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Preschool Morphological Awareness and Developmental Change in Early Reading Ability

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ABSTRACT

Purpose: This longitudinal study examined the contribution of preschool morphological awareness to word reading skills and reading comprehension, as well as to the developmental change of reading ability beyond other well-established oral language and cognitive predictors. A distinction was made between the domains of inflectional and derivational morphology.

Method: Two hundred and fifty-nine Norwegian-speaking children (46% female) with a mean age of 5.5 years were assessed in preschool on language measures and again in Grades 1 and 3 on measures of word reading accuracy and fluency and in Grades 3 and 4 on reading comprehension. We fit latent change score models with preschool predictors using parceling to control for measurement error.

Results: We found a unique contribution of preschool morphological awareness to reading comprehension in Grade 3, but no unique contribution to Grade 1 decoding. Neither awareness of inflections nor awareness of derivations predicted developmental change in word reading fluency between Grades 1 and 3 or change in reading comprehension between Grades 3 and 4 beyond the effect of control variables.

Conclusion: Our findings confirm the relevance of morphological awareness only for early attainment in reading comprehension and highlight the importance of accounting for measurement error in studying associations among variables aiming to discover specific contributions.

There is consensus in the field of reading development that oral language skills are fundamental for learning to read accurately and fluently, and ultimately becoming able to comprehend what is read (e.g., Lervåg & Melby-Lervåg, 2022a, 2022b). Among linguistic domains, morphology has attracted increased interest in recent decades. Morphological awareness refers to the ability to understand and manipulate the smallest units of meaning in language, such as affixes, roots, and stems (Kuo & Anderson, 2006). However, the evidence concerning the role of morphological awareness in the development of reading skills is not as straightforward as that for more thoroughly investigated domains. The role of morphology can vary depending on the morphological domain (inflectional vs. derivational), the orthographic depth of the language (transparent vs. deep orthographies), as well as the developmental stage of morphological awareness and/or that of the reading skill under investigation. As a result, it is still unclear whether morphological awareness contributes in a direct or/and indirect way to developing word reading accuracy, word reading fluency, and reading comprehension.

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Therefore, in the present study we followed a cohort of Norwegian children from preschool to fourth grade. We aimed to examine whether inflectional and derivational morphological awareness, assessed as distinct oral language skills prior to literacy instruction, make a unique contribution to the development of reading skills beyond other known oral language and cognitive predictors.

Morphological awareness and models of reading development

Theoretical frameworks of skilled reading have elaborated on testable theories about the mechanisms with which morphology supports reading comprehension. The Reading Systems Framework (C. Perfetti & Stafura, 2014; C. A. Perfetti et al., 2005) proposes that skilled readers achieve efficient reading comprehension by flexibly coordinating processes in three main systems, namely the orthographic, language comprehension, and cognitive control systems. According to this framework, morphology plays an important role in the orthographic system, which includes knowledge of spelling patterns, letter-sound correspondences, and morphological structure. It is posited that morphological knowledge allows skilled readers to recognize and generate new words based on their knowledge of how words are constructed from smaller units of meaning. The framework also suggests that morphology plays a role in language comprehension, as it can help readers to infer the meaning of unfamiliar words based on their knowledge of morphological structures.

Building on the Reading Systems Framework, and based on extensive evidence for robust associations between morphology and literacy development in English, Levesque et al. (2021) proposed the Morphological Pathways Framework. Within this framework, morphological awareness is seen as a broader metalinguistic skill that enables the proximal mechanisms of (a) morphological decoding, or use of morphemes in word reading emerging in early elementary school years (Deacon et al., 2017), and (b) morphological analysis, as a mechanism for lexical access in support of reading comprehension. Both mechanisms indirectly support children's reading comprehension. Levesque and colleagues (2017, 2019) showed that morphological analysis partially or entirely mediated the contribution of morphological awareness in reading comprehension development. This illustrates both a direct and an indirect pathway of morphological awareness through the lexicon, where morphological analysis evokes meaning in lexical representations, which in turn supports reading comprehension. Morphological awareness – perceived as a metalinguistic ability that integrates semantic, phonological, and syntactic processes – is proposed to likely feed into the comprehension component of the framework through a direct pathway in addition to the two indirect pathways.

Morphological awareness and word reading accuracy and fluency

Even though studies of languages with different orthographic transparency and morphological structure have demonstrated the significant role of morphological awareness in reading development, its predictive value may vary across orthographic systems and developmental stages of reading skill (J. F. Carlisle, 2000; Kuo & Anderson, 2006; Nunes et al., 2003). In their cross-linguistic study comparing English, French, and Greek, Desrochers et al. (2018) found that early second grade morphological awareness predicted later second-grade word reading accuracy, beyond the effects of phonological awareness and rapid automatized naming, only in English (the least transparent orthography of the three). It also predicted second-grade reading fluency in both English and French, but not in Greek (the most transparent orthography). These findings support the hypothesis of morphological facilitation, when reliance on grapheme-to-phoneme correspondences is not enough for achieving accurate and fluent word reading. However, Desrochers et al. (2018) did not control for early second-grade reading skills in their analyses, leaving open the possibility that their morphological awareness predictor was also reflecting early reading development variance and not only a specific contribution of metalinguistic awareness in the morphological domain.

Other studies have indicated that the contribution of morphological awareness to reading skills changes with development. Kirby et al. (2012) reported significant effects of Grade 2 morphological

awareness on concurrent measures of word reading accuracy, but not word reading speed. They found an increased contribution of morphological awareness to word reading accuracy and speed in Grade 3. More tellingly, Deacon et al. (2013) showed that morphological awareness, assessed in Grade 2, predicted word reading accuracy measured in Grade 3, even after accounting for earlier reading accuracy (autoregressor control).

Current evidence supports the early contribution of morphological awareness to reading development across languages with more transparent orthographies, such as Dutch (Rispens et al., 2008), Greek (Diamanti et al., 2017; Rothou & Padeliadu, 2015) and Hebrew (Cohen-Mimran et al., 2022). However, findings are not in complete agreement. In Greek, a relatively transparent orthography with rich inflectional and derivational morphology, Kargiotidis et al. (2022) tested 144 first graders to explore the direct and indirect effects of morphological awareness on early decoding, fluency, and reading comprehension. They only found an indirect effect of morphological awareness, through phonological awareness, on both word reading accuracy and fluency. In contrast, Diamanti et al. (2017) reported a significant unique contribution of pre-school morphological awareness to Grade 1 word reading accuracy, beyond phonological awareness and receptive and expressive vocabulary. Diamanti et al. did not find a unique contribution of morphological awareness to reading fluency, contradicting the findings of Manolitsis (2006), who reported a unique contribution of morphological awareness to single-word reading speed but not to word reading accuracy. Further, Cohen-Mimran et al. (2022) found that preschool morphological awareness predicted Grade 1 reading accuracy and fluency beyond the effect of preschool phonemic awareness among Hebrew speaking children.

Morphological awareness and reading comprehension

Morphological awareness has – in several studies across multiple orthographies – been found to be associated with reading comprehension beyond the effects of phonological awareness and vocabulary (J. F. Carlisle & Stone, 2005; Kuo & Anderson, 2010). This is consistent with its supportive role in the process of identifying and interpreting the meaning of morphologically complex words (Goodwin & Ahn, 2013). Children with stronger morphological awareness skills tend to exhibit higher levels of reading comprehension (J. F. Carlisle, 2010). In addition, there is evidence indicating that morphological awareness instruction in preschool and late elementary years can have long-term effects on reading comprehension, especially when combined with phonological awareness training (Lyster, 2002; Lyster et al., 2016; Manolitsis, 2017).

