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Alicia Rassel, Bruno Facon, Severine Casalis

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Morphological awareness and learning to read: impact of socio-economic status in French third graders

Alicia Rassel

Univ. Lille, CNRS, UMR 9193 - SCALab - Sciences Cognitives et Sciences Affectives, Univ. Lille, Lille, France

Bruno Facon

Univ. Lille, CNRS, UMR 9193 - SCALab - Sciences Cognitives et Sciences Affectives, Univ. Lille, Lille, France

Séverine Casalis

Univ. Lille, CNRS, UMR 9193 - SCALab - Sciences Cognitives et Sciences Affectives, Univ. Lille, Lille, France

Abstract

Background

In addition to phonological processing and vocabulary, morphological awareness has been clearly identified as contributing to learning to read. While the impact of socio-economic status (SES) has been identified for both phonological processing and vocabulary, less is known about the SES influence on morphological awareness and its relationship to reading achievement. The study had two aims: to assess the net effect of SES on morphological awareness, and to compare the independent contribution of morphological awareness to reading scores as a function of children's SES (middle vs low-SES) when phonological processing and vocabulary are held constant.

Methods

The sample included 162 French third graders from low- and middle-SES schools. Children were assessed on reading-related and literacy tests (phonological processing, vocabulary, morphological awareness, reading accuracy, fluency, and comprehension).

Results

First, while morphological awareness was lower for low-SES children, regression analyses showed that SES did not explain the morphological awareness score when phonological processing and vocabulary were taken into account. Second, while the morphological awareness contribution to reading accuracy did not differ across SES, its contribution to reading fluency was weaker in low-SES as compared to middle-SES children. Only vocabulary score predicted reading comprehension in low-SES. Interestingly, morphological awareness was stronger than vocabulary as a determinant of reading scores in middle-SES

children, while it seems more dissociated from vocabulary in accounting for reading scores in low-SES children.

Conclusion

The contribution of morphological awareness to low-SES children's reading scores opens possibilities for morphological awareness-based interventional studies in children with narrower vocabulary skills.

Key words: morphological awareness, phonological processing, vocabulary, reading achievement, low socio-economic status

Implications for Practice

What is already known about this topic

- While morphological awareness is strongly correlated with phonological awareness and vocabulary, it contributes to reading scores above and beyond these two reading-related skills.
- Reading skills, as well as phonological awareness and vocabulary are impacted by socio-economic status (SES).

What this paper adds

- SES did not directly impact morphological awareness when phonological processing and vocabulary were taken into account. This result suggests that morphological awareness may be limited by vocabulary, which is narrower in low-SES children.
- The contribution of morphological awareness to the text-reading accuracy score does not differ depending on SES, but its contributions to word-reading fluency and reading comprehension scores are SES-sensitive.

Implications for theory, policy, or practice

- The study indicates how connections among determinants of reading can be modified, especially when vocabulary is limited. Reading instruction in low-SES children may well benefit from intervention aimed at morphological awareness.

Morphological awareness and learning to read: impact of socio-economic status in French third graders.

Introduction

Morphological awareness is the ability to analyze and manipulate morphemes, the smallest language units of meaning (Carlisle, 1995). Derivational morphology refers to the creation of a word whose meaning depends on the combination of several morphemes. A derived word is thus composed of a root (e.g. *read*) to which one or several affixes can be added, attached before the root (prefix, e.g. *re* in *reread*), or after (suffix, e.g. *-er* in *reader*). Alphabetical scripts such as English and French are considered as morphophonemic (Venezky, 1999) because orthography encodes morphological information, which maintains constant spellings of morphemes, even if it entails inconsistencies in grapheme-to-phoneme mappings (see for example pronunciation of *sign-* in *sign* and *signature*). Several studies investigated the contribution of morphological awareness in learning to read, (see for example Kirby et al., 2012). In these studies, phonological skills and vocabulary, both of which predict reading acquisition (Snowling & Hulme, 2005), are taken into account, due to their interrelations with morphological awareness (see for example Anglin, 1993). Critically, phonological skills (Duncan & Seymour, 2000) and vocabulary (Hoff, 2006) are less developed in children from low socio-economic status (SES) homes. However, little is known about the impact of SES on morphological awareness. Hence, it is unclear if morphological awareness can contribute similarly to reading skills among groups of children of varying SES. The aim of the present study is to examine whether and how morphological awareness and SES interact in their prediction of children's reading skills.

Morphological awareness is assessed with a variety of tasks across studies. For example, pupils are asked to complete a sentence by providing a derived word, or a derived pseudoword in a derivation task (Singson et al., 2000), or they have to say if two words are related in a judgment task (Carlisle & Nomanbhoy, 1993). Most of the tasks assessing morphological awareness also tap into phonological, lexical and semantic processes (Spencer et al., 2015). Indeed, morphological awareness scores have been found to be closely connected to phonological skills - including phonological awareness (Carlisle & Nomanbhoy, 1993; Casalis & Louis-Alexandre, 2000) and phonological short-term memory (Singson et al., 2000) - and vocabulary (Anglin, 1993; Sparks & Deacon, 2015). Phonological skills and vocabulary are strong predictors of reading skills (Snowling & Hulme, 2005). Thus, a critical question is whether morphological awareness uniquely contribute to reading skills beyond the contribution of phonological skills and vocabulary.

