EDICIONES COMPLUTENSE

Revista de Investigación en Logopedia
e-ISSN: 2174-5218

ESTUDIOS

Why Morphology Matters for Reading and Spelling Development: A Theoretical and Empirical Perspective in Individuals With and Without Dyslexia

Estelle Ardanouy (corresponding author)
School of Humanities, Social Sciences and Law, University of Dundee, United Kingdown
Faculté de Psychologie et des Sciences de l'Education, Université de Genève, Switerland ✉

Pauline Quémart
Nantes Université, Univ Angers, Laboratoire de psychologie des Pays de la Loire, LPPL France ✉

https://dx.doi.org/10.5209/rlog.101706 Received March 18th 2025 • First decision March 30th 2025 • Accepted May 7th 2025.

Abstract: While phonology is a fundamental component of reading and spelling acquisition, broader language skills, such as morphology, also play a crucial role. At the same time, phonological deficits are widely recognized as a core characteristic of developmental dyslexia, making it difficult for individuals to segment words into phonemes and contributing to challenges in both reading and spelling. However, morphological processing is relatively preserved in this population. This article reviews studies highlighting the role of morphological units in reading and spelling during typical development and in individuals with dyslexia. Studies showing that training in morphological awareness can improve written language skills in individuals with dyslexia are also presented. Throughout the manuscript, we draw on the psycholinguistic grain size theory, which offers a valuable theoretical framework for understanding the factors that may influence the processing of morphological units when reading and spelling. Concrete examples of interventions based on morphological training for clinicians are also provided.
Keywords: morphology; reading; spelling; dyslexia

ES Por qué la morfología es importante para el desarrollo de la lectura y la ortografía: Una perspectiva teórica y empírica en personas con y sin dislexia

Resumen: Si bien la fonología es un componente fundamental en la adquisición de la lectura y la ortografía, otras habilidades lingüísticas más amplias, como la morfología, también desempeñan un papel crucial. Al mismo tiempo, los déficits fonológicos son ampliamente reconocidos como una característica central de la dislexia del desarrollo, lo que dificulta la segmentación de palabras en fonemas y contribuye a las dificultades en la lectura y la escritura. Sin embargo, el procesamiento morfológico se encuentra relativamente preservado en esta población. Este artículo revisa estudios que destacan el papel de las unidades morfológicas en la lectura y la ortografía durante el desarrollo típico y en personas con dislexia. También se presentan estudios que muestran que el entrenamiento en conciencia morfológica puede mejorar las habilidades de lenguaje escrito en personas con dislexia. A lo largo del manuscrito, nos basamos en la teoría del tamaño del grano psicolingüístico pues proporciona un marco teórico valioso para comprender los factores que pueden influir en el procesamiento de las unidades morfológicas en la lectura y la ortografía. Asimismo, se ofrecen ejemplos concretos de intervenciones basadas en el entrenamiento morfológico dirigidas a los clínicos.
Palabras clave: Dislexia; Lectura; Morfología; Ortografía.

How to cite it: Ardanouy, E., & Quémart, P. (2025). Why morphology matters for reading and spelling development: a theoretical and empirical perspective in individuals with and without dyslexia. (2025). What do we know about reading and spelling in shallow orthographies?. *Revista de Investigación en Logopedia* 15 (número especial), 61-73. https://dx.doi.org/10.5209/rlog.101706

Introduction

Learning to read and write involves multiple levels of linguistic analysis. Alphabetic writing systems (such as Spanish, French, or English) use graphemes to represent phonemes, the smallest units of sound in a language. The ability to process phonemic units is therefore crucial for reading and spelling acquisition (Melby-Lervåg et al., 2012; Míguez-Álvarez et al., 2022; Wagner & Torgesen, 1987). Literacy also depends on the ability to process graphemes, which are the smallest units used to represent phonemes in a writing system (Commissaire et al., 2018). Several studies have also highlighted the role of morphological units–such as prefixes, suffixes, and roots– when processing written language (e.g., Burani et al., 2002; Carlisle & Stone, 2003; D'Alessio et al., 2018; Laxon et al., 1992; Quémart et al., 2012). In this article, we will focus on the impact of morphological units on learning to read and write. First, we present both theoretical and empirical evidence supporting the importance of morphological processing in reading and spelling acquisition. We then review data on the written processing of morphological units among individuals with developmental dyslexia (DD). Finally, we demonstrate how these units can be used as part of an intervention strategy for individuals with DD.

Morphological processing in reading and spelling development

Over the past 30 years, numerous studies have explored the influence of morphological units on reading and spelling development. Empirical data from reading studies show that by third grade, students are able to read words and pseudowords consisting of a lexical base and a suffix (e.g., *dancer* for real words or *hairer* for pseudowords) more accurately than those formed from a sequence of letters that do not correspond to a lexical base and a suffix (e.g., *murder* for real words or *hupter* for pseudowords). These findings, first introduced by Laxon et al. (1992), have been replicated with measures of reading accuracy and/or fluency in English (Carlisle et al., 2001; Carlisle & Stone, 2003, 2005), as well as in languages with more transparent grapheme-to-phoneme correspondences such as French (Colé et al., 2012; Marec-Breton et al., 2005), Italian (Burani et al., 2002; Traficante et al., 2011) and Spanish (D'Alessio et al., 2018; Suárez-Coalla et al., 2017).

The lexical decision task has also been used to investigate whether access to the mental lexicon is facilitated by the presence of morphological units. When Italian children in grades 3 to 5 are asked to decide whether a pseudoword shown on a computer screen is an existing word in the language, they are slower and make more errors when the pseudowords include morphological units than when they do not (e.g., *donn-ista* where *donn* is an Italian root meaning "woman" and "ista" an Italian suffix meaning "the one who" vs. *dennosto* where neither *denn* nor *osto* are Italian affixes) (Burani et al., 2002; see also Quémart et al., 2012 for French). Decision on whether words exist or not is also influenced by morphological units. French-speaking children recognize words more quickly when they are composed of morphemic units rather than being morphologically simple (Casalis et al., 2015; Quémart et al., 2012). Similarly, lexical decision tasks show faster responses for words containing frequent rather than rare morphological units (in Spanish: Lázaro et al., 2013; in English: Carlisle & Katz, 2006). Taken together, These results support the idea that morphological units are processed during visual word identification.

Other studies have highlighted the role of morphological units in the production of written language. This can be observed in different contexts. Some researchers have looked at how the presence of morphological units affects spelling accuracy. In Italian, by third grade, students are more accurate in spelling pseudowords consisting of a lexical base and a suffix than in spelling morphologically simple pseudowords (Angelelli et al., 2014, 2017). Other researchers have manipulated the frequency of morphological units, hypothesizing that a frequency effect would reflect the processing of these units during spelling. For instance, in Spanish, children aged 7 to 12 make fewer spelling errors with morphologically complex words and pseudowords when these are built with a frequent lexical base (e.g., *peludo*, "hairy") as opposed to a less frequent one (e.g., *tejado*, "roof") (Suárez-Coalla et al., 2017).

In languages with inconsistent phoneme-grapheme correspondences (such as French or English), these inconsistencies can be resolved through morphological processing. For example, when students are asked to write a word containing an inconsistent grapheme, they are more likely to choose the correct one if it is part of a lexical base (e.g., *en* in *vendeur,* "sailor" in French) than if it is not part of a lexical base (e.g., *en* in *vendredi,* "Friday"). Such facilitation has been observed as early as age 6 in English (Deacon & Bryant, 2006a, 2006b; Kemp, 2006), although it takes until age 8 for students to make optimal use of morphological information (i.e., showing equivalent spelling accuracy for the lexical base alone and for the base as part of a derived word) (Deacon & Dhooge, 2010).

Morphological information also plays a key role in choosing the correct word endings. When the ending corresponds to a suffix (e.g., *-ette* in *fillette,* "little girl" in French), the likelihood of selecting the correct spelling is higher than when the ending does not correspond to a suffix (e.g., *-ette* in *girouette,* "wheathervane"). This effect has been observed from age 9 in English when spelling derivational suffixes or choosing the correct spelling for derivational suffixes (e.g., *-y* in *rocky* vs. *-y* in *study*) (Deacon & Bryant, 2005; Sangster & Deacon, 2011). A similar influence is seen from age 7 in English with inflectional suffixes (Deacon & Bryant, 2005).