It has been suggested that morphological awareness supports reading comprehension and its development both directly and indirectly through vocabulary and/or word-level reading skills (Kieffer & Lesaux, 2012; Manolitsis et al., 2019; Nagy et al., 2006). In a longitudinal study of children from 3rd to 4th grade, Deacon et al. (2014) found an indirect effect of morphological awareness on reading comprehension through word reading skills (controlling for phonological awareness, vocabulary, and non-verbal intelligence), in addition to direct effects of morphological awareness on reading comprehension and vice versa. They suggested that morphological awareness contributes to children's understanding of text both directly and through support of reading individual words, which in turn benefits reading comprehension. A variety of direct and indirect effects across languages have also been reported by additional studies of concurrent associations (e.g., Kargiotidis et al., 2022; Levesque et al., 2017); however, these are limited in their potential to illustrate the developmental importance of the reported relationships.

An important consideration in interpreting the reported associations is that in many cases morphological awareness is assessed well after the onset of literacy instruction. Relatively few studies (and mainly in consistent orthographies) have measured children's morphological awareness prior to systematic exposure to print (Casalis & Louis-Alexandre, 2000; Diamanti et al., 2017; Grigorakis, 2014; Pittas & Nunes, 2014). Thus, it is not clear whether the reported effects arise entirely as a product of oral language – and metalinguistic – development or, rather, reflect a learning trajectory that is influenced by orthographic morphological learning (e.g., consistently spelled affixes) and can thus be seen as part of reading development.

The degree of orthographic consistency of alphabetic languages may moderate the effect of morphological awareness on reading development, whether specific to morphological awareness or nonspecific – as part of a wider oral language construct. In their longitudinal cross-linguistic study, Caravolas et al. (2019) estimated a latent language variable for preschool oral language skills including morphological awareness along with syntax and vocabulary. For the consistent orthographies of Spanish, Czech, and Slovak, this preschool oral language variable predicted individual differences in Grade 2 reading comprehension, beyond Grade 1 word reading. For the inconsistent orthography of English, however, Grade 1 word reading ability was the single significant predictor of Grade 2 reading comprehension. In comparison, Desrochers et al. (2018) found that early Grade 2 morphological awareness was a unique predictor of late Grade 2 reading comprehension, beyond the effects of RAN and phonemic awareness, across the one consistent and the two inconsistent orthographies they examined (i.e., Greek, French, and English). However, vocabulary was not controlled for in this study.

Morphological domains and reading development

Morphology is not a unitary domain but encompasses a variety of word formation processes, including inflection, derivation, and compounding (Kuo & Anderson, 2006). Accordingly, morphological awareness may differ across these subdomains, both developmentally and in its association with language and reading development. In particular, inflectional morphological awareness refers to the ability to recognize and manipulate the grammatical inflections that can be added onto words to signal properties such as tense, number, and case. The inflectional morphology system is a small, closed class of high frequency grammatical suffixes (Mahony, 1994).

Derivational morphological awareness involves the ability to recognize and manipulate the morphemes that create new words or change the meaning of existing ones. The derivational process produces new words that may belong to a different grammatical category than the base word. For instance, in Norwegian, the suffix "–ing"/iŋ/can be added to the stem "les"/leːs/("to read") to create the noun word "lesing" ("reading"). The derivational process can be less transparent, whereby the base word differs phonologically and/or orthographically from the derived one (e.g., the nouns "produkt"/pruˈdʉkt/"product" and "produksjon"/prudʉˈkʃuːn/"production" derived by the verb "produsere"/prudʉˈseːre/"to produce"). The derivational morphology system is described as a large, open class of lexical affixes (Mahony, 1994) and its acquisition depends on the complexity of transformation between base and derived forms (J. Carlisle, 1988). Additionally, the lesser degree of transparency of the derivational process could further complicate its mastery (Casalis & Louis-Alexandre, 2000).

The morphological processes of grammatical inflection and productive derivation may not be equally accessible to children's awareness, as studies in both transparent and deep orthographies have shown that the developmental course of the two domains differs; awareness of inflectional morphology develops earlier than awareness of derivational morphology. Awareness of inflections is acquired as early as in preschool (Diamanti et al., 2018) and first school years (Diakogiorgi et al., 2005; Kuo & Anderson, 2006), whereas awareness of derivations is acquired toward the fourth year (J. F. Carlisle, 2000) and continues to develop (Berninger et al., 2010). Therefore based on the higher expected level of maturation of inflectional awareness in relation to that of derivational awareness, it can be hypothesized that inflectional awareness will be more predictive of early reading ability, when measured earlier (i.e., in preschool). When awareness of inflectional morphology is measured in preschool (Casalis & Louis-Alexandre, 2000) or first grade (Rispens et al., 2008), it makes a unique contribution to first-grade word reading skills. On the other hand, awareness of derivational morphology accounts for unique variance in word reading beyond second grade and this relationship becomes increasingly stronger (Singson et al., 2000).

Derivational morphological awareness appears particularly important for reading comprehension, especially when reading complex texts with more advanced vocabulary (J. F. Carlisle, 2010; Kuo & Anderson, 2010). J. F. Carlisle (2000) found that measures of derivational morphology had a significant concurrent contribution to reading comprehension and these relationships

were stronger for fifth graders than for third graders. In their longitudinal study, Nagy and colleagues (2006) assessed Grade 3 children on measures of morphological awareness, primarily involving derivations; and again in Grades 6 and 7 on measures of word recognition, reading comprehension, and spelling. Morphological awareness was a significant predictor of reading comprehension in both grades, controlling for phonological awareness, orthographic knowledge, and vocabulary. Nagy et al. suggested that morphological awareness contributes to reading comprehension in two ways: Better morphological awareness relates to better reading accuracy and fluency of morphologically complex words, which subsequently supports better comprehension; and, additionally, morphological awareness supports syntactic parsing, whereby suffixes signal syntactic structure, especially when the proportion of morphologically complex words increases.

The present study

It has become apparent that there are discrepancies in the findings of the reviewed studies arising from the numerous factors that may be involved in the study of morphological awareness and reading development, such as differences in age, orthography, materials; confounds with reading experience; longitudinal vs. cross-sectional designs; additional methodological limitations concerning confounding variables, measurement error, and different types of analyses.

The current study goes beyond existing research in several important ways. Against a background of contradictory evidence, we measured morphological awareness prior to the onset of literacy instruction and controlled for other language skills and cognitive predictors. We avoided biases introduced by measurement error (Cole & Preacher, 2014) using latent variables in structural equation modeling (SEM) instead of the more commonly used hierarchical multiple regression analyses, which are vulnerable to spurious effects due to imperfect reliability (Westfall et al., 2016). In particular, we studied the developmental change in word reading fluency between Grades 1–3 and reading comprehension between Grades 3–4 using latent change scores (LCS; Geiser, 2020), which rely on measures that are invariant over time and can thus be justifiably attributed to development. In this way we can also avoid limitations of previous studies due to lack of autoregressors of the outcome measures (Deacon et al., 2017; Levesque et al., 2019; see Lervåg & Melby-Lervåg, 2022b, for a discussion of such methodological issues).

To focus on the question of whether morphological awareness can have a specific and unique predictive value in early reading development, in our models, we controlled for the effects of well-established preschool predictors of each domain of reading skill. Specifically, for the prediction of word reading we included phonological awareness, letter knowledge, and rapid naming, whereas for the prediction of reading comprehension we turned to indices of language development including measures of vocabulary and receptive grammar. In both models we also controlled for nonverbal cognitive skills.

The present study was conducted in Norwegian, a language with a relatively transparent orthography and a complex syllabic structure (Seymour et al., 2003). Norwegian exhibits extensive derivational morphology that resembles that of other Germanic languages and English. Norwegian inflectional morphology of nouns and adjectives is more complex than English, including noun inflections for number and definiteness and adjective inflections for gender and number, but less complex than Greek, in which nouns and adjectives are inflected for gender, number, and case and verbs are inflected for voice, aspect, tense, number, and person (Ralli, 2003).

Based on this, the current study examines the following research questions:

(1) Does awareness of inflectional and derivational morphology, assessed prior to the onset of literacy instruction, predict word reading skills beyond other well-established predictors?
(2) Does awareness of inflectional and derivational morphology, assessed prior to the onset of literacy instruction, predict later reading comprehension skills beyond other well-established predictors?