Considering decoding and reading fluency, the contribution of phonological skills (Wagner & Torgesen, 1987) is explained by the fact that letters roughly represent phonemes and help children to acquire the alphabetical principle. Vocabulary might contribute to decoding and to reading fluency because knowing a word might help to decode it more accurately and more quickly (Nation & Snowling, 2004). Morphological awareness may not only allow correct pronunciation (compare *real* to *react*) but also might accelerate naming (Burani et al., 2002). As most of the unfamiliar words pupils from third to ninth grade daily encountered in texts contain several morphemes (Nagy & Anderson, 1984), there are reasons to examine whether morphological awareness uniquely contributes to these reading measures. Several studies have indicated the unique contribution of morphological awareness in word reading, once phonological skills and vocabulary have been taken into account (Casalis & Louis-Alexandre, 2000; Kirby et al., 2012).

Morphological awareness can contribute to reading comprehension beyond the contributions already observed for phonological skills (Wagner & Torgesen, 1987) and vocabulary (Muter et al., 2004; Nation & Snowling, 2004). Indeed, being able to attribute a correct meaning to a new word by consideration of its morphemes might contribute to the comprehension of written text independently of word knowledge. Some studies have found a direct contribution after controlling for phonological awareness (Deacon & Kirby, 2004), vocabulary (Casalis & Louis-Alexandre, 2000; Nagy et al., 2006) and even word reading (Deacon et al., 2014; Kirby et al., 2012; Levesque et al., 2017). Note that, its unique contribution is sometimes low due partly to the strong correlations between morphological knowledge and other predictors of reading acquisition (Nagy et al., 2014). While most of the studies have been conducted in English, one might wonder if they can be extended to other languages. French is a morphologically rich language, and its orthography encodes morphological information (Huot, 2001) even though its orthography is less opaque than English one's. In general, studies conducted on both morphological awareness and reading display closed patterns even though French children outperform English-speaking children in morphological awareness (Duncan et al., 2009) and are slightly more prone to use morphological units while decoding (Casalis et al., 2015).

Reading skills are affected by other factors such as socio-economic status, with low-SES children reaching lower reading achievement than their higher SES peers (Robertson, 1997). Moreover, low-SES is associated with poorer decoding abilities and poorer reading comprehension as well as slower growth of literacy (Fluss et al., 2008; Hecht et al., 2000). Note that a large majority of poor readers who enter school with significant delays in several early literacy skills, also have low SES (Duncan & Seymour, 2000; Fluss et al., 2008). At the same time, children from low-SES families show delayed development of phonological

processing (Duncan & Seymour, 2000) and have significantly weaker vocabularies than high-SES children (Hoff, 2006).

While the impact of SES on reading, phonological skills and vocabulary has been well documented, little is known about its impact on the development of morphological awareness and its relationship to the acquisition of reading by low-SES children. Note that, as mentioned above, there is strong correlation between vocabulary and morphological awareness. While being aware and knowing the morphemes of words fosters vocabulary growth (Anglin, 1993; Sparks & Deacon, 2015), one may wonder if vocabulary can help children to extract morphological rules (as suggested by Kieffer & Lesaux, 2007). Therefore, low-SES children might be less likely to develop morphological awareness because of their narrow vocabulary. Alternatively, morphological awareness may help low-SES children produce and understand words in spite of their lower vocabulary exposure because morphology relies at least partly on language mechanisms (morphological rules) and thus may help reading. While this possibility has not heretofore been studied, it might be interesting to investigate the contribution of morphological skills to reading in low-SES children.

To date, only few studies have investigated this issue. Apel et al. (2013) found that morphological awareness uniquely contributes to word reading and reading comprehension after controlling for phonological awareness in English language. This held for low-SES children in grade 2 but not in grade 1. Interestingly and consistently, the role of morphological awareness in children's word reading was found to be only indirect, via phonological awareness and listening comprehension, in French first graders from low-SES (Colé et al., 2018). We therefore need additional studies to answer this question, especially from and above grade 2. Indeed, while morphological awareness develops across grades, with the greatest growth occurring during the first three grades (Berninger et al., 2010), its contribution increases while the contribution of phonological skills decreases (Singson et al., 2000), as

early as Grade 2 in French language children for example (Casalis & Louis-Alexandre, 2000).

In addition, no previous study has *directly* compared the contribution of morphological awareness to reading as a function of SES, and this is the objective of the present study.

The present study

Following our general objective, the present study pursued two main aims that both considered the relationship between phonological processing, vocabulary and morphological awareness. The first was to assess the impact of SES on morphological awareness while controlling for phonological processing and vocabulary. The second aim was to examine whether the contribution of morphological awareness on reading achievement differs according to SES level (low vs middle) after phonological processing and vocabulary had been accounted for. The study was conducted in French third grade children from low and middle SES.

As mentioned above, on the one hand, low-SES children might be less likely to develop morphological awareness because of their narrow vocabulary, and the other one, morphological awareness may help low-SES children to produce and understand words in spite of their lower vocabulary exposure. If morphological awareness is strongly affected by SES and vocabulary growth, its contribution to reading might be low as it is poorly developed. Alternatively, if morphological awareness is shown to develop on low SES children, it could contribute stronger to reading to compensate for narrow vocabulary.