Finally, morphological information also helps with producing words that end in silent letters, a common difficulty in languages with inconsistent orthographies. In French, for example, at least 28% of words end with a silent letter (Gingras & Sénéchal, 2017). By age 7, children are more likely to correctly spell silent letters at the end of words when these words are linked to other words in the same morphological family, compared

to when no such link exists to clarify the spelling. For example, the likelihood of reporting the silent consonant at the end of French words increases when a related word is available (e.g., *renard* [ʁənaʁ] "fox", which is related to *renardeau* [ʁənaʁdo] *"kit"*) compared to words without a morphologically relative (e.g., *foulard* "scarf") (Pacton & Casalis, 2006; Sénéchal, 2000; Sénéchal et al., 2006). Improved accuracy with final silent letters that indicate the plural form, compared to silent letters with no morphological marker, has also been observed from first to third grade in Spanish (Defior et al., 2008).

Children also benefit from morphologically related words when they learn to spell new words that end with a silent letter. From grade 3 onward, the orthographic learning of monomorphemic words improves when words are presented in sentences that provide morphological information justifying the spelling of the final sound compared to sentences that do not offer such cues. An example of a morphological cue for the pseudoword *coirard* (/kwaRaR/) is its presentation in the sentence *On dit que la femelle, la coirarde, est encore plus colorée que le coirard* ("The *coirarde*, the female of the *coirard*, is said to be even more colorful") where the final silent *-d* in *coirard* is pronounced in its gender-inflected form *coirarde* (/kwaRaRd/) (Pacton et al., 2013, 2018). Note, however, that morphological facilitation in learning the spelling of new words emerges later in development (i.e., in Grade 5) when monomorphemic words are associated with a derived form (e.g., *rouvard* /RuvaR/ - *rouvardise* /RuvaRdiz/) than an inflected form (i.e. the feminine, e.g., *rouvard* /RuvaR/ - *rouvarde* / RuvaRd/) (Pacton & Peereman, 2023).

The impact of morphological processing is not only seen in spelling accuracy but also in writing fluency. Quémart and Lambert (2019) investigated how 4th and 5th grade children process the morphological structure of words during writing. In their study, the presence of two morphemes within words did not reduce writing latencies but did affect the time spent writing the letter just before the morphological boundary (i.e., the boundary between two morphemes), indicating that the morphological structure of words regulates the dynamics of handwriting. A similar influence of morphemes on writing dynamics was found in a study with English-speaking children aged 6 to 11 years (Breadmore & Deacon, 2019) and in Spanish-speaking children aged 7 to 12 years (Suárez-Coalla et al., 2017).

Why Process Morphological Units in Written Language?

The data presented above suggest that morphological processing influences both reading fluency and written production, while also facilitating access to lexical representations. The psycholinguistic grain size theory (Ziegler & Goswami, 2005) provides an insightful theoretical framework for explaining the role of morphological units in written language processing. This model predicts which units are processed during word identification (though not spelling) and how these processes develop over time. It proposes that the alignment between spoken and written language can occur through the encoding of linguistic units of varying sizes (graphemes, syllables, morphemes), with the size of the processed units depending on factors such as orthographic transparency and reading proficiency. According to this theory, processing morphological units helps overcome difficulties in matching graphemes and phonemes, enabling more efficient reading. These difficulties may arise from 1) a lack of transparency in grapheme-phoneme correspondences, or 2) a language disorder that impairs this mapping.

The Impact of Orthographic Transparency and Morphological Productivity on Morphological Processing

Psycholinguistic research has demonstrated the impact of orthographic transparency on the types of units processed in written language. In transparent orthographies (e.g., Spanish, Italian), there is a systematic correspondence between graphemes and phonemes. For instance, in Spanish, most graphemes have a consistent pronunciation. Only three consonants (c, g, and r) require contextual rules for their pronunciation. Additionally, Spanish syllabic structures are relatively simple, typically consisting of consonant-vowel patterns (Cuetos & Suárez-Coalla, 2009). In these transparent orthographies, learning to read and write primarily relies on phonological decoding–matching graphemes to phonemes. In contrast, in opaque orthographies (e.g., English), many grapheme-phoneme correspondences are inconsistent. For example, the same grapheme (e.g., "ch") can be pronounced in various ways (e.g., /tʃ/ in *chicken*, /k/ in *chorus*, and /ʃ/ in *chef*). Moreover, some languages (especially English) use many complex graphemes, consisting of multiple letters (e.g., "ough", "tch", "dge" in English). These multi-letter graphemes are used to represent sounds that do not correspond to a single letter. As a result, readers must rely on larger units, such as morphemes and syllables, to identify words (Caravolas et al., 2013). In summary, the psycholinguistic grain size theory proposes that in alphabetic orthographies, the size of the units mapped between spoken and written language depends on the consistency of grapheme-phoneme correspondences. Therefore, readers rely more on larger units (such as morphemes) in opaque orthographies than in transparent ones.

Research on morphological processing during reading acquisition has shown that such processing occurs in both transparent and opaque orthographies. For example, studies have shown that in Finnish, where phoneme-grapheme correspondences are nearly always one-to-one, morphologically complex words are processed more quickly than morphologically simple words (Lehtonen & Laine, 2003). In Spanish, children aged 7 to 12 are faster to start reading morphologically complex words (e.g., *peludo*, "hairy") than morphologically simple words (e.g., *pagana*, "pagan") (Suárez-Coalla et al., 2017). Few studies have directly compared morphological processing across languages to assess the impact of orthographic transparency on the types of units processed during reading. Third grade English-speaking students benefit more from the presence of morphological units in words when naming them, compared to their peers who speak French, German,

or Italian (Mousikou et al., 2020). This suggests that morphological processing plays a more significant role in languages with opaque orthographies than in those with transparent ones. Furthermore, the impact of morphological awareness on learning to read and write is greater in deep orthographies (such as English or French) than in transparent ones (like German or Spanish, Lee et al., 2022). These findings support the Grain Size Theory, which suggests that morphological processing is influenced by orthographic transparency.

Moreover, morphological processing during word reading is also shaped by the morphological productivity of the language. For example, French contains approximately 56% derived words compared to 46% in English (Mailhot et al., 2020; Sánchez Gutiérrez et al., 2018), and there are around 120 commonly used suffixes in French, compared to only 50 in active use in English (though 240 exist) (Crystal, 2003). A study by Duncan et al. (2009) showed that French-speaking children's morphological awareness skills develop earlier than those of English-speaking children in the initial stages of literacy acquisition. One possible reason could be the difference in morphological productivity between the two languages. We also know that morphological processing is more systematic in French than in English (Casalis et al., 2015). Morphological processing is also more pronounced in German than in French, as German has a higher level of morphological productivity (Beyersmann et al., 2021).

The hypothesis that the unit of matching between spoken and written language depends on the consistency of the relationships was originally proposed to explain functional units in reading rather than spelling. However, the same explanation can be applied to spelling development. The degree of consistency in phoneme-grapheme correspondences plays a role in spelling acquisition (Caravolas, 2006). In transparent orthographies, matching phonemes to graphemes is generally sufficient to spell most words correctly. However, in some languages, a single phoneme can have multiple possible orthographic representations. For example, in French, the phoneme /o/ can be spelled in several ways: o, ot, oh, os, eau, au, aux, aud, aut, ault. To handle these inconsistencies, learners must rely on memorizing some of these forms or use other patterns (morphological, graphotactic) that determine the use of one grapheme over another (Treiman & Kessler, 2014). For example, the sound /o/ is transcribed with the suffix *-eau* when referring to the offspring of an animal (e.g., *renardeau* "kit", *éléphanteau* "calf") (morphological pattern). Additionally, the sound /o/ can only be written as *eau* at the end of a word (graphotactic pattern). In opaque orthographies, memorizing these inconsistencies plays a major role in spelling acquisition.

This hypothesis has been tested by examining the effects of frequency and regularity on word production, based on orthographic consistency. For example, Marinelli et al. (2015) found stronger effects of frequency and regularity in English-speaking children compared to Italian-speaking children. Another strategy is to process morphological information during written production. In opaque orthographies, the many inconsistencies observed in phoneme-grapheme mappings reflect the influence of another system: the semiographic system (Mahrer, 2017). Some linguistic units (typically graphemes) do not represent sounds but instead carry morpho-syntactic information. This is the case, for example, with silent letters in the middle (e.g., *sept,* "seven") or at the end (e.g., *placard,* "closet") of words, which indicate relationships with words in the same morphological family (e.g., *septennal,* "septienal" or *septante,* "seventy"; *placarder,* "to board up" or *placardage,* "boarding up").