Method

Participants

A sample of 259 Norwegian-speaking children (119 girls) with a mean age of 5.5 years (*SD* = 3.5 months, range = 59–72 months) was recruited from 58 preschools (and subsequently 35 schools) in the outskirts of Oslo, in municipalities with average population indices of income and education level (Statistics Norway, 2021a, 2021b). Children were assessed once a year, from December to February in preschool and Grades 1 and 4, and between November and December in Grade 3. Informed consent was given by the legal guardians of the children prior to their inclusion in the study and oral assent from the children was ensured before each assessment, with the option of withdrawing at any point. Children diagnosed with developmental auditory, cognitive, or behavioral impairments and children with a first language other than Norwegian were excluded. In addition, five children were excluded because either the child themself or the parents opted to withdraw. In accordance with the Norwegian legal framework for non-medical research that was in effect at the time the study was initiated, the project was approved by the Data Protection Official for Research (NSD personvernombud, case 54,745). The study conforms to the recognized standards presented in the Declaration of Helsinki.

Design and procedure

We were interested in the development of the two main dimensions of reading skill, namely word reading, and comprehension, specifically focusing on their growth once they can be meaningfully distinguished. For reading comprehension, this means after basic decoding skills have been established in Grade 1. Indeed, we did not even measure reading comprehension in Grade 1, as most children's skills are still too limited to permit meaningful assessment in January. This is in part because in Norway there is no literacy instruction in preschool and children begin to formally learn the letters in August of Grade 1. Children attend preschool from 12 months old until 6 years old when they enter primary school. Thus preschool includes the year attended at 5 years that is commonly known as kindergarten; however, there is no structured educational curriculum for this year, and therefore we refer to it as preschool. In addition, children do not receive any type of morphological awareness training nor explicit instruction on morphemes as part of their reading curriculum during the early school grades.

Data collection in Grade 2 was interrupted as schools closed due to Covid-19, leaving an unmanageable proportion of missing data in variables of interest. Thus, we examine reading comprehension growth from Grade 3 to Grade 4. Word reading skills, on the other hand, can be meaningfully assessed from Grade 1 onwards, thus we examined growth from Grade 1 to Grade 3.

Trained graduate students assessed the children at their preschools and schools. We used well-known standardized measures of reading comprehension, vocabulary, syntax, and word reading, and research-developed measures of morphological awareness. These were part of a larger test battery used to assess children's development of reading and math skills, which required 3 hour-long sessions in preschool and Grade 1, and a single hour-long session in Grades 3 and 4. Study design and data management followed the guidelines of the Norwegian Center of Research Data (2022).

Measures

Reading measures

Reading Comprehension. We assessed reading comprehension with a Norwegian translation of the Neale Analysis of Reading Ability (NARA-II; Neale, 1997). The test comprised six stories of increasing

difficulty. The child read each story aloud for the examiner, who then asked open-ended questions (four for the first story and eight for the following five stories). Some of the questions required making inferences about explicit and implicit information in each story. The task was discontinued when the child exceeded a prespecified criterion of decoding errors or failed to answer correctly any of the questions for a story. McDonald's omega total (Revelle, 2022) indicated that this task had very good internal consistency in Grade 3 ($\omega_t = .85$) and Grade 4 ($\omega_t = .84$).

Word Reading Fluency. We measured word reading fluency with a Norwegian adaptation of the Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1997) forms A and B with real words. The child was asked to read the words as quickly and accurately as possible with a time limit of 45 seconds. Each list consisted of words presented in four columns of increasing difficulty. We used the number of correctly read words per minute (WPM) as a measure of word reading in Grades 1 and 3. The correlation between forms A and B were .94 and .93 for Grades 1 and 3, respectively, reflecting excellent reliability.

Word Reading Accuracy. We used a word reading accuracy test (Språk 6–16; Ottem & Frost, 2005) consisting of 3 blocks of 10 words of increasing difficulty. After administering trial items, the child read the words without time constraints. Blocks 1 and 2 were always administered. The test was stopped if the child made five consecutive mistakes within the second block, otherwise the third block was administered. Each word was scored with two points if all sounds were read as a complete word with correct stress, or with one point if the child sounded out the word's segments (all correct but not fully blended) or stressed it incorrectly. Other responses were scored as zero. Internal consistency was excellent ($\omega_t = .93$).

Language measures

Inflectional Morphology. The inflectional production task (adapted from Diamanti et al., 2018) required the child to produce inflections of pseudoverbs, pseudonouns, and pseudoadjectives. For instance, after presenting a picture of a turtle drawing on a piece of paper, the examiner said, "The turtle colors the *paper" (åmtet/'omte/, a definite neuter singular pseudonoun in Norwegian meant to refer to the sheet of paper and constructed to match the phonological structure of the real word/'arke/ meaning sheet of paper), and then showed a second picture in which the turtle drew on several pieces of paper. In the subsequent sentence, "The turtle colors . . . ," the child was required to say "the *papers" (åmtene/'omtene/) to indicate the change from singular to plural. There were 4 practice items and 16 test items (see online repository for item performance and description). The task exhibited very good internal consistency in preschool ($\omega_t = .86$).

Derivational Morphology. In the derivational production task (adapted from Diamanti et al., 2018), the child was asked to produce a derivation of a real target word. For instance, when presenting a picture of a cat with lots of hair, the examiner said, "The cat has a lot of hair (hår/hoːr/); the cat is very . . . " and the correct reply would be "hairy" (hårete/hoːrete/). There were four practice items and 14 test items. Most items required participants to derive nouns, adjectives, and adverbs from verbs or verbs from nouns (see the online repository for more information about the test, including all items, parts of speech, and performance per item). The task had adequate internal consistency in preschool ($\omega_t = .67$).

Vocabulary. Expressive vocabulary was assessed with the Norwegian version of the word definition subscale of the Wechsler Preschool and Primary Scale of Intelligence, 4th edition (WPPSI-IV; Wechsler, 2012). The child was asked to explain the meaning of a spoken word, and the quality of the description was scored as either incorrect, simple, or sophisticated based on the test manual scoring guidelines (0, 1, and 2 points, respectively). Preschool vocabulary exhibited very good internal consistency ($\omega_t = .89$).

Syntax. A Norwegian translation of the Test for Reception of Grammar–2 (TROG; Bishop, 2003) was used to measure syntactical/grammatical comprehension. The child was presented with four drawings and asked to select the one that depicted the sentence spoken by the examiner. For instance, the sentence "the man is not sitting" required attention to syntactic structure to disambiguate pictures of a man sitting, a man standing, a red dog, and a white dog (correct answer: a man standing). The task consisted of 80 items arranged in 20 blocks of increasing complexity. The task was discontinued after one or more errors in five consecutive blocks. Internal consistency was excellent ($\omega_t = .97$).

Control measures

Phoneme Awareness. Phoneme awareness was measured with a phoneme isolation task consisting of two subscales of 12 items each. In each subscale, the first four items required choosing the one word (out of three) beginning with the phoneme pronounced by the examiner. For the remaining items the child was asked to pronounce the initial phoneme in a word. For instance, "what is the first sound in the word/lam/?" The correct answer would be/l/. Twelve items involved the isolation of initial phonemes and 12 of final phonemes. The items were scored as correct or incorrect, and the assessment was discontinued after six consecutive errors. The task exhibited excellent reliability ($\omega_t = .95$).

Rapid Automatized Naming. We used two indicators of rapid automatized naming (RAN). In the first task the child was presented with a matrix of 32 color circles (red, yellow, green, and blue) arranged in random order in eight columns by four rows. The second task depicted four repeated objects instead of colors (mouse, boat, boy, and door) in the same spatial arrangement. Items were presented in the same order for all participants. Before the assessment, the child practiced naming each stimulus on a separate sheet. Then the child was asked to name the color (or object) following a standard reading direction as quickly and correctly as possible. We recorded the time spent naming the stimuli in each matrix, and transformed to rates by inversion before analysis. The correlation (Pearson's r) between the rates in the two tasks was .67.

