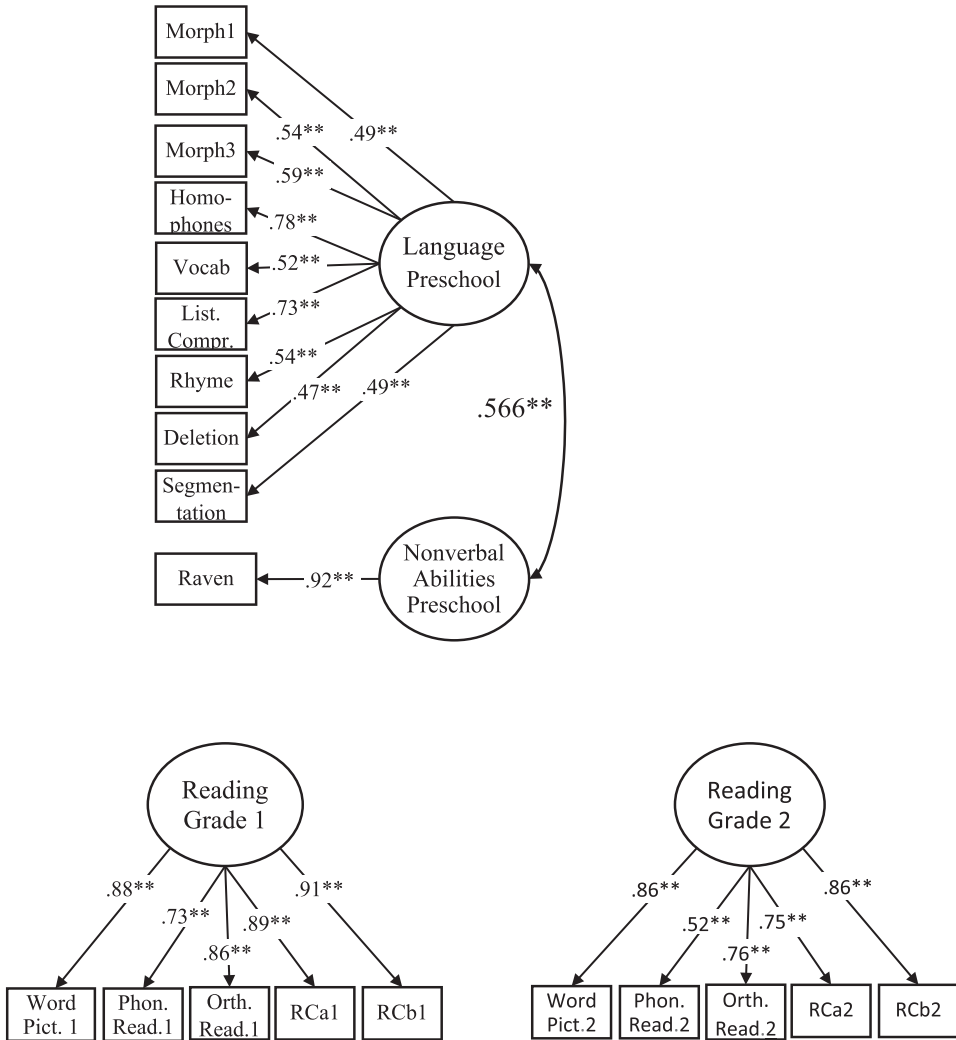


FIGURE 1. Confirmatory factor analyses of Language and Nonverbal Abilities in preschool, Reading in Grade 1 and Reading in Grade 2. All coefficients are standardised.

the data, $\chi^2(198) = 246.408, p = .011, RMSEA = .028$ (10% CI = .014–.038), CFI = .984, TIL = .978, SRMR = .036.

As can be seen, language in preschool predicted reading comprehension in Grade 9 both directly ($\beta = .386$) and indirectly through reading in Grade 1 and Grade 2 ($\beta = .474$) with a total effect of $\beta = .860$. Both language in preschool and reading in Grade 1 predicted reading in Grade 2 ($\beta = .729$), and only the language factor in preschool predicted reading in Grade 1. The β s are standardised regression coefficients. A total of 84.7% of the variance in reading comprehension in Grade 9 was explained by the language and reading constructs measured in preschool and Grade 2. To check that equivalent effects operated across the three groups, we assessed a three-group model with all regressions fixed to be equal across groups to the equivalent model where all regressions were freely estimated, this model showed metric invariance and there was no difference between the constrained