As mentioned earlier, processing morphological units within words enhances spelling accuracy and modulates writing speed. This type of processing has been observed in both transparent orthographies, such as Spanish and Italian (Angelelli et al., 2014, 2017; Suárez-Coalla et al., 2017) and opaque orthographies, such as English (Deacon & Bryant, 2005; Deacon & Dhooge, 2010; Sangster & Deacon, 2011) and French (Pacton & Casalis, 2006; Sénéchal, 2000; Sénéchal et al., 2006). However, no cross-linguistic study to date has examined the impact of orthographic transparency on morphological processing in word spelling. A closer look at the results of published studies, however, suggests that morphological processing is more consistently observed in opaque orthographies than in transparent ones. For example, in Italian, Angelelli et al. (2014) found that morphological structure influenced pseudoword production but not word production. The impact of morphological units may therefore depend on word frequency, with less reliance on morphemes when producing frequent words compared to rare words or pseudowords in transparent orthographies. Orthographic transparency may also affect the timing of the influence of morphological units on production, with an earlier impact on the time course of word writing in Spanish than in French (Suárez-Coalla et al., 2017).

To sum up, the psycholinguistic grain size theory explains why readers need to process morphological units during reading, and it also makes predictions about the importance of this kind of processing in writing. While this processing does not always improve reading and spelling accuracy, it does enhance fluency, particularly in more advanced readers. These findings emphasize the value of raising young readers' awareness of processing the morphological units of their language, even when the orthographies are transparent. As we will see below, this awareness is especially crucial for readers who struggle with phonological processing.

The Impact of Reading Level on Morphological Processing

The grain size theory (Ziegler & Goswami, 2005) not only helps explain the impact of consistency in the correspondence between spoken and written language on the processing of morphological units, but also highlights the importance of training readers, especially those with DD, to process morphological units when they struggle with grapheme-phoneme correspondence.

Beginning and advanced readers rely on different linguistic units during visual word recognition. In alphabetic languages, beginner readers start by mapping smaller units, such as phonemes and graphemes, to establish correspondences between written and spoken language (Seymour & Duncan, 1997). Once they master decoding, intermediate readers begin to process larger units such as syllables and morphemes, which allows them to process groups of letters rather than individual ones. They develop morphological processing strategies to speed up the recognition of more complex words. These strategies, which reflect a

greater reliance on larger units when spelling, become more refined in advanced readers. They tend to rely on morphemes, or even whole words when they are morphologically simple. To illustrate this developmental trend, studies have shown that the impact of the number of letters on word recognition decreases with age (Aghababian & Nazir, 2000; Ballot & Zesiger, 2024; Tiffin-Richards & Schroeder, 2015). These results reflect the growing reliance on the lexical route of reading as children age, making reading more automatic.

The shift from processing small to large grain units depends on reading experience: the more a reader is exposed to written language, the more they enrich their orthographic lexicon (Share, 1995), which allows them to gradually transition from an analytical phonological processing (small units) to a lexical and morphological processing (large units). The evolution in the size of the units processed in writing also depends on phonological and morphological skills. Phonological skills promote the understanding of the alphabetic principle (Byrne & Fielding-Barnsley, 1989), thus facilitating the implementation of grapho-phonological decoding. Morphological skills allow for the extraction of morphemic units in words, which leads readers to process units larger than graphemes. This strategy improves reading speed and allows for more efficient word recognition, especially for words with inconsistent grapho-phonological correspondences.

Supporting this idea, morphological awareness influences written language learning more in deep orthographies than in transparent ones (Lee et al., 2022; Manolitsis et al., 2017). In addition, the contribution of morphological awareness to literacy seems to be more significant over the course of development, as predicted by the psycholinguistic grain size theory (Desrochers et al., 2018). Note, however, that very little data has been published in transparent orthographies, or on advanced readers compared to beginning readers. Nonetheless, an early influence of morphological awareness on literacy acquisition has been evidenced in the transparent Greek orthography (Diamanti et al., 2017; Grigorakis & Manolitsis, 2021; Manolitsis et al., 2017), suggesting that the contribution of morphological awareness to reading and spelling is not limited to advanced readers and spellers.

Finally, given the significant role of phonological and morphological skills in the types of units processed during reading and writing, several studies have explored the impact of phonological processing disorders on morphological processing. Specifically, readers with developmental dyslexia struggle with processing the phonological structure of language, which interferes with establishing grapho-phonological correspondences and, consequently, with processing fine-grained linguistic units (Rack et al., 1992; Snowling, 1998; Ziegler & Goswami, 2005). However, they tend to develop morphological skills that are stronger than would be expected based on their reading level (Elbro & Arnbak, 1996). It has therefore been suggested that morphemes could serve as processing units in word recognition for dyslexic readers, as they are larger than graphemes and carry meaning. This hypothesis is further discussed in the next section.

Morphological skills in people with developmental dyslexia

Developmental dyslexia (DD) is defined as a specific learning disorder that leads to difficulties in word reading, decoding, and spelling (Catts et al., 2024;Carroll et al., 2025). These difficulties persist into adulthood, resulting in lower employment rates (Gerber, 2012) and more limited access to higher education (Horn & Berktold, 1999).

Morphological awareness in developmental dyslexia

A growing number of studies have focused on morphological knowledge in individuals with DD. First, in children, a recent meta-analysis synthesized 40 studies involving a total of 5,018 participants, aiming to determine whether children with DD exhibit a deficit in morphological awareness (Georgiou et al., 2022). The analysis revealed that the morphological awareness skills of children with DD were significantly lower than those of age-matched peers (g = 1.11) but similar to those of younger children matched on reading level (g = -0.08). None of the following moderators were found to be significant: the language spoken by the children, the type of task used to assess morphological awareness, or the modality of task administration (oral or written). Only age was identified as a moderator of the deficit: the older the children, the greater the gap in morphological awareness between children with DD and typically developing peers matched by age. Nevertheless, in French-speaking children, two studies found performance differences depending on the tasks considered (Berthiaume & Daigle, 2014; Casalis et al., 2004). Casalis et al., (2004) explained these differences by the significant involvement of phonological skills in certain tasks. For example, removing or adding an affix to a word requires a phonological analysis of the structure of the word to know where to cut it. Deacon et al. (2008), on the other hand, hypothesized that it was the difficulty of the task, rather than the type of task, that could cause differences. For example, performing a task with real words might be relatively straightforward, whereas using pseudowords could lead to greater difficulties.

It therefore seems that the skills of children with DD are similar to those of younger children matched on reading level. This is why some authors have suggested that morphological awareness skills are relatively preserved compared to phonological skills, which are still impaired in children with DD compared to younger children with the same reading level.

In adults, the situation is less clear. A study by Law et al. (2015) compared English-speaking adults with DD to age-matched adults without the disorder. Within the dyslexic group, they identified two subgroups: a group of “compensated” adults who had higher literacy scores than expected given their disorder, and a group of “non-compensated” adults with lower literacy scores. This study found equivalent morphological awareness accuracy performance in compensated adults with DD compared to the control group, but lower performance in non-compensated adults with DD. Two studies conducted with French-speaking adults concluded that adults with DD and age-matched adults performed equivalently on morphological awareness tasks (Cavalli et al., 2017; Martin et al., 2014). However, a closer look at the results reveals some differences:

slower response times for the dyslexia group on the suffixed word detection task in Cavalli et al. (2017), and significantly slower response times for the suffixation decision task in Martin et al. (2014). Additionally, another French study using the same suffixation decision task as Cavalli et al. (2014) found significantly lower accuracy in the dyslexic group compared to the control group (Ardanouy & Quémart, under review). These differences may potentially be explained by what Law et al. (2015) highlighted in their study: the heterogeneous performance levels among adults with DD and their varying degrees of compensation for their condition.