Method

Participants

One hundred and sixty-two third graders, without any identified speech/language disorder or learning disability, were recruited from elementary schools in the North of France. Children were divided into two groups depending on the socio-economic status (SES) of their school. Low-SES schools were identified in the French educational system as belonging to the "High Priority Education Network". Criteria are: parents' occupations (workers and employees, including unemployed), high proportion of families receiving financial assistance from the government, families living in "sensitive" urban areas, and high proportion of children repeating a grade. Middle-SES schools were located in middle-class areas which did not meet the criteria described above. Data from 2 children were excluded from analysis due to a repetition of school year and data from 12 children due to their having outliers relative to their group (above or below 3 SD for at least one of the variables studied). Seventy-four children came from a low-SES school (the Low-SES group, 54% girls, mean age = 8.73 years, $SD = 0.33$ year) and 74 came from a middle-SES school (the Middle-SES group, 48% girls, mean age = 8.71 years, $SD = 0.36$ year). Written parental assent was required. This study was reviewed and approved by the Research Ethics Committee of the University of Lille (MORPHOLEC 2016-1-S047).

Measures

Phonological processing

Children's phonological awareness was assessed using the phoneme deletion subtest of the French battery "Evaluation du langage écrit" (*Written language evaluation*, EVALEC, Sprenger-Charolles et al., 2005). Children must pronounce a pseudoword after deleting the initial phoneme. This subtest comprises 12 monosyllabic pseudowords. The score was the number of correct responses. Maximum score was 12; reliability was poor (Cronbach's $\alpha =$

.292). Note that, due to both poor reliability and ceiling effect (see Results part), this test was removed.

Phonological short-term memory was assessed by the pseudoword repetition subtest from the Neuropsychological Battery NEPSY II (Korkman et al., 2012). This subtest comprises 12 pseudowords containing from two to five syllables. The examiner pronounces each pseudoword and the child must repeat it. The score was the number of correctly repeated syllables. Maximum score was 46; reliability was satisfactory (Cronbach's $\alpha = .705$).

Morphological awareness

Three different tasks from the French battery MORPHOTE for grades 1 to 5 (Casalis & Macchi, 2016) were designed to assess various aspects of morphological awareness. Two tasks (Production and Oddity) used words, the third (Definition) used pseudowords in order to neutralize possible effects of vocabulary knowledge and word retrieval. Tasks were administered only orally; no written information was provided. Scores were the number of correct responses.

In the Production task, children had to complete an oral sentence with a derived word. Sentences are definitions and directly contain the word to be derived (e.g., When something can be washed, it is ___ *washable*). Children had to produce 20 suffixed words and 12 prefixed words. Maximum score was 32; reliability was satisfactory (Cronbach's $\alpha = .844$).

In the Oddity task, the examiner gave four words verbally and children had to choose the word, among 4, which did not belong to the same family (e.g., for *ferme*, *fermer*, *fermier*, *fermette* (farm, to close, farmer, farm house), the correct answer is *fermer*, to close). There were 10 series of 4 words. Maximum score was 10; reliability was marginal (Cronbach's $\alpha = .633$).

In the Definition task, a pseudoword containing an affix was pronounced with two definitions. Children had to choose the correct one (e.g. *Returgir* - *Turgir once again* or *Come*

out of a turge). Ten pseudowords, two with prefixes and eight with suffixes were presented. Maximum score was 10; reliability was poor (Cronbach's $\alpha = .554$).

Vocabulary

Receptive vocabulary was evaluated using the Echelle de Vocabulaire en Image Peabody (Dunn et al., 1993), a French adaptation of the Peabody Picture Vocabulary Test. A plate with four pictures was shown and the child had to choose the picture that best matches the word spoken by the examiner. All children were presented with the same 70 plates corresponding to the test's odd numbered items (that is half of the test items to save time). The score was the number of correct responses. Maximum score was 70; reliability was satisfactory (Cronbach's α was .810).

Reading abilities

Three tests were designed to assess reading skills:

The Alouette test (Lefavrais, 1967) was used to assess *Accuracy* in connected text reading. The text is 265 words long including many categories of words (frequent, rare, simple and derived). Several words are only weakly predictable because the meaning is difficult to establish. Children must read the text aloud within 3-minutes. The Accuracy score is the percentage of correctly read words relative to the total number of words read.

Fluency was evaluated by an experimenter-developed test of word reading divided into two parts under time pressure. Two lists of 100 nouns from a large scope of frequency (mean: 23; range: 0.5 - 170 per million) were presented. Words in the lists were ordered with decreasing frequency. One list included only derived words — containing two to three morphemes — while the other had only non-derived words containing 2 to 5 syllables. Children had one

minute per list to read aloud as quickly as possible avoiding mistakes. Thus, when the first list was presented, the child had one minute to read as many words as possible. After one minute, reading was stopped and the second list was presented for one minute. A whole score was calculated by adding the number of correctly read words of the two lists. The Fluency score is the number of correctly read words in two minutes. Maximum was 200.

Reading Comprehension was assessed by the “La visite du Château” (*The Visit to the Castle*) subtest of the “Batterie de Langage oral, langage écrit, mémoire, attention” (*Oral Language, Written Language, Memory, Attention Battery*, L2MA-2, Chevrie-Muller et al., 2010).

Children had to read a text silently and then answer oral questions (text removed). One point was given for every correct response. Maximum was 15 points.

Procedure

Tests were administered individually in a quiet room at the school. Testing was divided into two sessions each lasting 20 to 30 minutes and separated by at least one day but always within the same week. Instructions, examples and training items with feedback were provided for each test.