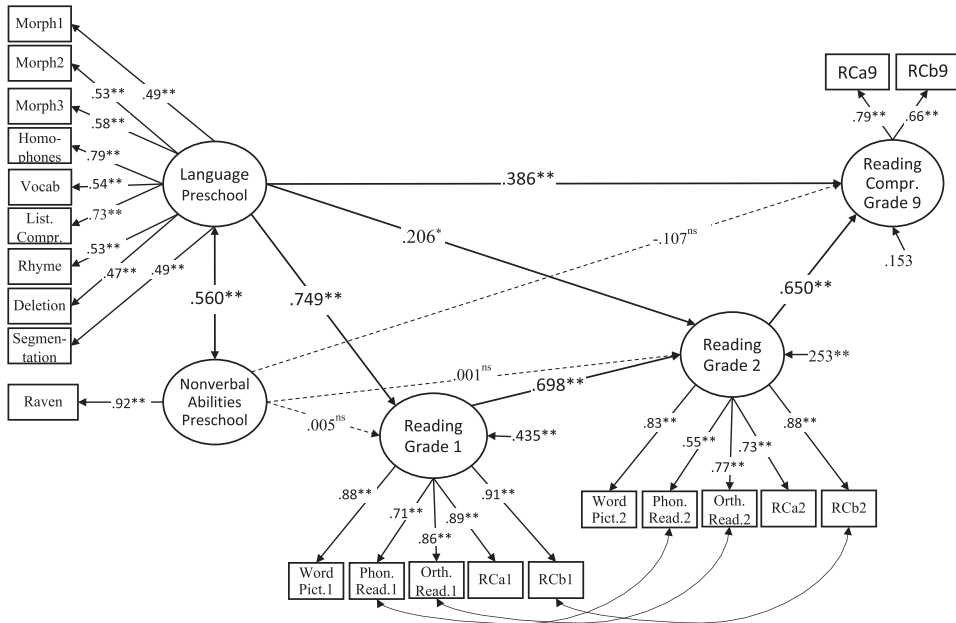


FIGURE 2. Structural equation model where reading Comprehension in Grade 9 is regressed on Language and Nonverbal Abilities in preschool, Reading in Grade 1 and Reading in Grade 2. All coefficients are standardised.

and unconstrained models, $\chi^2 = 25.521, p = .0612$. This confirms that the pattern of regression coefficients shown in Figure 2 does not differ across groups.

Discussion

In this study, we assessed the longitudinal predictors of reading comprehension between preschool and ninth grade. The study is unique in the range of skills measured in preschool, including morphological awareness, the use of latent constructs to provide reliable measures of reading and language and the length of time over which development was assessed. The findings confirm the key role of language skills as a foundation for learning to read and as a robust predictor of longer-term reading comprehension outcomes.

In preschool, we found strong correlations between measures of morphological awareness, phonological awareness and language comprehension. While it was possible to model the data from these measures with three latent variables, high correlations among them suggested that a more parsimonious model included a single preschool language factor comprising vocabulary, homophone recognition and listening comprehension together with the metalinguistic skills of phonological and morphological awareness. These findings are consistent with those of several recent studies reporting that preschool language is a unitary factor; they provide no evidence to suggest that morphological awareness is distinct at this stage of development, although it may become important in later school grades (Kieffer et al., 2016).

Similarly, in Grades 1 and 2, all the word reading tasks loaded highly on a single latent variable. Thus, there was no evidence for any differentiation of orthographic and

phonological reading strategies. Arguably, the transparency of the Norwegian orthography might explain this uniformity of reading skills after only a year of formal schooling. Perhaps, more surprisingly, reading comprehension also loaded highly on this factor. While this finding converges with others in older children (e.g., Foorman et al., 2015), it should be borne in mind that here all the tests of reading comprehension were group administered and hence the children who were better at word reading tended to be better able to comprehend the short passages used (cf. Keenan, Betjemann, & Olson, 2008).

Finally, we asked whether preschool language skills had effects on the development of reading comprehension in Grade 9. We found that preschool language had both direct and indirect effects on reading comprehension: some 55% of the variance in Grade 1 reading could be explained by preschool language skills after which reading itself was a predictor of later word reading and reading comprehension. Notwithstanding these strong effects, language in preschool accounted for additional variance in reading comprehension in Grade 9, providing longitudinal evidence for the simple view of reading.

Together, our findings show that morphological awareness, phonological awareness and language comprehension skills form a unitary language factor in the preschool years and this is a critical foundation for reading development. Preschool language skills also have long-range direct and indirect effects on the development of reading comprehension. For children at risk for reading problems, oral language interventions may be effective ways of facilitating reading development (Hulme, Snowling, West, Lervåg, & Melby-Lervåg, in press).

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Margareth Snowling took up the role of President of St. John's College, Oxford, in September 2012. Before that, she held a personal Chair in the Department of Psychology at the University of York where she was Co-Director of the Centre for Reading and Language. Snowling completed her first degree at Bristol and her doctorate at University College London. She is also professionally qualified as a clinical psychologist. She is a Past-President of the Society for the Scientific Study of Reading and one of the Joint Editors of the *Journal of Child Psychology and Psychiatry*. She served as a

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Charles Hulme is professor of Psychology and Education in the Department of Education and William Golding Senior Research Fellow at Brasenose College. He has broad research interests in reading, language and memory processes and their development and is an expert on randomised controlled trials in Education. His work on reading development has made important contributions to understanding the role of phonological skills in learning to read. He has also explored the role of wider language skills (particularly vocabulary knowledge and grammatical skills) as influences on the development of reading comprehension. His publications include a number of assessment materials including the Phonological Abilities Test (1997), the York Assessment of Reading for Comprehension (YARC, 2009) and Sound Linkage (2014) as well as several books dealing with various aspects of reading development. He is the former Editor-in-Chief of the journal *Scientific Studies of Reading* (2007–2009) and is currently a Senior Editor of the Association of Psychological Science's flagship journal, *Psychological Science*. In 2009, he published 'Developmental disorders of language, learning and cognition' (Wiley-Blackwell; co-authored with Maggie Snowling). He holds an honorary doctorate from the University of Oslo (2014) and is also a visiting professor at the same university. He is a member of Academia Europea and a Fellow of the Academy of Social Sciences. He received the Feitelson Research Award from the International Reading Association (1998) and the Marion Welchman International Award for Contributions to the study of Dyslexia from the British Dyslexia Association (2016). He is a Fellow of the Academy of Social Sciences, a Fellow of Academia Europaea and a Fellow of the British Academy. Professor Charles Hulme has broad research interests in reading, language and memory processes and is an expert of Randomised Controlled Trials evaluating interventions for reading and language difficulties in children. He is a former Editor-in-Chief of the journal *Scientific Studies of Reading* (2007–2009) and is currently a Senior Editor of *Psychological Science*, the flagship journal of the Association for Psychological Science. He is the author of some 190 articles and chapters, and some 11 authored or edited books.

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