Letter Knowledge. We assessed the child's knowledge of the Norwegian alphabet by asking the child to name consonants and vowels in two separate subtasks. Items were scored as correct if the child provided either the name or the sound of letters presented on a sheet. The two subtasks were highly correlated ($r = .81$).

Nonverbal Abilities. We used Raven's Colored Progressive Matrices (CPM; Raven, 2000) to measure nonverbal intelligence and abstract reasoning ability. The test requires children to visually identify a missing piece in a design and choose the piece that completes the design from an array of eight choices. The test consists of 36 items in three sets of 12 with increasing within-set complexity and is administered without time constraints. Internal consistency was adequate ($\omega_t = .75$).

Analyses

Following standard practice in structural equation modeling, analyses were conducted in a stepwise procedure. The first step concerns the measurement model for the latent predictor constructs. To this end, we performed a confirmatory factor analysis (CFA) of the eight predictor constructs measured in preschool, namely inflectional morphology, derivational morphology, vocabulary, syntax, letter knowledge, non-verbal abilities, phoneme awareness, and RAN, as well as Grade 1 reading accuracy. A parcel approach was chosen for constructs indicated by a single test, to control for measurement error (Cole & Preacher, 2014) and to separate sources of variance for assessing measurement scalar invariance across time (Geiser, 2020). That is, scores for subsets of items were summed to create "subscales" (parcels) for each test. In this way the latent variable picks up the shared variance across the parcels, effectively discarding measurement error (the unshared variance) and thereby adjusting to the reliability of the test. Little et al. (2022) guidelines were followed to create three parcels from each test.

The second step concerns modeling the latent outcome constructs, that is, word reading fluency measured in Grades 1 and 3 and reading comprehension measured in Grades 3 and 4. For each of these, we estimated latent change-score (LCS) models (Geiser, 2020) consisting of the initial status (intercept) and a latent change score (slope) representing the change from the initial status. Little et al. (2022) approach for parceling was used for reading comprehension, which was assessed with a single test (NARA). For word reading fluency, we used WPM of the two forms as indicators, with weights constrained to be equal.

In the third and final step, separate structural equation models (SEMs) were estimated to test if preschool inflectional morphology and derivational morphology predicted the initial status and change score of the reading outcomes, that is, (a) of word reading fluency, controlling for phoneme awareness, RAN, letter knowledge, and nonverbal ability; and (b) of reading comprehension, controlling for vocabulary, syntax, word reading, and nonverbal abilities.

All models were fit using the maximum likelihood estimator in Mplus 7 (Muthén & Muthén, 1998–2017), handling missing values by full information maximum likelihood (FIML). Data and output for the estimated models are available at https://osf.io/3t95n/?view_only=4559f11367554befa4f86b157b4e2caa.

Results

Descriptive statistics and correlations between observed variables for all measures are shown in Tables 1 and 2. All variables were approximately normally distributed. Preschool inflectional and derivational morphological awareness was longitudinally correlated with word reading accuracy and fluency assessed in first grade and with reading comprehension assessed in third and fourth grade. However, morphological awareness of inflections and derivations was not longitudinally correlated with third-grade reading fluency.

Table 1. Descriptive statistics.

Measure	*n*	*M*	*SD*	Min – Max	Skewness	Kurtosis	*ωt*
1. Reading Comprehension							
NARA G3	227	15.54	5.25	1–33	0.04	0.35	.85
NARA G4	225	20.64	5.67	7–35	0.15	−0.37	.84
2. Word Reading							
TOWRE A G1	240	21.81	13.46	0–62.67	1.00	1.10	–
TOWRE B G1	240	18.92	13.28	0–57.33	1.21	1.05	–
TOWRE A G3	229	63.53	17.81	22.67–102.6	−0.06	−0.78	–
TOWRE B G3	229	64.22	19.16	14.67–104	−0.28	−0.32	–
3. Morphological Awareness							
Inflectional PS	241	7.00	4.10	0–16	0.18	−0.78	.86
Derivational PS	241	4.62	2.27	0–11	0.40	0.13	.67
4. Vocabulary							
WPSSI PS	236	24.11	7.01	5–43	−0.33	−0.22	.89
5. Syntax							
TROG PS	241	44.82	17.91	1–73	−0.34	−0.86	.97
6. Phoneme Awareness	241	11.40	6.60	2–24	0.50	−1.04	.95
7. Letter Knowledge							
Vowels PS	241	4.88	2.65	0–9	0.03	−1.00	–
Consonants PS	241	9.32	6.06	0–17	−0.05	−1.56	–
8. RAN							
Objects PS	235	14.97	3.42	7.06–27.27	0.36	0.77	–
Colors PS	235	14.52	4.30	4.38–27.27	0.31	0.15	–
9. Nonverbal Abilities							
Raven CPM PS	236	17.77	4.45	7–35	0.27	0.27	.73
10. Reading Accuracy							
Språk 6–16 G1	236	40.12	13.12	0–60	−0.98	0.23	.93

Note. PS = Preschool; G1 = Grade 1; G3 = Grade 3; G4 = Grade 4.; ω_t = McDonald's omega total reliability coefficient.

Table 2. Bivariate correlations between observed variables.

Measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	.15	.16
1. NARA G3	–															
2. NARA G4	.653***	–														
3. TOWRE A G1	.316***	.270***	–													
4. TOWRE B G1	.314***	.308***	.939***	–												
5. TOWRE A G3	.376***	.358***	.607***	.618***	–											
6. TOWRE B G3	.393***	.342***	.623***	.630***	.931***	–										
7. Inflectional PS	.300***	.251***	.290***	.276***	.104	.093	–									
8. Derivational PS	.285***	.226***	.136*	.147*	.108	.109	.488***	–								
9. Vocabulary PS	.282***	.322***	.116	.108	.110	.106	.266***	.151*	–							
10. Syntax PS	.304***	.257***	.273***	.252***	.163*	.187**	.408***	.235***	.238***	–						
11. RAN Colors PS	.247***	.248***	.359***	.343***	.427***	.410***	.164*	.119	.081	.270***	–					
12. RAN Objects PS	.187**	.153*	.342***	.309***	.419***	.374***	.078	.040	.061	.148*	.670***	–				
13. Vowels PS	.330***	.233***	.530***	.478***	.331***	.338***	.288***	.236***	.236***	.313***	.218***	.221***	–			
14. Consonants PS	.274***	.192**	.495***	.464***	.308***	.327***	.314***	.186**	.232***	.250***	.248***	.258***	.814***	–		
15. Phoneme Awareness PS	.287***	.196**	.501***	.495***	.250***	.266***	.362***	.232***	.227***	.423***	.244***	.218***	.582***	.594***	–	
16. Raven CPM PS	.089	.089	.183**	161*	.057	.041	.400***	.196**	.157*	.354***	.137*	−.014	.296***	.340***	.315***	–
17. Reading Accuracy G1	.331***	.330***	.563***	.535***	.363***	.365***	.175**	.147*	.134*	.155*	.169**	.064	.371***	.314***	.316***	.064

Note. PS = Preschool; G1 = Grade 1; G3 = Grade 3; G4 = Grade 4; *** = $p < .001$, ** = $p < .010$; * = $p < .050$; Correlations are standardized Pearson's r estimated with Full Information Maximum Likelihood in Mplus.

Measurement models

Predictor constructs

CFA factor correlations and loadings for all preschool predictors and word reading accuracy are shown in Table 3. As expected, strong correlations were found between the two morphology tasks and between phoneme awareness and letter knowledge. All factor variances were significant, and the model had an excellent fit to the data (χ^2 (245) = 267.678, p = .153, RMSEA = .020 [90% CI: .000–.033], CFI = .994, TLI = .993, SRMR = .034).