Results

Effects of SES on Morphological Awareness

We compared children’s scores for all variables as a function of SES (Low-SES vs Middle-SES). The mean and standard deviation for each comparison is shown in Table 1, as well as the corresponding independent-samples *t* test or Mann-Whitney *U*, as appropriate. As might be expected, between-groups comparisons and Cohen’s *d* showed that Low-SES children performed uniformly lower than Middle-SES children (all *ps* < .002). As both groups showed

a ceiling effect for Phonological Awareness, this variable was not further analysed. SES was related to all three morphological awareness tasks.

< Table 1 about here >

Table 2 summarizes hierarchical regression analyses conducted to determine the amount of variance in Morphological Awareness explained by SES while controlling for Phonological Short-Term Memory and Vocabulary. The latter variables were entered first in the equation, followed by SES (coded 0 and 1 for Low-SES and Middle-SES participants, respectively). To facilitate the interpretation, scores were standardised to *z* scores for the regression analyses. Finally, to avoid multicollinearity between morphological awareness measures, we computed a composite score using the mean of the three task's *z* scores.

Phonological Short-Term Memory and Vocabulary together accounted for 44.6% of the variance of Morphological Awareness. After taking into account these two reading-related skills, SES explained less than 1% of the variance (ns).

<Table 2 about here >

Contribution of Morphological Awareness to reading ability as a function of SES

In order to examine the contribution of morphological awareness to reading scores as a function of SES (low vs middle), for the whole sample we first computed Pearson correlations among the reading-related skills (Phonological Short-Term Memory, Vocabulary and

Morphological Awareness) and the reading measures. As expected, all variables were positively intercorrelated (all $ps < .05$). Considering the 9 correlations between the ensemble of reading-related scores and the ensemble of reading scores, the median $R^2 = 18.0\%$ and the maximum $R^2 = 31.9\%$ (Morphological Awareness vs. Reading Comprehension).

< Table 3 about here >

We then computed Pearson correlations between the reading-related skills (Phonological Short-Term Memory, Vocabulary and Morphological Awareness) and the three reading scores in each SES group separately (Table 4). The intercorrelations were generally moderate to strong for Middle-SES children (Table 4, above the diagonal), the sole exception concerning Phonological Short-Term Memory, which correlated significantly only with Morphological Awareness and Reading Comprehension. Considering the 9 correlations between reading-related scores and reading scores, the median $R^2 = 12.7\%$ and the maximum $R^2 = 53.0\%$ (again, Morphological Awareness vs. Reading Comprehension). By comparison, for Low-SES, the intercorrelations were moderate to weak at best (Table 4, below the diagonal). Phonological Short-Term Memory correlated significantly only with Morphological Awareness and Text-reading Accuracy. Likewise, Vocabulary correlated significantly with Morphological Awareness and Reading Comprehension but not with Text-reading Accuracy or Word-reading Fluency. Finally, Morphological Awareness was correlated with all other measures excepted Reading Comprehension for which the correlation is only marginal, $r(74) = .228, p = .051$. Considering the 9 correlations between reading-related scores and reading scores, the median $R^2 = 5.5\%$ and the maximum $R^2 = 10.6\%$ (Vocabulary vs. Reading Comprehension).

< Table 4 about here >

We conducted hierarchical linear regression analyses to estimate the specific contribution of Morphological Awareness to the three reading test scores (Accuracy, Fluency and Comprehension) and to investigate the interaction between Morphological Awareness and SES. In each analysis, Phonological Short-Term Memory, Vocabulary and Morphological Awareness were entered, followed by SES and finally the Morphological Awareness \times SES interaction term. When the interaction was significant, the regression analyses were run for each SES group separately. In these subsequent analyses, only the reading-related variables were entered. To facilitate comparisons across groups, predictors were systematically entered in the regression models regardless of the previously observed correlation.

Text-reading Accuracy

For Text-reading Accuracy, the Morphological Awareness \times SES interaction term was not statistically significant, $F(1, 142) = .476, p = .491$, so we report analyses without this interaction term (Table 5). The four variables successively introduced in the regression equation accounted for 30.8% of the total variance of Text-Reading Accuracy. Phonological Short-Term Memory explained 10.3% of the variance and Vocabulary accounted for an additional 8.2%. Morphological Awareness explained 3.7 % of Text-Reading Accuracy variance. Finally, SES accounted for an additional 8.6% of the variance. Examination of regression coefficients from the last step of the analysis showed that neither Phonological Short-Term Memory nor Vocabulary influenced Text-reading Accuracy once Morphological Awareness and SES had been taken into account.

< Table 5 about here >

Word-reading Fluency

The variables successively introduced in the regression equation accounted for a total of 36.6% of the variance in Word-reading Fluency. Phonological Short-Term Memory explained 4.4%, $F(1, 146) = .6.678, p = .011$, Vocabulary accounted for an additional 16.1%, $F(1, 145) = 29.249, p < .001$, and Morphological Awareness explained 10.9 %, $F(1, 144) = 22.844, p < .001$. SES also explained a small but significant 1.9 % part of the variance, $F(1, 143) = 4.048, p = .046$. Importantly, the Morphological Awareness \times SES interaction term was statistically significant suggesting a differential effect of Morphological Awareness depending on the participants' SES, $\Delta R^2 = .034, F(1, 142) = 7.553, p = .007$. Therefore we conducted a separate regression for each of the two SES groups. Results are summarized in Table 6.