This notion of compensation has often been used in research on DD, even suggesting that morphological awareness could be a factor aiding compensation (Cavalli et al., 2017; Law et al., 2018). However, the picture does not seem so clear regarding whether morphological awareness is a process of compensation. Indeed, not all studies show equivalent skills between adults with DD and neurotypical adults. According to Livingston and Happé (2017), the "compensation" is a process that improves the behavioral expression of a disorder. Applied to DD, this would mean achieving higher performance in reading fluency, spelling or reading comprehension than is expected for people with DD, reaching a level equivalent to that of adults in the general population. Therefore, this hypothesis has not yet been verified and needs to be explored further. Nevertheless, morphemes appear to be available as oral units for individuals with DD, potentially serving as useful support for mapping oral and written units. As explained in the psycholinguistic grain size theory, this ability to process morphemes could help them improve their reading and spelling skills.

Morphological knowledge and literacy in DD

For word reading, several studies have shown that children with DD read pseudowords composed of two morphological units faster than simple pseudowords. This benefit was more pronounced in individuals with DD compared to children matched on chronological age or reading level (Burani, 2009; Law & Ghesquière, 2022; Suárez-Coalla & Cuetos, 2013). More specifically, the study by Suárez-Coalla & Cuetos, (2013) compared Spanish children aged 7 to 10, with and without DD, matched on chronological age, in reading morphologically derived words, non-derived words, and pseudowords considered morphologically complex. Children with DD show better reading speed performance for morphologically derived words than for simple words, whereas this effect was not present in children without DD. Suárez-Coalla et al. (2017) added that children with DD benefit from the presence of a frequent high root for reading unfamiliar morphologically derived words. Studies by Lázaro and colleagues on Spanish children with and without reading difficulties have helped clarify this effect. In Lázaro (2012), a pseudoword definition task showed no superiority effect of root frequency (compared to morphologically derived words with a lower-frequency root) between children with reading difficulties and typically developing children, likely because they had unlimited time to apply their morphological processes. In Lázaro et al. (2013), they did not find this effect on reaction times in a lexical decision task among children with reading difficulties. Only typically developing children benefited from a root frequency effect, suggesting that morphological processing does not occur automatically (within a limited time) in children with reading difficulties.

Several studies have aimed to show that morphological processing in individuals with DD is morpho-semantic in nature (Elbro & Arnbak, 1996; Quémart & Casalis, 2015). This type of processing is defined as the ability to activate a set of words that belong to the same morphological family and are semantically related.

Other studies highlight the role of morphological processing in reading fluency (Giazitzidou & Padeliadu, 2022; Lefèvre et al., 2022). The study by (Giazitzidou & Padeliadu, 2022) on Greek children with DD (a transparent orthographic system) shows that morphological awareness predicts reading fluency, but only in the early grades. In contrast, the study by Lefèvre et al. (2022) on French-speaking adolescents with DD demonstrates that morphological priming predicts reading fluency, whereas morphological awareness does not. The authors explain this effect by suggesting that adolescents with DD can quickly extract morphological units within a written word, which helps them recognize it more rapidly and thus improves their reading fluency.

In spelling, several studies have shown that children with DD spell words containing morphological information more accurately than other words (Angelelli et al., 2017; Ardanouy & Quémart, under review; Bourassa et al., 2006, 2019; Bourassa & Treiman, 2008; Quémart & Casalis, 2017; Suárez-Coalla et al., 2017). For example, Bourassa and Treiman (2008) found that Italian-speaking children with DD performed worse than their age-matched peers in spelling derived words but were better at spelling morphologically derived words compared to simple words. Another study by Bourassa et al. (2019) showed that English children with DD have equivalent spelling performance on derived words to younger children matched on reading and spelling level but perform worse than children of the same chronological age. Moreover, two studies on French-speaking adolescents and adults with DD found that they benefit more from morphological strategies when spelling the final silent letter of a word, provided it could be predicted through morphology (e.g., the word *bavard* [bavaʁ] (chatty) can be inferred from a related word like *bavarder* [bavaʁde] (to chat)) (Ardanouy & Quémart, under review; Quémart & Casalis, 2017).

Thus, individuals with DD are able to process morphological units in writing, which helps them improve their reading accuracy, fluency, and spelling. These findings highlight the importance of implementing interventions focused on developing morphological awareness to enhance literacy skills.

Morphological awareness intervention

In individuals with typical development

Several systematic reviews have focused on the effectiveness of morphological awareness interventions aimed at improving children's reading and spelling skills (Bowers et al., 2010; Colenbrander et al., 2024; Goodwin & Ahn, 2013). The most recent systematic review (Colenbrander et al., 2024) reports on the impact

of morphology instruction on literacy outcomes in English-speaking children, from kindergarten to Grade 6, across 28 different studies. This review concludes that effect sizes are small to moderate for reading and spelling outcomes, with larger effect sizes for trained words compared to untrained words. More specifically, transfer effects to untrained words were observed only for spelling, not for reading. Results for reading comprehension were more mixed and did not show a significant effect. Few effects were found for delayed post-tests, partly because very few studies included a delayed measure. None of the moderators (dose, instructor, type of control group, type of task used to measure outcomes, linguistic context) had an impact on the effectiveness of the interventions. However, the study reports a trend toward higher effect sizes (significantly different from 0) when the intervention is conducted by the researcher or research assistant, when it lasts more than 20 hours, when the control group is passive or engaged in a different activity (not receiving linguistic training), and when outcomes are measured using researcher-created tasks.

The systematic review by Bowers et al. (2010) is also interesting because it did not only include studies in English but also in different alphabetic languages (only 4 out of 22 studies). They included children (N = 2652) from preschool to Grade 8. The review's results showed effects on morphological awareness (d = 0.65), phonological awareness (d = 0.34), reading (d = 0.41), spelling (d = 0.49), and vocabulary (d = 0.35) when children were compared to control groups receiving interventions as business as usual. When morphological interventions were compared to alternative interventions (e.g., phonological training), the effect sizes were noticeably smaller but still significant for morphological awareness (d = 0.51), phonological awareness (d = 0.08), reading (d = 0.05), spelling (d = 0.05), and vocabulary (d = 0.20).

To our knowledge, very few intervention studies on morphology have been published in languages with transparent orthographies. A recent short intervention study on morphological analyses highlights the benefit of using explicit instruction to enhance the recognition of suffixes in new words among Spanish-speaking Grade 3 children (Martinez et al., 2024). In this study, children appear to form an orthographic representation of suffixes only after receiving explicit instruction. Moreover, two intensive and explicit interventions are particularly interesting as they were conducted in French, a language with a transparent orthography for reading but an opaque orthography for spelling, with Grade 3 and 4 children (Ardanouy et al., 2023; Casalis et al., 2018). The results showed moderate to large effect sizes on morphological awareness and spelling (for both trained and untrained words, on affixes and roots), with long term effects (delayed post-tests conducted 3 and 5 months later). However, no effect was found on the reading of untrained morphologically derived words (Ardanouy et al., 2023). In the same vein, no effect was found on reading skills when training morphological awareness in kindergarten for French-speaking children on their reading skills in Grade 1, in contrast to phonological awareness training, which showed interesting effects (Casalis & Colé, 2009).

Among adolescent-adults (aged 15 to 19), Goodwin and Ahn (2013) report in their meta-analysis a lack of effect of morphological interventions on literacy. However, only three studies focused on this age group, compared to 56 studies on younger participants, which may explain the absence of effect. The literature on this population is lacking.

In individuals with developmental dyslexia

For children with DD, several reviews have demonstrated the effectiveness of morphological interventions in improving literacy skills (Brady & Mason, 2024; Galuschka et al., 2020; Goodwin & Ahn, 2010). The meta-analysis by Goodwin and Ahn (2010) aimed to assess the effectiveness of morphological interventions on literacy skills, focusing exclusively on children with literacy difficulties. A total of 17 studies (10 of which were in English) were included in this review, covering children from preschool to grade 12. The effect sizes of the interventions ranged from low to moderate for phonological awareness (d = 0.49), morphological awareness (d = 0.40), spelling (d = 0.20), and reading comprehension (d = 0.24). No effect was found for reading decoding (see also Traficante, 2013 for transparent orthographies). It is interesting to note that at least 10 hours of training are required to demonstrate an effect and that children with learning disabilities, reading disabilities, speech and language impairments, struggling readers, and English language learners, all benefit from morphological interventions. Finally, interventions that combine morphology with another type of instruction (such as adding comprehension training) are the most effective.