Factor loadings for all constructs were high, confirming successful parceling. Because they are parts of the same test, the three parcels should a priori be contributing equally to the construct. Wald tests showed that imposing equality constraints on the factor loadings of the three parcels for nonverbal abilities, syntax, and vocabulary did not significantly affect model fit (χ^2 (1) = 0.873, p = .349; χ^2 (1) = 0.911, p = .340; and χ^2 (1) = 1.486, p = .223, respectively). We retained these constraints in the following models.

Outcome constructs

The means, variances, and factor loadings for the LCS models estimated separately for word reading fluency and reading comprehension are listed in Table 4. There was scalar measurement invariance across time for both word reading fluency (χ^2 (4) = 4.967, p = .083) and reading comprehension (χ^2 (4) = 8.58, p = .072), and the model fits were excellent (word reading fluency: χ^2 (2) = 4.967, p = .083, RMSEA = .078 [90% CI: .000–.168], CFI = .997, TLI = .992, SRMR = .020; reading comprehension: χ^2 (9) = 12.007, p = .209, RMSEA = .038 [90% CI: .000–.088], CFI = .995, TLI = .992, SRMR = .047).

As shown in Table 4, there was significant growth and significant variation around both the initial status and the growth (change score) for both word reading fluency and reading comprehension. For reading comprehension, there was a negative correlation between initial status and change. This negative correlation reflects compensatory trends indicating that individuals with high initial scores showed less change than those with lower initial scores.

Does preschool inflectional and derivational morphological awareness predict later word reading skills?

The SEM predicting word reading fluency is shown in Figure 1. Neither inflectional nor derivational morphological awareness predicted word reading fluency beyond the other constructs. Follow-up models including only inflectional and only derivational morphological awareness (available at the online repository) confirmed that neither contributed significant unique variance when entered alone. Phoneme awareness, RAN, and letter knowledge predicted word reading fluency in Grade 1; only RAN predicted the change in word reading fluency between Grades 1 and 3. Specifically, higher preschool RAN rates were associated with faster growth in word reading fluency. Preschool predictors explained 41% of word reading fluency variance in Grade 1 and 19% of the change in word reading fluency between Grades 1–3. This model fit the data very well (χ^2 (145) = 175.869, p = .041, RMSEA = .030 [90% CI: .006–.044], CFI = .990, TLI = .987, SRMR = .032).

Similar results were found when Grade 1 word reading accuracy was included in the model (see Figure A1 in Appendix). Letter knowledge and phonological awareness were the only significant predictors of word accuracy (i.e., not RAN). Phoneme awareness explained a similar proportion of variation in word reading accuracy when letter knowledge was removed (β = .309, p < .001, R^2 = .13), but only letter knowledge was a significant predictor when both were included, as they shared a lot of variance (r = .663).

Table 3. Standardized factor loadings and factor correlations for the predictor constructs at preschool and reading accuracy in grade 1.

	Factor loadings (λ)			Correlations between latent variables							
CFA	Indicator 1	Indicator 2	Indicator 3	1.	2.	3.	4.	5.	6.	7.	8
1. Inflectional Morphology[1]	.809	.774	.847	–							
2. Derivational Morphology[1]	.613	.679	.563	.651***	–						
3. Vocabulary[1]	.802	.818	.790	.307***	.200*	–					
4. Syntax[1]	.944	.968	.970	.449***	.295***	.264***	–				
5. Letter Knowledge[2]	.893	.912	–	.361***	.290***	.282***	.313***	–			
6. Non-verbal Abilities[1]	.658	.678	.740	.512***	.278**	.217**	.432***	.412***	–		
7. Phoneme Awareness[1]	.896	.940	.940	.405***	.291***	.257***	.443***	.663***	.373***	–	
8. RAN[3]	.914	.734	–	.170*	.122	.102	.289***	.291**	.112	.284***	–
9. Reading Accuracy[1]	.903	.935	.914	.192**	.180*	.146*	.154*	.394***	.071	.329***	.191**

*** = p < .001, ** = p < .010; * = p < .050; all factor loadings were significant at $p < .001$; [1]the indicators are parcels; [2]the indicators are Vowels and Consonants respectively; [3]the indicators are RAN Colors and RAN objects respectively.

Table 4. Mean, variances and factor loadings for the latent change score models of the outcome constructs.

	Intercept (I)[a]	Latent change score (LCS)		Corr I – LCS	Time[a]	Factor loadings (λ)		
	variance	*M*	Variance	*r*		Indicator 1	Indicator 2	Indicator 3
1. Reading comprehension[b]	2.51	1.55	1.18	−.39	G3	.879	.821	.659
					G4	.776	.836	.714
2. Word reading fluency[c]	150.29	42.06	171.76	−.09 ns	G1	.938	.997	––
					G3	.960	.969	––

All estimates were significant at $p = < .001$; ns = non-significant; [a]The mean of the intercept is fixed to zero for identification; [b]the indicators are parcels (Neale items); [c] the indicators are TOWRE form A and B respectively; G1 = Grade 1, G3 = Grade 3, G4 = Grade 4.

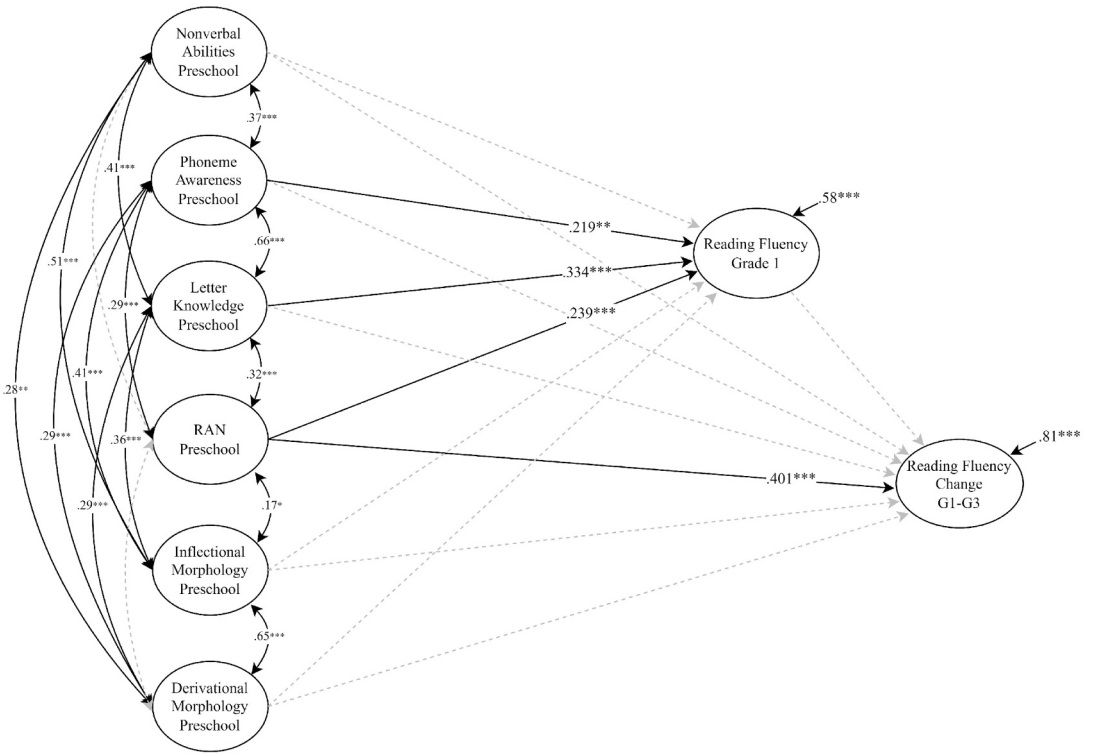

Figure 1. Prediction of reading fluency initial and latent change score from grades 1–3. *Note*. For simplicity, only the structural relations are shown; Single-headed arrows are regression paths, and double-headed are correlations; Significant paths are in **bold;** *** = $p < .001$, ** = $p < .010$; * = $p < .050$.