< Table 6 about here >

In Middle-SES (Table 6, upper panel), Phonological Short-Term Memory by itself failed to account for significant variance in Fluency, while Vocabulary contributed 23.2%. Morphological Awareness contributed 17.9%, and finally, regression coefficients of the last step indicate that Morphological Awareness was the only predictor of Word-reading Fluency, when Phonological Short-Term Memory and Vocabulary were held constant. In Low-SES (Table 6, lower panel), neither Phonological Short-Term Memory nor Vocabulary scores accounted for significant portions of variance. However, even if its contribution was

marginally nonsignificant, Morphological Awareness contributed 4.1% of the total variance in Word-reading Fluency. Thus, the Low-SES model explained only 8.3% of the variance in Word-reading Fluency as compared with the Middle-SES group's 41.1%.

Reading Comprehension

Variables introduced in the regression equation accounted for 42% of the total variance of Reading Comprehension score. Phonological Short-Term Memory accounted for 7.4% of the variance, $F(1, 146) = 11.641, p = .001$, Vocabulary accounted for an additional 21.8%, $F(1, 145) = 44.629, p < .001$, and, Morphological Awareness also explained 7.7 % of Reading Comprehension variance, $F(1, 144) = 17.622, p < .001$. SES failed to explain additional significant variance in Reading Comprehension, $\Delta R^2 = .003, F(1, 143) = .623, p = .431$. Finally, the Morphological Awareness \times SES interaction term was statistically significant, $\Delta R^2 = .048, F(1, 142) = 11.862, p = .001$, suggesting a differential effect of Morphological Awareness depending on the participants' SES. Thus, as for Word-reading Fluency, we conducted separate regression analyses for each of the two SES groups. Results are summarized in Table 7.

< Table 7 about here >

In children from Middle-SES, Phonological Short-Term Memory, Vocabulary and Morphological Awareness specifically accounted for 7.5%, 24.4%, and 22%, of the Reading Comprehension variance, respectively. As observed for the Word-reading Fluency test, regression coefficients in the last step of the analysis indicate that Morphological Awareness

was, all other things equal, the only significant predictor of Reading Comprehension. In Low-SES children, Vocabulary was the only significant predictor of Reading Comprehension, accounting for 9.8% of the variance. Neither Phonological Short-Term Memory nor Morphological Awareness contributed to the Reading Comprehension variance. In all, the three variables explained 53.9% of the variance in Reading Comprehension for Middle-SES children, and only 11.7% for those of Low-SES.

Discussion

This study analysed morphological awareness and its contribution to reading achievement in French third graders as a function of SES (middle vs. low) while taking into account interrelations between morphological awareness, phonological processing and vocabulary. While several studies have evidenced a unique contribution of morphological awareness in reading skills, in English as in French, it is unclear how SES affects this contribution, given that vocabulary and phonological skills are less developed in low-SES children. This study explored that question for French along two paths.

The first was to assess the impact of SES on morphological awareness. The direct comparison showed an effect of SES that does not hold up when phonological skills (limited here to phonological short-term memory) and vocabulary are taken into account. Hence, the greater the phonological and vocabulary skills, the greater the morphological awareness. This can be explained by the fact that the morphological awareness task also involves phonological processes and lexical and semantic knowledge. For example, to manipulate morphemes, it is necessary to keep them in phonological short-term memory. Note that morphological awareness is highly correlated with phonological and vocabulary knowledge at both levels of SES. However, this result, evidenced here for the first time to our knowledge, also suggests that SES does not directly affect morphological awareness in itself, even though vocabulary and other causes may limit its development. Thus, it is possible that the poorer performance

on the morphological awareness task by low-SES children is a consequence of their poorer phonological skills (Duncan & Seymour, 2000) and narrower vocabulary (Hoff, 2006). Importantly, provided that the vocabulary gap between lower and higher SES continues to grow over time (Maguire et al., 2018), longitudinal studies are necessary to see if the gap in morphological awareness also increases with age. Yet, it would be particularly interesting to examine the extent to which morphological skills can contribute independently to reading skills beyond the reading-related skills used here, and overall, if their contribution differs from that observed in middle-SES children. This was the second objective.

Because morphological awareness might be differently involved depending on the measure, we considered three reading measures. Morphological awareness's contribution to text-reading accuracy did not differ between the Low- and Middle-SES groups. However, SES did modify the effect of morphological awareness on word-reading fluency and reading comprehension. Morphological awareness made an independent contribution to both of these reading scores in the Middle-SES group, while its effect was not significant (or barely marginal) in the Low-SES group, after taking into account phonological skills and vocabulary. We therefore discuss results observed in each group separately.

Considering the Middle-SES group, our results agree with previous studies according to which morphological awareness contributes beyond phonological skills and vocabulary when predicting text-reading accuracy (Casalis & Louis-Alexandre, 2000; Kirby et al., 2012) and reading comprehension (Casalis & Louis-Alexandre, 2000; Deacon et al., 2014; Deacon & Kirby, 2004; Levesque et al., 2017; Nagy et al., 2006) and beyond the contribution of vocabulary when predicting word-reading fluency (Casalis & Louis-Alexandre, 2000), the contribution of phonological skills being nonsignificant for this measure. Reading a text containing several categories of words (frequent, rare, simple and derived) may rely on units of various sizes (graphemes, words, morphemes) and therefore involves phonological skills

and vocabulary as well as morphological awareness. As described above, being able to identify and isolate morpheme units might not only allow correct pronunciation but might also accelerate naming (Burani et al., 2002). In addition, as pointed out by Nagy et al. (2006), morphological awareness can be associated with greater accuracy and fluency in decoding morphologically complex words, which would in turn contribute to greater comprehension. Thus, morphological awareness can contribute to reading comprehension by helping children decode complex words and also break up complex words to understand their meaning (see also Levesque et al., 2017).