In their meta-analysis, Galuschka et al. (2020) review the most effective interventions for spelling remediation in learners with DD. This review shows a large effect size for morphological interventions (8 studies out of 26) on spelling and a small effect size for reading. The effect of morphological intervention on reading is particularly noteworthy, given that the intervention primarily focused on spelling. Moreover, this review does not show a significant difference in effectiveness across age groups but highlights an emerging trend suggesting that the effects of morphological interventions tend to increase with age, whereas the effects of phonological interventions tend to decrease with age (see also Suggate, 2016). Nevertheless, Galuschka et al. (2020) encourage starting morphological instruction as early as possible in children's educational curriculum, particularly once phonics are mastered.

For adults with DD, the literature on interventions in morphology is more limited. Only two published studies, to our knowledge, have demonstrated the benefits of morphological training in adults with DD. The first study, conducted by Bar-Kochva (2016), focused on Hebrew-speaking university students with DD. Hebrew has a highly transparent orthography and a rich morphological structure. The training consisted of two 25-minute sessions in the form of a lexical decision task. The results are interesting, as they show effects on certain reading tasks (text reading only) and spelling but not on reading comprehension. These findings are supported by the study by Gray et al. (2018), which compared two groups of adults with DD: one received

morpho-phonemic intervention, while the other underwent semantic training. Both groups showed similar improvements in trained-word performance (reading comprehension, reading, and spelling), but only the morphology-trained group exhibited generalization effects on reading.

Finally, in a morphological training study conducted with French-speaking university students with DD, results showed greater learning effects (in morphological awareness, reading fluency, and spelling) in the morphology group compared to the control group (Ardanouy et al., in prep). Regarding generalization, effects were observed on morphological awareness and affix spelling but not on base-word spelling or fluency in reading untrained words. These effects persisted over the long term. The results in adults thus appear promising but warrant further exploration, considering the interlinguistic differences of each language–such as orthographic consistency and morphological richness.

Active ingredients in the intervention

The content of the intervention is often a key question for clinicians. The goal of this part is to provide some guidelines for constructing a morphological intervention. First, in the general recommendations, an important element that seems crucial but is not exclusive to morphological interventions is that the intervention should be explicit (Martinez et al., 2024) and as intensive as possible (Wanzek et al., 2018). Additionally, Nunes et al. (2003) recommend using both oral and written modalities together, especially if the intervention aims to improve written skills. The literature tends to show that morphological interventions are more effective when integrated with other literacy instructions, such as phonological or orthographic knowledge (Kirby & Bowers, 2017).

Regarding more specific recommendations for morphological interventions, Reed (2008), in his narrative review, emphasized the importance of studying word roots, not just the affixes. It is therefore important to dedicate sessions focused on breaking words down into prefixes, roots, and suffixes in order to effectively distinguish between the different morphemes and understand how each component contribute to a word's meaning (Carlisle, 2000). It also seems beneficial to consistently pair these interventions with semantic explanations, since clearly defining the words used maximizes the intervention's effectiveness (Goodwin & Ahn, 2010). Activities should therefore target both the meaning and use of affixes, as well as words and base forms alone (Kirby & Bowers, 2017). These last authors add that it is interesting to present morphology as a problem to solve, so that children act like detectives in analyzing words into morphemes to increase their motivation. Another particularly important factor to consider when training in morphology is teaching children that when an affix (a prefix or a suffix) is added to a root to create a new word, this can result in orthographic and/or phonological changes to the root of the word (Kearns et al., 2016; Kirby & Bowers, 2017; Steacy et al., 2022). For example, in the word "*glorious*," the "y" in the base "*glory*" changes to an "i.". These morphological changes are particularly complex for children to master, making it essential to explicitly address them during instruction.

Here are some activities used in studies that have proven effective (Brady & Mason, 2024): word sorting tasks – where children must sort word cards with or without target affixes; decoding tasks – reading morphologically complex words; segmenting words into morphemes while associating the meaning of each morpheme (either orally or in writing); spelling morphologically complex words while explaining the spelling rules associated with the addition of an affix (e.g., run/runner). Kirby and Bowers (2017) further suggest that teaching morphological word families can be enhanced using word matrices, where a base word is presented at the center, and its possible prefixes and suffixes are mapped around it to form related words (Ng et al., 2022). To find examples of concrete interventions conducted with children with DD in orthographic systems of different consistencies, see, for example, the following papers: Ardanouy et al. (Ardanouy et al., 2024) for French; (Bar-Kochva et al., 2020) for Hebrew; (Mendes & Kirby, 2024) for English.

Conclusion

This paper highlights the importance of morphology in learning to read and spell for both typically developing children and those with DD. As emphasized by the psycholinguistic grain size theory, once grapheme-phoneme correspondences are mastered, larger linguistic units, such as morphemes, can be recruited to enhance reading and spelling accuracy and fluency, particularly in languages with the most opaque orthographies. Although morphological processing is generally expected in advanced readers and spellers, as well as in opaque orthographies, a substantial body of research shows that morphological processing also occurs early in literacy acquisition and in transparent orthographies. Moreover, although individuals with DD have impaired phonological awareness, their morphological awareness remains relatively preserved. As a result, it can support more fluent reading and more accurate spelling. Interventions in this area represent a promising approach for improving reading and spelling skills, regardless of whether individual have difficulties in this area.

Authorship declaration: Estelle Ardanouy y Pauline Quémart: Article conceptualization; Data collection; First draft writing; Methodology; Writing revision draft.

Article conceptualization: Data collection; First draft writing; Methodology; Writing revision draft.

References

Aghababian, V., & Nazir, T. A. (2000). Developing normal reading skills: Aspects of the visual processes underlying word recognition. *Journal of Experimental Child Psychology*, *76*(2), 123-150. https://doi.org/10.1006/jecp.1999.2540

Angelelli, P., Marinelli, C. V., & Burani, C. (2014). The effect of morphology on spelling and reading accuracy: A study on Italian children. *Frontiers in Psychology*, *Article 5*, 1373-1373.

Angelelli, P., Marinelli, C. V., De Salvatore, M., & Burani, C. (2017). Morpheme-based reading and spelling in Italian children with developmental dyslexia and dysorthography: Morpheme-based reading and spelling. *Dyslexia*, *23*(4), 387-405. https://doi.org/10.1002/dys.1554

Ardanouy, E., & Quémart, P. (under review). Spelling morphology and its relationship with morphological awareness in French-speaking adults with developmental dyslexia.

Ardanouy, E., Zesiger, P., & Delage, H. (2023). Intensive and explicit derivational morphology training in school-aged children: An effective way to improve morphological awareness, spelling and reading? *Reading and Writing*. https://doi.org/10.1007/s11145-023-10454-y

Ardanouy, E., Zesiger, P., & Delage, H. (2025). Derivational morphology training in French-speaking, 9- to 14- year-old children and adolescents with developmental dyslexia: Does it improve morphological awareness, reading and spelling outcome measures? *Journal of Learning Disabilities*, *58*(1), 62-77. https://doi.org/10.1177/00222194231223526

Ardanouy, E., Zesiger, P., & Delage, H. (in prep). Morphological intervention in French-speaking university adults with developmental dyslexia: Effects on morphological awareness, reading, and spelling.

Ballot, C., & Zesiger, P. (2024). Effects of word length and frequency on word identification in second- and fifth-grade children as a function of language skills. *Journal of Experimental Child Psychology*, *243*, 105912. https://doi.org/10.1016/j.jecp.2024.105912

Bar-Kochva, I. (2016). An examination of an intervention program designed to enhance reading and spelling through the training of morphological decomposition in word recognition. *Scientific Studies of Reading*, *20*(2), 163-172. https://doi.org/10.1080/10888438.2015.1108321

Bar-Kochva, I., Korinth, S. P., & Hasselhorn, M. (2020). Effects of a morpheme-based training procedure on the literacy skills of readers with a reading disability. *Applied Psycholinguistics*, *41*(5), 1061-1082. https://doi.org/10.1017/S0142716420000120

Berthiaume, R., & Daigle, D. (2014). Are dyslexic children sensitive to the morphological structure of words when they read? The case of dyslexic readers of French: Are dyslexic children sensitive to the morphological structure of words when they read? *Dyslexia*, *20*(3), 241-260. https://doi.org/10.1002/dys.1476

Beyersmann, E., Mousikou, P., Schroeder, S., Javourey-Drevet, L., Ziegler, J. C., & Grainger, J. (2021). The dynamics of morphological processing in developing readers: A cross-linguistic masked priming study. *Journal of Experimental Child Psychology*, *208*, 105140. https://doi.org/10.1016/j.jecp.2021.105140