Does preschool inflectional and derivational morphological awareness predict later reading comprehension skills?

The SEM predicting reading comprehension can be seen in Figure 2. In preschool, derivational morphological awareness – but not inflectional morphological awareness – was a predictor of reading comprehension in Grade 3. Additionally, preschool vocabulary, syntactic skills, and Grade 3 word reading fluency also predicted reading comprehension. Only Grade 3 reading comprehension predicted the change in reading comprehension between Grade 3 and Grade 4. The predictors explained 38% of reading comprehension variance in Grade 1 and 17% of the change in reading comprehension. This model had an excellent fit to the data (χ^2 (209) = 195.076, $p = .747$, RMSEA < .001 [90% CI: .000–.021], CFI = 1.00, TLI = 1.00, SRMR = .042).

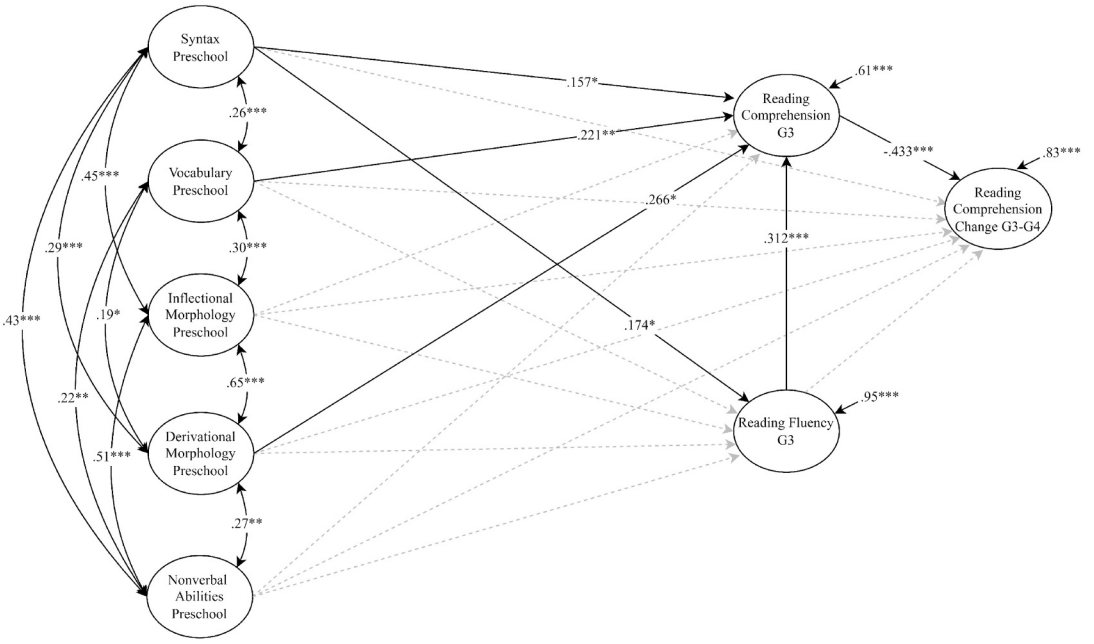

Figure 2. Prediction of reading comprehension initial and latent change score from grades 3–4. *Note*. For simplicity, only the structural relations are shown; Single-headed arrows are regression paths, and double-headed are correlations; Significant paths are in **bold;** *** = $p < .001$, ** = $p < .010$; * = $p < .050$.

Our results also indicated that derivational and inflectional morphological awareness shared predictive variance, because preschool inflectional awareness was a significant predictor of Grade 3 reading comprehension ($\beta = .275$, $p = .002$) when derivational awareness was removed from the model. However, the unique contribution of morphological awareness of derivations predominated when both morphological domains were used as predictors of reading comprehension.

The importance of latent variable modeling

In addition to the analytical approach described above, we also conducted two analyses using suboptimal – but more commonly employed – procedures. Specifically, we conducted a set of hierarchical multiple regression analyses and also fit a set of path models using the observed variables rather than parcel-based latent variables. In both of these sets of analyses, and as expected theoretically and empirically (Cole & Preacher, 2014; Westfall et al., 2016), several spurious significant effects emerged due to the lack of control for measurement error. The additional analyses are available as supplementary materials and online at the study's OSF repository.

Discussion

The present study examined the predictive role of preschool morphological awareness of inflections and derivations in the development of early word reading and reading comprehension. We report evidence for a longitudinal association, but no unique contribution, between morphological awareness and word reading ability at the onset of development of the latter. In contrast, we found a unique contribution of morphological awareness to third-grade reading comprehension beyond other established early predictors. Neither morphological awareness nor any other language or cognitive preschool predictor accounted for further growth in reading comprehension beyond third grade.

Morphological awareness and word reading accuracy and fluency

Awareness of both morphological domains in preschool was associated with first-grade reading accuracy and fluency, evidenced by significant longitudinal correlations, with morphological awareness of inflections having a stronger correlation with word reading than awareness of derivations. It seems that morphological awareness is linked to early reading along with the other language skills (specifically phonological awareness, vocabulary, and syntax) and other well-established predictors of word reading (like letter knowledge and RAN) measured in preschool. The use of latent variables for the constructs of inflectional and derivational morphological awareness, and the control for other language skills and cognitive predictors, resulted in neither domain of morphological awareness being a unique predictor of first-grade word reading accuracy and fluency. These findings align with those of Desrochers et al. (2018), who compared consistent and inconsistent orthographies and found that early second grade morphological awareness did not predict late second-grade reading accuracy or reading fluency in Greek (contrasting with findings for English and, partly, French). Our finding regarding the lack of unique predictive value of preschool morphological awareness for first-grade reading fluency and accuracy also partly agree with the findings of Diamanti et al. (2017) and Manolitsis (2006), respectively.

It could be argued that, due to the relative transparency of the Norwegian orthographic system, phoneme – grapheme conversion is adequate for achieving accurate and fluent word reading, at least at this early point in reading development. However, our findings are not consistent with the evidence from the transparent orthography of (pointed) Hebrew (Cohen-Mimran et al., 2022), in which preschool morphological awareness was a significant predictor of Grade 1 reading accuracy and fluency after controlling for preschool phonemic awareness. This discrepancy could be explained in terms of the differences in morphology between the two languages. Specifically, all Hebrew nouns and verbs are polymorphemic, increasing the salience and importance of morphology in reading development, in contrast to much more limited inflectional suffixation in Norwegian.

In lieu of linguistic and other theoretical explanations, discrepancies might also have resulted due to methodological limitations in former studies, such as biases introduced by measurement error. In particular, measurement error can result in correlated variables picking up shared variance and seemingly making a unique contribution to the prediction of an outcome in the absence of a real direct effect (Westfall et al., 2016). Regression models suffer from this problem regardless of whether control variables are entered individually, as a plain sum composite, or as a weighted sum from principal components analysis, because measurement error attenuates correlations in every case. In the present study we avoided such biases by introducing latent variables, which may have led to more reliable results. Indeed, our alternative analyses using more traditional regression approaches did result in additional (but spurious) "unique" contributions of morphological awareness variables, confirming the need to control measurement error using latent variables.

Previous evidence suggests that the contribution of morphological awareness to reading skills increases with development (Deacon et al., 2013; Kirby et al., 2012), as children come across words with more complex morphological structure in their school readings and as the demands of reading accurately and fluently become greater (Rispens et al., 2008). Based on this it would not have been surprising to find a unique contribution of morphological awareness to third-grade word reading accuracy, beyond effects of phonological awareness and letter knowledge, as well as to word reading fluency beyond effects of RAN and phonological awareness. It might also be expected that, at this point in reading development, awareness of derivational morphology becomes more relevant for supporting fast and accurate recognition of more complex words that contain derivational morphemes. Higher levels of derivational awareness could theoretically be particularly important for achieving more accurate and faster reading of words containing less transparent derivational suffixes, whereby the derived word differs phonologically and/or orthographically from the root.