Interestingly, for all reading measures, morphological awareness contributed beyond vocabulary score, and the contribution of vocabulary did not survive once morphological awareness was entered. These results are consistent with other studies in reading comprehension showing that, from grade 4, vocabulary does not uniquely contribute beyond morphological awareness (Nagy et al., 2006; see also Levesque et al., 2017). This suggests that morphological awareness, as our composite score measured it, includes a broad component of word processing as compared to vocabulary, including, for example, syntactic knowledge (see for example Tyler & Nagy, 1989).

In all, the picture portrayed here is that morphological awareness uniquely contributes to all aspects of reading (decoding, fluency and comprehension) in middle-SES children, reflecting therefore the relevance of morphological awareness in models of reading acquisition (Berninger et al., 2010). This picture, observed in French children, is consistent with that observed in English children, reflecting a pattern that goes beyond some language specificities.

The picture is somewhat different for low-SES children. The only similar pattern observed concerned text-reading accuracy, in which morphological awareness was found to contribute to the reading score beyond the contribution of phonological skills and vocabulary. This

clearly indicates that low-SES children can mobilize their morphological skills when they have to decode a text which contains several categories of words. Interestingly, the contribution of phonological skills did not survive when SES was entered into the equation. In addition, phonological skills were correlated with text-reading accuracy only in the Low-SES group. This indicates that phonological skills are influenced by SES (Duncan & Seymour, 2000) and continue to be associated with text-reading accuracy in Low-SES children. Regarding word-reading fluency, the pattern differed from that observed in Middle-SES children. Vocabulary did not account for variance in word-reading fluency in Low-SES children, while there was only a nonsignificant trend for morphological awareness. The lack of a vocabulary contribution to variance in fluency is surprising because it did predict text-reading accuracy. It is likely that the variability of the materials would occasion variability in reading strategies. Reading lists of words in which some are potentially unknown to children of limited vocabulary, might engage a reading strategy based on decoding rather more than on word retrieval. By contrast, reading a text in which larger categories of words are involved (function words, frequent words, short words, rare words) might engage a broader range of processes (decoding, whole-word retrieval). Finally, the contribution of morphological awareness to the word-reading fluency score was only marginal. While it is difficult to interpret such a finding, the significant correlation between morphological awareness and word-reading fluency also suggests that morphological awareness is associated with fluency, even though its unique contribution is small.

Considering reading comprehension, again, the profile in Low-SES children differed from that of Middle-SES children, as phonological processing and morphological awareness did not contribute to reading comprehension. Vocabulary significantly contributed to reading comprehension, a result in line with previous studies conducted in low-SES children (Gentaz et al., 2013; Kieffer & Lesaux, 2007). Critically, only a marginal non-significant correlation

was observed between reading comprehension and morphological awareness. This contrasts with Apel et al. (2013)'s finding that morphological awareness uniquely contributes to reading comprehension in English second graders of low-SES. It is possible that these differences were due to methodological issues rather than language specificities, which seem few important (see above). Indeed, it is likely that the contribution of morphological awareness to reading comprehension depends on the tasks involved; the authors found a contribution from a derivation task only, perhaps reflecting a stronger involvement of lexical knowledge. Another difference lies in the comprehension test. In Apel et al. (2013), study, children had to indicate whether a sentence was correct or not after reading it silently while in our study children had to answer oral questions after reading silently a text. Finally, the contribution of vocabulary to reading comprehension was not taken into account in the Apel's study, which makes results of these studies difficult to compare (Apel et al., 2013). In all, the contribution of morphological awareness was found here to be weaker in the Low-SES group, except for text-reading accuracy. More precisely, it appears that, in Low-SES children, the less demanding the reading task (from decoding, to fluency, to comprehension), the greater the contribution of morphological awareness.

Our study intended to examine how morphological awareness and SES interact in their prediction of children's reading skills. Here, the link between vocabulary and morphological awareness is a key issue. Given that vocabulary is narrower in low-SES children (Hoff, 2006), and given the connection between morphological awareness and vocabulary observed in previous studies and in high-SES groups (Anglin, 1993; Sparks & Deacon, 2015), we could have expected a weaker level of morphological awareness in low-SES children, which is what we observed. Alternatively, we could have expected a greater contribution of morphological awareness in low-SES children to compensate for their poor vocabulary skills, as morphological awareness also depends on language rules and can contribute to reading by

facilitating decoding as well as comprehension. We did not observe this kind of compensation of morphological awareness for narrow vocabulary except as a nonsignificant trend in word-reading fluency, possibly because the relevant skills are too weak.

Yet, the connection between morphological awareness and vocabulary is complex. On the one hand, morphological analysis of words may foster vocabulary growth (Anglin, 1993; Berninger et al., 2010; Sparks & Deacon, 2015). Exposed to new complex words, children might learn them more easily if they are able to analyse them into familiar morphemes according to the morphological rules. On the other hand, a threshold amount of vocabulary might be necessary to promote extraction of morphological rules (see Kieffer & Lesaux, 2007). Therefore, it is possible that our sample of children from low-SES did not reach a threshold of vocabulary sufficient to develop large morphological skills as compared to middle-SES children. We also observed that either morphological awareness (in a marginal way) or vocabulary contributed to word-reading fluency and reading comprehension, making their contribution more dissociated compared to middle-SES children. Such a dissociation was observed in first grade children with low-SES for word reading (Colé et al., 2018). Thus, studies in low-SES children complement research on the relationship between morphological awareness and vocabulary in reading skills as they highlight a new pattern of connexion between reading-related skills. Note that these arguments rely on correlation, and the issue of causality remains unresolved. Interventional studies are needed to further test potential causal connections between morphological awareness and vocabulary, especially in low-SES children with limited vocabularies.