Bourassa, D. C., Bargen, M., Delmonte, M., & Deacon, S. H. (2019). Staying rooted: Spelling performance in children with dyslexia. *Applied Psycholinguistics*, *40*(2), 427-444. https://doi.org/10.1017/S0142716418000632

Bourassa, D. C., & Treiman, R. (2008). Morphological constancy in spelling: A comparison of children with dyslexia and typically developing children. *Dyslexia*, *14*(3), 155-169. https://doi.org/10.1002/dys.368

Bourassa, D. C., Treiman, R., & Kessler, B. (2006). Use of morphology in spelling by children with dyslexia and typically developing children. *Memory & Cognition*, *34*(3), 703-714. https://doi.org/10.3758/BF03193589

Bowers, P. N., Kirby, J. R., & Deacon, S. H. (2010). The effects of morphological instruction on literacy skills: A systematic review of the literature. *Review of Educational Research*, *80*(2), 144-179. https://doi.org/10.3102/0034654309359353

Brady, S., & Mason, L. H. (2024). A literature review of morphological awareness interventions and the effects on literacy outcomes. *Learning Disability Quarterly*, *47*(1), 16-29. https://doi.org/10.1177/07319487231171388

Breadmore, H. L., & Deacon, S. H. (2019). Morphological processing before and during children's spelling. *Scientific Studies of Reading*, *23*(2), 178-191. https://doi.org/10.1080/10888438.2018.1499745

Burani, C. (2009). Reading fluency and morpho-lexical processing: Developmental studies in Italian. *Revista de Logopedia, Foniatría y Audiología*, *29*(2), 97-103. https://doi.org/10.1016/S0214-4603(09)70147-0

Burani, C., Marcolini, S., & Stella, G. (2002). How early does morpholexical reading develop in readers of a shallow orthography? *Brain and Language*, *81*(1), 568-586. https://doi.org/10.1006/brln.2001.2548

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic awareness and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology*, *81*(3), 313-321. https://doi.org/10.1037/0022-0663.81.3.313

Caravolas, M. (2006). Learning to spell in different languages : How orthographic variables might affect early literacy. In R. M. Joshi & P. G. Aaron (Éds.), *Handbook of Orthography and Literacy* (p. 497-511). Lawrence Erlbaum Associates.

Caravolas, M., Lervåg, A., Defior, S., Seidlová Málková, G., & Hulme, C. (2013). Different patterns, but equivalent predictors of growth in reading in consistent and inconsistent orthographies. *Psychological Science*, *24*(8), 1398-1407. https://doi.org/10.1177/0956797612473122

Carlisle, J. F. (2000). Awareness of the structure and meaning of morphologically complex words : Impact on reading. *Reading and Writing*, *12* (3-4), 169-190. https://doi.org/10.1007/s11145-005-5766-2

Carlisle, J. F., & Katz, L. (2006). Effects of word and morpheme familiarity on reading of derived words. *Reading and Writing*, *19*(7), 669-693.

Carlisle, J. F., & Stone, C. A. (2003). The effects of morphological structure on children's reading of derived words in English. In E. Assink & D. Sandra (Éds.), *Reading Complex Words : Cross-Language Studies* (p. 27-52). Kluwer Academic.

Carlisle, J. F., & Stone, C. A. (2005). Exploring the role of morphemes in word reading. *Reading Research Quarterly*, *40*(4), 428-449. https://doi.org/10.1598/RRQ.40.4.3

Carlisle, J. F., Stone, C., & Katz, L. (2001). The effects of phonological transparency on reading derived words. *Annals of Dyslexia*, *51*(1), 249-274. https://doi.org/10.1007/s11881-001-0013-2

Carroll, J. M., Holden, C., Kirby, P., Thompson, P. A., Snowling, M. J., & Panel, the D. D. (2025). Toward a consensus on dyslexia: Findings from a Delphi study. *Journal of Child Psychology and Psychiatry*. https://doi.org/10.1111/jcpp.14123

Casalis, S., & Colé, P. (2009). On the relationship between morphological and phonological awareness: Effects of training in kindergarten and in first-grade reading. *First Language*, *29*(1), 113-142. https://doi.org/10.1177/0142723708097484

Casalis, S., Colé, P., & Sopo, D. (2004). Morphological awareness in developmental dyslexia. *Annals of Dyslexia*, *54*(1), 114-138. https://doi.org/10.1007/s11881-004-0006-z

Casalis, S., Pacton, S., Lefevre, F., & Fayol, M. (2018). Morphological training in spelling: Immediate and long-term effects of an interventional study in French third graders. *Learning and Instruction*, *53*, 89-98. https://doi.org/10.1016/j.learninstruc.2017.07.009

Casalis, S., Quémart, P., & Duncan, L. G. (2015). How language affects children's use of derivational morphology in visual word and pseudoword processing: Evidence from a cross-language study. *Frontiers in Psychology*, *6*, Article 752. https://doi.org/10.3389/fpsyg.2015.00452

Catts, H. W., Terry, N. P., Lonigan, C. J., Compton, D. L., Wagner, R. K., Steacy, L. M., Farquharson, K., & Petscher, Y. (2024). Revisiting the definition of dyslexia. *Annals of Dyslexia*, *74*(3), 282-302. https://doi.org/10.1007/s11881-023-00295-3

Cavalli, E., Duncan, L. G., Elbro, C., El Ahmadi, A., & Colé, P. (2017). Phonemic–Morphemic dissociation in university students with dyslexia: An index of reading compensation? *Annals of Dyslexia*, *67*(1), 63-84. https://doi.org/10.1007/s11881-016-0138-y

Colé, P., Bouton, S., Leuwers, C., Casalis, S., & Sprenger-Charolles, L. (2012). Stem and derivational-suffix processing during reading by French second and third graders. *Applied Psycholinguistics*, *33*(01), 97-120. https://doi.org/10.1017/S0142716411000282

Colenbrander, D., von Hagen, A., Kohnen, S., Wegener, S., Ko, K., Beyersmann, E., Behzadnia, A., Parrila, R., & Castles, A. (2024). The effects of morphological instruction on literacy outcomes for children in English-speaking countries : A systematic review and meta-analysis. *Educational Psychology Review*, *36*(4), Article 119. https://doi.org/10.1007/s10648-024-09953-3

Commissaire, E., Besse, A.-S., Demont, E., & Casalis, S. (2018). Grapheme coding during sublexical processing in French third and fifth graders. *Journal of Experimental Child Psychology*, *173*, 78-84. https://doi.org/10.1016/j.jecp.2018.03.006

Crystal, D. (2003). *The Cambridge encyclopedia of the English language* (2nd ed.). Cambridge University Press.

Cuetos, F., & Suárez-Coalla, P. (2009). From grapheme to word in reading acquisition in Spanish. *Applied Psycholinguistics*, *30*(4), 583-601. https://doi.org/10.1017/S0142716409990038

D'Alessio, M. J., Jaichenco, V., & Wilson, M. A. (2018). The role of morphology in word naming in Spanish-speaking children. *Applied Psycholinguistics*, *39*(5), 1065-1093.

Deacon, S. H., & Bryant, P. (2005). What young children do and do not know about the spelling of inflections and derivations. *Developmental Science*, *8*(6), 583-594. https://doi.org/10.1111/j.1467-7687.2005.00449.x

Deacon, S. H., & Bryant, P. (2006a). Getting to the root : Young writers' sensitivity to the role of root morphemes in the spelling of inflected and derived words. *Journal of Child Language*, *33*(2), 401-417. doi: 10.1017/s0305000906007409.

Deacon, S. H., & Bryant, P. (2006b). This turnip's not for turning: Children's morphological awareness and their use of root morphemes in spelling. *British Journal of Developmental Psychology*, *24*(3), 567-575. https://doi.org/10.1348/026151005X50834

Deacon, S. H., & Dhooge, S. (2010). Developmental stability and changes in the impact of root consistency on children's spelling. *Reading and Writing*, *23*(9), 1055-1069. https://doi.org/10.1007/s11145-009-9195-5

Deacon, S. H., Parrila, R., & Kirby, J. R. (2008). A review of the evidence on morphological processing in dyslexics and poor readers: A strength or weakness? In *The SAGE Handbook of Dyslexia* (p. 212-238). SAGE Publications Ltd. https://doi.org/10.4135/9780857020987

Defior, S., Alegría, J., Titos, R., & Martos, F. (2008). Using morphology when spelling in a shallow orthographic system: The case of Spanish. *Cognitive Development*, *23*(1), 204-215. https://doi.org/10.1016/j.cogdev.2007.01.003

Desrochers, A., Manolitsis, G., Gaudreau, P., & Georgiou, G. K. (2018). Early contribution of morphological awareness to literacy skills across languages varying in orthographic consistency. *Reading and Writing*, *31*(8), 1695-1719.