Still, our latent variable models indicate that neither inflectional nor derivational morphological awareness significantly predicted third-grade reading accuracy and fluency over and above the control

variables. Our results are at odds with those of studies in opaque orthographies such as English and French (J. F. Carlisle, 2000; Casalis & Louis-Alexandre, 2000; Singson et al., 2000). Orthographic transparency is one possible reason for the difference in findings. However, these studies used hierarchical regression instead of latent variable modeling, which makes them vulnerable to detection of spurious statistical contributions due to measurement error. Our results also differ from findings in the Dutch orthography, which resembles Norwegian, in which awareness of derivational morphology made a (small but) independent contribution to Grade 6 reading ability (Rispens et al., 2008). However, the latter study was not longitudinal; therefore, it is possible that the reported effect may be due to an inverse direction of causation. That is, exposure to different types of printed words has led to orthographic morphological learning that has contributed to the further development of morphological awareness.

A similar pattern of results emerged regarding the developmental change in word reading fluency between first and third grades. Specifically, preliterate awareness of neither inflectional nor derivational morphology predicted developmental change in word reading fluency between Grade 1 and Grade 3; only RAN made a significant prediction. This finding does not provide support to the morphological facilitation hypothesis. Instead, the results are consistent with an emerging understanding of developing reading fluency as a trajectory involving mastery of first accuracy and then speed of individual word reading (Juul et al., 2014; Karageorgos et al., 2020; Verhoeven et al., 2022) with individual differences eventually exhibiting a predominance of sequential processing skills, indexed by RAN, after the first couple of elementary school grades (Altani et al., 2020; Romero et al., 2024).

Morphological awareness and reading comprehension

Turning to reading comprehension, our findings confirm the significant role of morphological awareness in the Norwegian language, which is characterized by quite complex inflectional and extensive derivational morphological processes. We found an independent contribution of preschool morphological awareness to Grade 3 reading comprehension, consistent with the relatively few studies (most of them in transparent languages) that have assessed children's morphological awareness prior to systematic literacy instruction (Casalis & Louis-Alexandre, 2000; Diamanti et al., 2017; Grigorakis & Manolitsis, 2021; Pittas & Nunes, 2014). This turned out to be a time-limited effect, as further growth in reading comprehension (from Grade 3 to Grade 4) was not predicted by preschool morphological awareness (or any of the control predictors).

Furthermore, one of the aims of the present study was to contrast the role of metalinguistic awareness of two distinct morphological domains, namely inflectional and derivational morphology, in reading comprehension and in the developmental change of this ability. We found longitudinal associations between preschool morphological awareness of both inflections and derivations and reading comprehension in third and fourth grades. The bivariate correlations were stronger for inflectional than for derivational morphological awareness, most likely due to the difference in reliability between the two subtests. However, when controlling for measurement error using latent variables, it was awareness of derivational morphology that made the strongest unique contribution to third-grade reading comprehension beyond the effects of vocabulary, syntax, and nonverbal abilities, despite its lower reliability. In contrast, a unique (but spurious) contribution of awareness of inflectional morphology, beyond that of derivational morphology, was found in the multiple regression analyses, likely owing to the difference in reliability. This goes on to highlight the importance of accounting for measurement error in studying associations among variables aiming to discover specific contributions (Westfall et al., 2016).

In particular, we found evidence of shared predictive variance among derivational and inflectional morphological awareness, which highlights the interplay of both types of morphological awareness in supporting the development of reading comprehension. It can be argued that children who are able to pay attention to and explicitly manipulate the morphemes that signal properties such as tense, number, and case,

as well as those that create new words or change the meaning of existing ones, prior to print exposure, are better equipped for developing their reading comprehension ability. Yet, awareness of derivations was the single independent predictor of third-grade reading comprehension when both morphological domains were considered together, consistent with evidence from previous studies that was suggestive of the particular significance of this type of morphological awareness for reading comprehension, especially when texts include more advanced vocabulary (J. F. Carlisle, 2010; Kuo & Anderson, 2010; Nagy et al., 2006).

Two kinds of reasons can be offered for the advantage of derivational morphological awareness (compared to inflectional) in contributing to reading comprehension: One concerns the domain content, thus implicating a cognitive substrate for the association, whereas the other concerns developmental individual differences, implicating psychometric reasons. The two types of reasons are not mutually exclusive and may act in synergy.

Considering domain content first, the findings could simply mean that derivations carry more information that a reader with stronger awareness of these morphemes can use for accessing the meaning of unfamiliar words. In addition, derivations indicate the grammatical category that the word belongs to, and being able to pick up this information could support understanding at the sentence level and subsequently lead to a better understanding at the text level. In other words, preschool awareness of derivations indicates a higher sensitivity to the structure of words and how that relates to meaning, and this heightened sensitivity – further developed after a few years of school and reading experience – can be directly applied to understanding texts. Thus, readers can use their knowledge of how word parts relate to word meanings to process texts more effectively, supporting better reading comprehension. To this end, both inflectional and derivational morphological awareness can be relevant at first blush. However, as noted in the introduction, inflectional information is both more superficial and more widespread, in other words less demanding and less informative, and thus less likely to have a substantial effect on comprehension later on. In contrast, derivational morphology provides richer cues to meaning, allowing efficient processing of less familiar words and thus having the potential for greater effects on comprehension.

Turning to psychometric considerations, performance on preschool tests of derivational awareness may be more strongly predictive of future reading comprehension than performance on tests of inflectional awareness because derivational awareness develops later and thus the test may probe more demanding aspects of the metalinguistic skills that are relevant for comprehension. According to this view, children who develop derivational morphological awareness earlier demonstrate heightened sensitivity to structured associations between form and meaning, which will be important for reading comprehension later. This is not because of the type of information carried by derivational suffixes (in comparison to inflectional) or because of the consistency and breadth of occurrence of these suffixes, but because the developmental trajectory of processing these suffixes results in the final preschool year being a particularly opportune window of sensitivity to probe the efficiency of the underlying skills and differentiate among future readers of varying potential.

Relevance for models of language and reading development

Our discussion of potential specific effects of morphological awareness and indeed of substantial differences between derivational and inflectional morphological awareness may seem at odds with previous findings stressing the unity of language development, at least during preschool and early elementary grades (e.g., Bates & Goodman, 1997; Klem et al., 2015; Language and Reading Research Consortium, 2015, 2017) and, correspondingly, the largely unidimensional predictive associations with reading comprehension (e.g., Hjetland et al., 2019; Lyster et al., 2016). However, one can argue that our findings are not really in contradiction of previous studies, for two reasons. First, the well-established unidimensional language construct concerns domains of language knowledge and use, such as vocabulary and grammar, whereas our tests of morphological awareness were meant to tap a primarily meta-linguistic domain that requires additional cognitive and meta-cognitive skills beyond communicative language use. Even though one's knowledge of and ability to use language must be the

main factor driving performance in our morphological awareness tasks, we contend that there is ample room for meta-linguistic and meta-cognitive ability to affect performance in the interaction context of these tests, which require a narrow focus on specific linguistic elements outside of their familiar context of communicative language use.

Second, the apparent alignment of morphological awareness with this unidimensional language construct in Lyster et al. (2016) concerned tests of compounding that were (a) less demanding than our tests and (b) a lot more usage-oriented rather than probing meta-linguistic skills per se. We have confirmed that our two tests of morphological awareness do not fit a single language factor along with the other language tests unless residual covariation is explicitly modeled; and that derivational morphological awareness makes a (small but) significant additional contribution to the prediction of Grade 3 reading comprehension beyond the single language construct (analyses available in supplementary materials). We thus contend that morphological awareness, when specifically probed at the appropriate meta-linguistic level with sufficiently demanding tasks, does not entirely align with the unidimensional language construct and can thus provide additional valuable information with respect to meta-linguistic development and future reading comprehension.