Interestingly, a few interventional studies have already been conducted with low-SES children (see for example Apel & Diehm, 2014). Direct effects of intervention were observed on morphological awareness, indicating that low-SES children are sensitive to intervention to improve morphological skills. However, the study did not aim to investigate their connection

to vocabulary. Therefore, the issue of the potential development of vocabulary in low-SES children remains open.

Another important issue is to know whether our results are specific to French, which has a morphologically rich system and whose orthography is more transparent than English, or can be generalized to other languages including English. We cannot strongly answer as we did not include cross-language comparison. Interestingly, our results in Middle-SES children was closed to English previous results. It is therefore reasonable to consider that our results from Low-SES children can also be generalised, at least in alphabetical scripts, although only cross-language comparisons can evidence fine differences.

Limitations and Future Directions

Our study has some limitations. First, the proportion of reading variance accounted for by our variables was much smaller in Low-SES children than in those of Middle-SES. Related to this issue, the phonological awareness score, only evaluated by the deletion of the first phoneme, was discarded because of scale attenuation effects. It might have explained a significant part of the reading variance in Low-SES children. In all, other sources of variance should account for reading scores in Low-SES children, and our study, focused on morphology, did not involve them. Note that even limiting the purpose to morphology, there are several ways to assess both morphological awareness and reading. Considering morphological awareness, we decided to use three tasks and to compute a composite score in order to provide a general overview. Alternatively, one can consider that each morphological awareness task represents a specific ability that might be linked to a specific measure of reading. It is likely that the contribution of the morphological score depends both on the morphological awareness task and the reading measure.

Likewise, the grade selection must also be questioned. Focusing on third graders may limit the Matthew effect generally observed in reading: the more a child reads, the more he/she can develop linguistic and cognitive skills associated with reading (Stanovich, 2009). However, as morphological awareness contributes to reading skills, reading activity in itself promotes morphological awareness (Deacon et al., 2014). In addition, compared to Middle-SES, decoding abilities (accuracy and fluency scores) were not correlated with reading comprehension scores in the low-SES group. Hence, one may wonder, even though our Low-SES children have not been identified speech/language disorders, whether their decoding skills (especially fluency) are sufficiently developed for reading comprehension compared to Middle-SES, which might, in turn, promote morphological awareness. Furthermore, the comprehension test was based on silent reading. Therefore, we cannot be sure that the child had read the whole text before trying to answer the questions. To partially attack this issue, further research is needed comparing low-SES children with younger higher-SES children who are matched on reading level, to know whether morphological awareness benefits especially the children whose reading skills are sufficiently developed.

Finally, our findings are based on correlations. Future studies are needed to solve the issue of causality. This point is important because several variables are interconnected. Notably, interventional studies would allow us to directly determine whether or not a lack of vocabulary can be supplemented by a stronger development of morphological awareness in at-need populations.

Conclusion

In conclusion, while SES does not directly affect morphological awareness in itself, it affects the unique contribution of morphological awareness to reading scores. While strongly correlated with vocabulary, morphological awareness uniquely contributes to reading

measures in Middle-SES and, but only to a much lesser extent, in French Low-SES third graders. Low-SES children, despite their lower scores in each measure of reading, can use their morphological awareness to bolster reading accuracy and, as a trend, fluency.

Interestingly, regression analyses suggest a slight dissociation between vocabulary and morphological awareness in accounting for reading scores, a dissociation that is especially pronounced in Low-SES children and thus would seem to open a window for targeted interventions focused on morphological awareness.

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Table 1*Descriptive statistics for the two SES groups, between comparison and Cohen's d indices*

Variable	Middle-SES		Low-SES		<i>t</i> (146)	<i>p</i>	Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Phonological Short-Term Memory (<i>max = 46</i>)	41.38	2.98	38.88	3.91	4.376	<.001	0.719
Phonological Awareness (<i>max = 12</i>)	11.39	.825	10.70	1.16	-	<.001 ^a	
Morphological Awareness							
<i>Production task</i> (<i>max = 32</i>)	22.54	5.14	17.93	4.52	5.794	<.001	0.539
<i>Oddity task</i> (<i>max = 10</i>)	8.43	1.54	7.46	2.04	3.276	.001	0.539
<i>Definition task</i> (<i>max = 10</i>)	7.08	2.10	5.95	1.99	3.380	.001	0.556
Vocabulary (<i>max = 70</i>)	54.35	6.58	48.32	5.64	5.984	<.001	0.984
Reading scores							
<i>Text-reading Accuracy (%)</i>	95.74	2.50	91.77	4.48	6.665	<.001	1.096
<i>Word-reading Fluency</i> (<i>max = 200</i>)	117.51	37.68	91.32	29.12	4.731	<.001	0.778
<i>Reading Comprehension</i> (<i>max = 15</i>)	8.74	3.20	6.65	2.80	4.242	<.001	0.697

Note. ^aMann-Whitney U test.