Diamanti, V., Mouzaki, A., Ralli, A., Antoniou, F., Papaioannou, S., & Protopapas, A. (2017). Preschool phonological and morphological awareness as longitudinal predictors of early reading and spelling development in Greek. *Frontiers in Psychology*, *8*, 2039. doi: 10.3389/fpsyg.2017.02039

Duncan, L. G., Casalis, S., & Colé, P. (2009). Early meta-linguistic awareness of derivational morphology: Some observations from a comparison of English and French. *Applied Psycholinguistics*, *30*, 405-440. doi: https://doi.org/10.1017/S0142716409090213

Elbro, C., & Arnbak, E. (1996). The role of morpheme recognition and morphological awareness in dyslexia. *Annals of Dyslexia*, *46*, 31-31. doi: 10.1007/BF02648177.

Galuschka, K., Görgen, R., Kalmar, J., Haberstroh, S., Schmalz, X., & Schulte-Körne, G. (2020). Effectiveness of spelling interventions for learners with dyslexia: A meta-analysis and systematic review. *Educational Psychologist*, *55*(1), 1-20. https://doi.org/10.1080/00461520.2019.1659794

Georgiou, G. K., Vieira, A. P. A., Rothou, K. M., Kirby, J. R., Antoniuk, A., Martinez, D., & Guo, K. (2022). A meta-analysis of morphological awareness deficits in developmental dyslexia. *Scientific Studies of Reading*, 1-19. https://doi.org/10.1080/10888438.2022.2155524

Gerber, P. J. (2012). The impact of learning disabilities on adulthood : A review of the evidenced-based literature for research and practice in adult education. *Journal of Learning Disabilities*, *45*(1), 31-46. https://doi.org/10.1177/0022219411426858

Giazitzidou, S., & Padeliadu, S. (2022). Contribution of morphological awareness to reading fluency of children with and without dyslexia: Evidence from a transparent orthography. *Annals of Dyslexia*, *72*(3), 509-531. https://doi.org/10.1007/s11881-022-00267-z

Gingras, M., & Sénéchal, M. (2017). Silex: A database for silent-letter endings in French words. *Behavior Research Methods*, *49*(5), 1894-1904. https://doi.org/10.3758/s13428-016-0832-z

Goodwin, A. P., & Ahn, S. (2010). A meta-analysis of morphological interventions: Effects on literacy achievement of children with literacy difficulties. *Annals of Dyslexia*, *60*(2), 183-208. https://doi.org/10.1007/s11881-010-0041-x

Goodwin, A. P., & Ahn, S. (2013). A meta-analysis of morphological interventions in English : Effects on literacy outcomes for school-age children. *Scientific Studies of Reading*, *17*(4), 257-285. https://doi.org/10.1080/10888438.2012.689791

Gray, S. H., Ehri, L. C., & Locke, J. L. (2018). Morpho-phonemic analysis boosts word reading for adult struggling readers. *Reading and Writing*, *31*(1), 75-98. https://doi.org/10.1007/s11145-017-9774-9

Grigorakis, I., & Manolitsis, G. (2021). Longitudinal effects of different aspects of morphological awareness skills on early spelling development. *Reading and Writing*, *34*(4), 945-979. https://doi.org/10.1007/s11145-020-10098-2

Horn, L. J., & Berktold, J. (1999). Students with disabilities in postsecondary education : A profile of preparation, participation, and outcomes. *Education Statistics Quarterly*. Retrieved from https://www.semanticscholar.org/paper/Students-with-Disabilities-in-Postsecondary-A-of-Horn-Berktold/5f45359dfc97b76a4d06a3b32fd73b0d69bb7caa

Kearns, D. M., Steacy, L. M., Compton, D. L., Gilbert, J. K., Goodwin, A. P., Cho, E., Lindstrom, E. R., & Collins, A. A. (2016). Modeling polymorphemic word recognition: Exploring differences among children with early-emerging and late-emerging word reading difficulty. *Journal of Learning Disabilities*, *49*(4), 368-394. https://doi.org/10.1177/0022219414554229

Kemp, N. (2006). Children's spelling of base, inflected, and derived words: Links with morphological awareness. *Reading and Writing*, *19*(7), 737-765. https://doi.org/10.1007/s11145-006-9001-6

Kirby, J. R., & Bowers, P. N. (2017). Morphological instruction and literacy: Binding phonological, orthographic, and semantic features of words. In K. Cain, D. L. Compton, & R. Parrila (Eds.), *Theories of Reading Development* (p. 437-462). John Benjamins Publishing Company. https://doi.org/10.1075/swll.15.24kir

Law, J. M., & Ghesquière, P. (2022). Morphological processing in children with developmental dyslexia: A visual masked priming study. *Reading Research Quarterly*, *57*(3), 863-877. https://doi.org/10.1002/rrq.450

Law, J. M., Veispak, A., Vanderauwera, J., & Ghesquière, P. (2018). Morphological awareness and visual processing of derivational morphology in high-functioning adults with dyslexia: An avenue to compensation? *Applied Psycholinguistics*, *39*(3), 483-506. https://doi.org/10.1017/S0142716417000467

Law, J. M., Wouters, J., & Ghesquière, P. (2015). Morphological awareness and its role in compensation in adults with dyslexia. *Dyslexia*, *21*(3), 254-272. https://doi.org/10.1002/dys.1495

Lázaro, M. (2012). A study of base frequency in Spanish skilled and reading-disabled children: all children benefit from morphological processing in defining complex pseudowords. *Dyslexia*, *18*(2), 130–138. https://doi.org/10.1002/dys.1436

Lázaro, M., Camacho, L., & Burani, C. (2013). Morphological processing in reading disabled and skilled Spanish children. *Dyslexia*, *19*(3), 178–188. doi: 10.1002/dys.1458

Laxon, V., Rickard, M., & Coltheart, V. (1992). Children read affixed words and non-words. *British Journal of Psychology*, *83*(3), 407-423. https://doi.org/10.1111/j.2044-8295.1992.tb02450.x

Lee, J. won, Wolters, A., & Grace Kim, Y.-S. (2022). The relations of morphological awareness with language and literacy skills vary depending on orthographic depth and nature of morphological awareness. *Review of Educational Research*, *93*(4), 528-558. https://doi.org/10.3102/00346543221123816

Lefèvre, E., Law, J. M., Quémart, P., Anders, R., & Cavalli, E. (2022). What's morphology got to do with it : Oral reading fluency in adolescents with dyslexia. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *49*(8), 1345-1360. https://doi.org/10.1037/xlm0001163

Lehtonen, M., & Laine, M. (2003). How word frequency affects morphological processing in monolinguals and bilinguals. *Bilingualism: Language and Cognition*, *6*(3), 213-225. https://doi.org/10.1017/S1366728903001147

Livingston, L. A., & Happé, F. (2017). Conceptualising compensation in neurodevelopmental disorders : Reflections from autism spectrum disorder. *Neuroscience & Biobehavioral Reviews*, *80*, 729-742. https://doi.org/10.1016/j.neubiorev.2017.06.005

Mahrer, R. (2017). *Phonographie : La représentation écrite de l'oral en français* (Vol. 3). Walter de Gruyter GmbH & Co KG.