Developmental considerations are also important with respect to reading comprehension. We tested children's reading comprehension in Grades 3 and 4 because performance at earlier grades might be dominated by decoding skills. As noted in the introduction, literacy instruction in Norway begins in first grade. Most children enter school without any reading skills, and reading takes more time to develop compared to other relatively transparent orthographies such as Greek (Seymour et al., 2003). Our findings regarding the developmental change of reading comprehension from third to fourth grade may seem at odds with J. F. Carlisle (2000), who found that the contribution of derivational morphological awareness was stronger for fifth grade than for third-grade reading comprehension. However, Carlisle examined concurrent associations, which are limited in their capacity to illustrate developmental significance. Concurrent associations are also affected by reading experience and the orthographic knowledge of morphological structure that results from this experience. In our study we have focused on the oral language and meta-linguistic precursors of comprehension, aiming to specifically minimize any influence of orthographic knowledge. This is not to deny the role of orthographic morphological structure in supporting reading comprehension, which is likely quite substantial, as documented in numerous studies mentioned above. Further research is warranted to explore the potential of morphological awareness, assessed with written tasks or at least after literacy instruction, in predicting growth in reading comprehension. The role of morphology instruction in different curricula may also be relevant in this context.

Our study found that developmental change in reading comprehension past Grade 3 was not predicted by preschool morphological awareness or by vocabulary and grammatical/syntactic skills. It seems that preschool oral language skills have supported the development of reading comprehension, and have exhausted their predictive power, by third grade. Reading comprehension skills beyond this stage can further develop by building on existing comprehension skills (and associated language skills as they have developed by that age; Hjetland et al., 2019). Notably, our findings support a compensatory model for the development of reading comprehension insofar as the coefficient from Grade 3 to Grade 4 reading comprehension was negative. In other words, children performing higher in Grade 3 made on average smaller gains in Grade 4. This finding is consistent with a number of studies on so-called Matthew effects in reading comprehension, which have often failed to detect divergence (i.e., a Matthew effect), in contrast to other domains of reading skill, such as decoding efficiency (Pfost et al., 2014).

Turning to theoretical frameworks of reading development, like the Morphological Pathways Framework (Levesque et al., 2021), our findings provide empirical evidence in support of the proposed direct pathway through which the metalinguistic skill of morphological awareness feeds into the reading comprehension component by integrating semantic, phonological, and syntactic processes. The support is nonetheless partial, as we did not find evidence for additional indirect effects of morphological awareness to reading comprehension

through word reading or, indeed, for specific effects of morphological awareness on the development of word reading itself. We can therefore conclude that the framework could only partly generalize to languages with more transparent orthographies than the one in which it was originally conceptualized. In addition, further research using methods controlling for measurement error will be needed to verify the purported links of morphological awareness to word reading in the languages with less transparent orthographies.

Limitations

The relatively low reliability index of the task of derivational morphological awareness ($\omega_t = .67$) and the use of single tests instead of multiple tasks as indicators for corresponding latent constructs can introduce measurement noise (Cole & Preacher, 2014). To mitigate against these limitations, we have employed a parcel approach (Little et al., 2022) to control for measurement error and for separating sources of variance to assess measurement scalar invariance across time. The use of single tests limits interpretability to the extent that the relevant domains are not comprehensively covered (e.g., vocabulary breadth), but does not invalidate the conclusions with respect to the specific tests that were used. Most importantly, using latent variables with parcels successfully deals with the problem of attenuated correlations due to measurement noise, increasing our confidence in the conclusions regarding the unique contributions of our morphological awareness variables.

An additional limitation of the study concerns the absence of a task for measuring the morphological domain of lexical compounding, which together with the processes of inflectional and derivational morphology occur in the Norwegian language. A task of lexical compounding had been originally developed, in which children had to identify two word bases within a compound word. However, when we analyzed the data from preschool children collected during the pilot phase of the study, a ceiling effect was found, which led to the exclusion of that task from the test battery.

Conclusion

In sum, we have found that preschool morphological awareness, assessed prior to any formal literacy instruction, is a unique predictor of later reading comprehension but not of word reading skills. Neither morphological awareness nor any other variables predicted further growth in reading comprehension beyond third grade; there is thus no evidence that preschool measures can predict developmental change beyond early attainment. Consequently, predicting early attainment can be crucial whether subsequent development is stable or unpredictable. Our findings have practical implications for the content of early language activities for supporting language development, for the early identification of risk factors of later reading comprehension difficulties, as well as for the content of prevention programs. Specifically, the findings indicate that testing children's vocabulary skills may be fruitfully augmented by testing morphological awareness as part of language screening in preschool years, consistent with previous findings suggesting that explicit morphological awareness training can be a valuable addition to the preschool curriculum.

Disclosure statement

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Data availability statement

Data and analyses for reviewers: https://osf.io/3t95n/?view_only=4559f11367554befa4f86b157b4e2caa

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Appendix

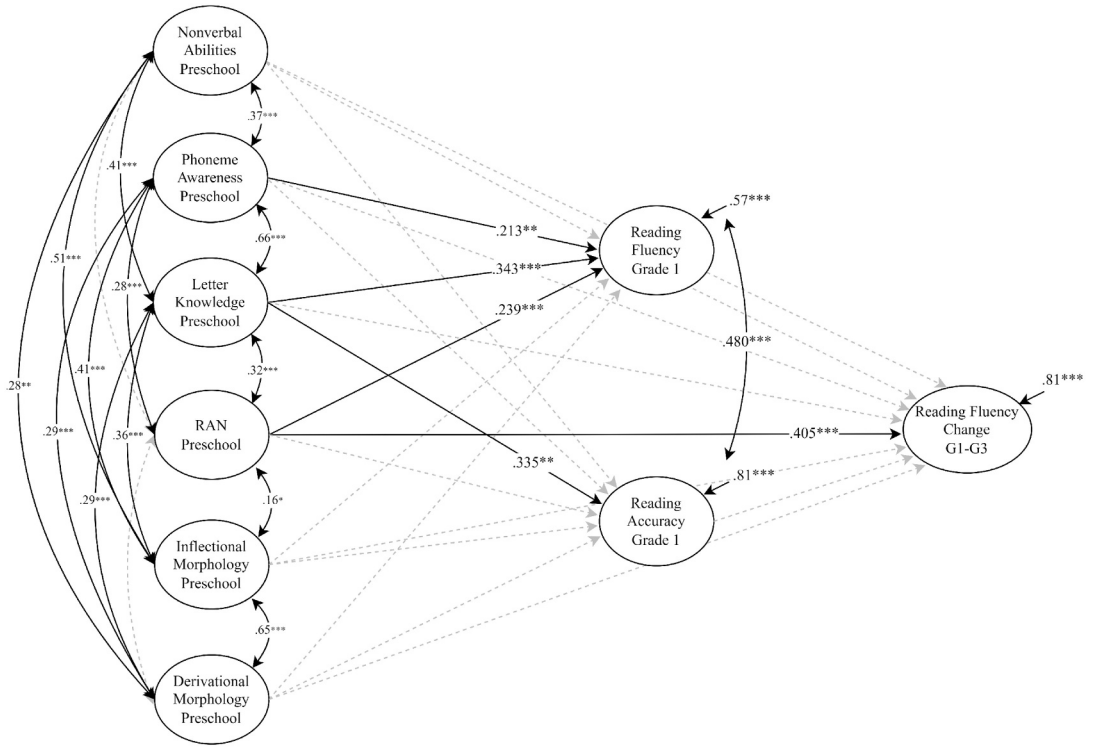

Figure A1. Prediction of reading fluency initial and latent change score from grades 1–3 and reading accuracy in grade 1. *Note*. For simplicity, only the structural relations are shown; Single-headed arrows are regression paths, and double-headed are correlations; Significant paths are in **bold;** *** = $p < .001$, ** = $p < .010$; * = $p < .050$; Model fit = χ^2 (197) = 237.549, $p = .026$, RMSEA = .029 [90% CI: .011–.042], CFI = .990, TLI = .987, SRMR = .033.