Table 2*Hierarchical Regression Results for Morphological Awareness*

	Variable	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	<i>R</i> ²	ΔR^2
			<i>LL</i>	<i>UL</i>			
Step 1	Phonological Short-Term Memory	.234***	.106	.362	.065	.446	.446***
	Vocabulary	.560***	.432	.688	.065		
Step 2	Phonological Short-Term Memory	.213**	.082	.345	.067	.453	.006
	Vocabulary	.526***	.388	.664	.070		
	Socio-economic Status	.183	-.097	.462	.141		

Notes. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3*Pearson correlations for study variables for the whole sample*

Variable	1	2	3	4	5	6
1. Phonological Short-Term Memory	—					
2. Vocabulary	.296**	—				
3. Morphological Awareness	.400**	.629**	—			
4. Text-reading Accuracy	.321**	.368**	.424**	—		
5. Word-reading Fluency	.209*	.445**	.544**	.622**	—	
6. Reading Comprehension	.272**	.526**	.565**	.356**	.425**	—

Notes. * $p < .05$. ** $p < .01$. all p-values are two tailed.

Table 4*Pearson correlations for study variables by SES*

Variable	1	2	3	4	5	6
1. Phonological Short-Term Memory	—	.217	.289*	.093	.027	.274*
2. Vocabulary	.138	—	.671**	.264*	.476**	.542**
3. Morphological Awareness	.352**	.414**	—	.357**	.615**	.728**
4. Text-reading Accuracy	.235*	.173	.277*	—	.556**	.370**
5. Word-reading Fluency	.173	.132	.275*	.622**	—	.499**
6. Reading Comprehension	.104	.325**	.228†	.176	.123	—

Notes. The results for the Middle-SES group ($n = 74$) are shown above the diagonal. Those for the Low-SES group ($n = 74$) are shown below the diagonal.

† $p < .10$. * $p < .05$. ** $p < .01$. all p -values are two tailed.

Table 5*Hierarchical Regression Results for Text-reading Accuracy*

Variable	B	95% CI for B		$SE B$	R^2	ΔR^2
		LL	UL			
Step 1 Phonological Short-Term Memory	.321***	.167	.476	.078	.103	.103***
Step 2 Phonological Short-Term Memory	.233**	.078	.388	.078	.185	.082***
Vocabulary	.299***	.144	.454	.078		
Step 3 Phonological Short-Term Memory	.173*	.014	.331	.080	.222	.037*
Vocabulary	.155	-.033	.342	.095		
Morphological Awareness	.258*	.062	.453	.099		
Step 4 Phonological Short-Term Memory	.105	-.049	.258	.078	.308	.086***
Vocabulary	.051	-.133	.235	.093		
Morphological Awareness	.215*	.029	.401	.094		

Socio-economic Status .676*** .358 .993 .161

Notes. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6

Hierarchical Regression Results for Word-reading Fluency by SES

Variable	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	R^2	ΔR^2
		<i>LL</i>	<i>UL</i>			
Word-reading Fluency, Middle-SES group						
Step 1 Phonological Short-Term Memory	.027	-.208	.262	.118	.001	.001
Step 2 Phonological Short-Term Memory	-.080	-.292	.133	.106	.233	.232***
Vocabulary	.494***	.281	.706	.106		
Step 3 Phonological Short-Term Memory	-.167†	-.358	.024	.096	.411	.179***
Vocabulary	.123	-.124	.369	.124		
Morphological Awareness	.581***	.330	.833	.126		
Word-reading Fluency, Low-SES group						
Step 1 Phonological Short-Term Memory	.173	-.059	.230	.116	.030	.030
Step 2 Phonological Short-Term Memory	.157	-.077	.391	.117	.042	.012
Vocabulary	.111	-.123	.345	.117		
Step 3 Phonological Short-Term Memory	.087	-.157	.331	.122	.083	.041†
Vocabulary	.023	-.228	.274	.126		
Morphological Awareness	.235†	-.030	.500	.133		

Notes. CI = confidence interval; *LL* = lower limit; *UL* = upper limit. The results for the Middle-SES group ($n = 74$) are shown in upper panel. The results for the Low-SES group ($n = 74$) are shown in lower panel

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7*Hierarchical Regression Results for Reading Comprehension by SES*

Variable	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	<i>R</i> ²	ΔR^2
		<i>LL</i>	<i>UL</i>			
Reading Comprehension, Middle-SES group						
Step 1 Phonological Short-Term Memory	.274*	.048	.500	.113	.075	.075*
Step 2 Phonological Short-Term Memory	.164	-.036	.364	.100	.319	.244***
Vocabulary	.560***	.306	.706	.100		
Step 3 Phonological Short-Term Memory	.067	-.102	.236	.085	.539	.220***
Vocabulary	.094	-.124	.312	.109		
Morphological Awareness	.646***	.423	.868	.112		
Reading Comprehension, Low-SES group						
Step 1 Phonological Short-Term Memory	.104	-.130	.337	.117	.011	.011
Step 2 Phonological Short-Term Memory	.060	-.166	.285	.113	.109	.098**
Vocabulary	.316**	.091	.542	.113		
Step 3 Phonological Short-Term Memory	.029	-.210	.269	.120	.117	.008
Vocabulary	.278*	.032	.524	.123		
Morphological Awareness	.102	-.158	.363	.131		

Notes. CI = confidence interval; *LL* = lower limit; *UL* = upper limit. The results for the Middle-SES group (n = 74) are shown in upper panel. The results for the Low-SES group (n = 74) are shown in lower panel

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.