Manolitsis, G., Grigorakis, I., & Georgiou, G. K. (2017). The longitudinal contribution of early morphological awareness skills to reading fluency and comprehension in Greek. *Frontiers in Psychology*, *8*, Article 1793. doi: 10.3389/fpsyg.2017.01793

Marec-Breton, N., Gombert, J.-E., & Colé, P. (2005). Traitements morphologiques lors de la reconnaissance des mots écrits chez les apprentis lecteurs. *L'Année Psychologique*, *105*, 9-45. https://doi.org/10.3406/psy.2005.3818

Marinelli, C. V., Romani, C., Burani, C., & Zoccolotti, P. (2015). Spelling acquisition in English and Italian : A cross-linguistic study. *Frontiers in Psychology*, *6*, Article 1843. https://doi.org/10.3389/fpsyg.2015.01843

Martin, J., Frauenfelder, U. H., & Colé, P. (2014). Morphological awareness in dyslexic university students. *Applied Psycholinguistics*, *35*(6), 1213-1233. https://doi.org/10.1017/S0142716413000167

Martinez, D., Colenbrander, D., Inoue, T., Falcón, A., Rubí, R., Parrila, R., & Georgiou, G. K. (2024). The effects of explicit morphological analysis instruction in early elementary Spanish speakers. *Journal of Experimental Child Psychology*, *246*, 106004. https://doi.org/10.1016/j.jecp.2024.106004

Melby-Lervåg, M., Lyster, S.-A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read : A meta-Analytic Review. *Psychological Bulletin*, *138*(2), 322-352. https://doi.org/10.1037/a0026744

Mendes, B. B., & Kirby, J. R. (2024). The effects of a morphological awareness intervention on reading and spelling ability of children with dyslexia. *Learning Disability Quarterly*, *47*(4), 222-233. https://doi.org/10.1177/07319487241259775

Míguez-Álvarez, C., Cuevas-Alonso, M., & Saavedra, Á. (2022). Relationships between phonological awareness and reading in Spanish : A meta-analysis. *Language Learning*, *72*(1), 113-157. https://doi.org/10.1111/lang.12471

Mousikou, P., Beyersmann, E., Ktori, M., Javourey-Drevet, L., Crepaldi, D., Ziegler, J. C., Grainger, J., & Schroeder, S. (2020). Orthographic consistency influences morphological processing in reading aloud : Evidence from a cross-linguistic study. *Developmental Science*, *23*(6), e12952. https://doi.org/10.1111/desc.12952

Ng, M. M. R., Bowers, P. N., & Bowers, J. S. (2022). A promising new tool for literacy instruction: The morphological matrix. *PLoS ONE*, *17*(1), Article e0262260. https://doi.org/10.1371/journal.pone.0262260

Nunes, T., Bryant, P., & Olsson, J. (2003). Learning morphological and phonological spelling rules: An intervention study. *Scientific Studies of Reading*, *7*(3), 289-307. https://doi.org/10.1207/S1532799XSSR0703_6

Pacton, S., & Casalis, S. (2006). L'utilisation d'informations morphologiques en orthographe rend-elle le cauchemar(d?) des lettres muettes moins cauchemardesque ? *Rééducation orthophonique*, *225*, 129-144.

Pacton, S., Foulin, J.-N., Casalis, S., & Treiman, R. (2013). Children benefit from morphological relatedness when they learn to spell new words. *Frontiers in Psychology*, *4*. 1-7. https://doi.org/10.3389/fpsyg.2013.00696

Pacton, S., Jaco, A. A., Nys, M., Foulin, J. N., Treiman, R., & Peereman, R. (2018). Children benefit from morphological relatedness independently of orthographic relatedness when they learn to spell new words. *Journal of Experimental Child Psychology*, *171*, 71-83. doi: 10.1016/j.jecp.2018.02.003

Pacton, S., & Peereman, R. (2023). Morphology as an aid in orthographic learning of new words : The influence of inflected and derived forms in spelling acquisition. *Journal of Experimental Child Psychology*, *232*, 105675. https://doi.org/10.1016/j.jecp.2023.105675

Quémart, P., & Casalis, S. (2015). Visual processing of derivational morphology in children with developmental dyslexia : Insights from masked priming. *Applied Psycholinguistics*, *36*(2), 345-376. https://doi.org/10.1017/S014271641300026X

Quémart, P., & Casalis, S. (2017). Morphology and spelling in French students with dyslexia : The case of silent final letters. *Annals of Dyslexia*, *67*(1), 85-98. https://doi.org/10.1007/s11881-016-0133-3

Quémart, P., Casalis, S., & Duncan, L. G. (2012). Exploring the role of bases and suffixes when reading familiar and unfamiliar words : Evidence from French young readers. *Scientific Studies of Reading*, *16*(5), 424-442. https://doi.org/10.1080/10888438.2011.584333

Quémart, P., & Lambert, E. (2019). The influence of the morphological structure of words on the dynamics of handwriting in adults and fourth and sixth grade children. *Reading and Writing*, *32*(1), 175-195. https://doi.org/10.1007/s11145-017-9762-0

Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia : A review. *Reading Research Quarterly*, *27*, 29-53.

Reed, D. K. (2008). A synthesis of morphology interventions and effects on reading outcomes for students in grades K–12. *Learning Disabilities Research & Practice*, *23*(1), 36-49. https://doi.org/10.1111/j.1540-5826.2007.00261.x

Sangster, L., & Deacon, S. H. (2011). Development in children's sensitivity to the role of derivations in spelling. *Canadian Journal of Experimental Psychology*, *65*(2), 133-139. doi: 10.1037/a0018569.

Sénéchal, M. (2000). Morphological effects in children's spelling of French words. *Canadian Journal of Experimental Psychology*, *54*, 76-86. doi: 10.1037/h0087331.

Sénéchal, M., Basque, M. T., & Leclaire, T. (2006). Morphological knowledge as revealed in children's spelling accuracy and reports of spelling strategies. *Journal of Experimental Child Psychology*, *95*, 231-254. doi: 10.1016/j.jecp.2006.05.003.

Seymour, P. H. K., & Duncan, L. G. (1997). Small versus large unit theories of reading acquisition. *Dyslexia*, *3*, 125-134. https://doi.org/10.1002/(SICI)1099-0909(199709)

Share, D. L. (1995). Phonological recoding and self-teaching : Sine qua non of reading acquisition. *Cognition*, *55*, 151-218. doi: 10.1016/0010-0277(94)00645-2.

Snowling, M. (1998). Dyslexia as a phonological deficit : Evidence and implications. *Child Psychology and Psychiatry Review*, *3*(1), 4-11. https://doi.org/10.1111/1475-3588.00201

Steacy, L. M., Rigobon, V. M., Edwards, A. A., Abes, D. R., Marencin, N. C., Smith, K., Elliott, J. D., Wade-Woolley, L., & Compton, D. L. (2022). Modeling complex word reading: Examining influences at the level of the

word and child on mono- and polymorphemic word reading. *Scientific Studies of Reading*, *26*(6), 527-544. https://doi.org/10.1080/10888438.2022.2077109

Suárez-Coalla, P., & Cuetos, F. (2013). The role of morphology in reading in spanish-speaking children with dyslexia. *The Spanish Journal of Psychology*, *16*, E51. https://doi.org/10.1017/sjp.2013.58

Suárez-Coalla, P., Martínez-García, C., & Cuetos, F. (2017). Morpheme-based reading and writing in Spanish children with dyslexia. *Frontiers in Psychology*, *8*, Article 1952. https://doi.org/10.3389/fpsyg.2017.01952

Suggate, S. P. (2016). A meta-analysis of the long-term effects of phonemic awareness, phonics, fluency, and reading comprehension interventions. *Journal of Learning Disabilities*, *49*(1), 77-96. https://doi.org/10.1177/0022219414528540

Tiffin-Richards, S. P., & Schroeder, S. (2015). Word length and frequency effects on children's eye movements during silent reading. *Vision Research*, *113*(Pt A), 33-43. https://doi.org/10.1016/j.visres.2015.05.008

Traficante, D. (2012). From graphemes to morphemes: An alternative way to improve skills in children with dyslexia. *Revista de Investigación En Logopedia*, *2*(2), 163–185.

Traficante, D., Marcolini, S., Luci, A., Zoccolotti, P., & Burani, C. (2011). How do roots and suffixes influence reading of pseudowords: A study of young Italian readers with and without dyslexia. *Language and cognitive processes*, *26*(4-6), 777-793. https://doi.org/10.1080/01690965.2010.496553

Treiman, R., & Kessler, B. (2014). *How children learn to spell words*. Oxford University Press.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, *101*(2), 192-212. https://doi.org/10.1037/0033-2909.101.2.192

Wanzek, J., Stevens, E. A., Williams, K. J., Scammacca, N., Vaughn, S., & Sargent, K. (2018). Current Evidence on the Effects of Intensive Early Reading Interventions. *Journal of Learning Disabilities*, *51*(6), 612-624. https://doi.org/10.1177/0022219418775110

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, *131*(1), 3-29. https://doi.org/10.1037/0033-2909.131.1.3