



HAL
open science

Morphology as an aid in orthographic learning of new words: The influence of inflected and derived forms in spelling acquisition

Sébastien Pacton, Ronald Peereman

► **To cite this version:**

Sébastien Pacton, Ronald Peereman. 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*, 2023, 232, pp.105675. 10.1016/j.jecp.2023.105675 . hal-04083781

HAL Id: hal-04083781

<https://hal.science/hal-04083781>

Submitted on 13 Nov 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Morphology as an aid in orthographic learning of new words:
The influence of inflected and derived forms in spelling acquisition

Sébastien Pacton¹ & Ronald Peereman²

1. Memory and Cognition Lab, Institute of Psychology, University of Sorbonne Paris Cité, 92100 Boulogne-Billancourt, France
2. University of Grenoble Alpes, University of Savoie Mont Blanc, Centre National de la Recherche Scientifique (CNRS), Laboratoire de Psychologie et Neurocognition (LPNC), 38000 Grenoble, France

Abstract

Prior studies have shown that children are sensitive to the principle of root consistency whereby root morphemes retain their spelling across related words. The current study used an implicit learning situation to examine, in 56 third and 56 fifth French graders, whether orthographic learning of new morphologically simple words ending in a silent letter benefited from morphological relatedness with inflected and derived forms. Two conditions were contrasted. In the morphological condition, the new words (e.g., *clirot*, with a final silent *t*) appeared in short stories along with a morphologically related form in which the silent letter of the root was pronounced, justifying the presence of the silent letter in the root word. The morphologically complex form was an inflectional form (e.g., *clirote*) for half of the children, and a derived form (e.g., *clirotage*) for the other half. In the non-morphological condition, the new words were not accompanied by morphologically related forms. After children had read the stories, their orthographic learning was assessed by asking them to choose the correct spelling of each nonword from among three phonologically plausible alternatives (e.g., *clirot*, *cliros*, and *cliro*). Children chose correct spellings more often in the morphological condition than in the non-morphological condition for both types of morphology in Grade 5, but only for inflectional morphology in Grade 3. Our findings indicate that, in learning new spellings, French children seem to rely on the root consistency principle earlier for inflectional than for derivational morphology. Possible reasons for this developmental delay in mastering derivational morphology are discussed.

Keywords

Morphology, Inflected, Derived, Root consistency, Implicit learning, Spelling, Orthographic learning

In writing systems such as English and French, many words can be spelled in more than one way (Hanna et al., 1966, for English; Peereman et al., 2007; Sénéchal et al., 2015, for French). Because these writing systems represent information about both phonemes, the minimal units of sound in language, and morphemes, the minimal units of meaning, sensitivity to the morphemic structure of words can help in choosing between alternative spellings. Many studies have investigated how children learn to appreciate various types of morphological information (e.g., Deacon et al., 2008; Pacton & Deacon, 2008; Pollo et al., 2007; Sénéchal & Kearnan, 2007). Most of them asked children to spell letter sequences in real words in order to investigate whether morphological knowledge was helpful or not (e.g., Deacon & Bryant, 2006; Treiman et al., 1994). A few other studies have used nonword items to assess whether children benefit from morphological relatedness when they learn to spell new words (Pacton et al., 2013; 2018; Tucker et al., 2016). For example, Pacton et al. (2018) assessed 8-to 11-year old children's orthographic learning of French monomorphemic nonwords containing a final sound that can be spelled in more than one way (e.g., /kwaRaR/ spelled coirard with a final silent -d). In one condition, monomorphemic nonwords were accompanied by morphologically related nonwords that disambiguated the spelling of the final sound of the monomorphemic nonwords (e.g., the final silent -d of coirard pronounced in the gender-inflected form coirarde /kwaRaRd/). Orthographic learning was better in this condition than when monomorphemic nonwords were not accompanied by morphologically related nonwords. However, unlike several studies contrasting inflected and derived forms in the use of the root consistency principle (e.g., Deacon & Dhooge, 2010; Treiman et al., 1994), the studies by Pacton et al. (2013, 2018) did not manipulate the type of morphologically related words. The aim of the current study therefore was to investigate whether French children in Grades 3 and 5 benefit similarly from related inflected and derived forms when

they learn to spell new words in a self-teaching situation similar to the one used by Pacton et al. (2013, 2018).

Words are composed of morphemes, both free and bound. Free morphemes can stand alone whereas bound morphemes are attached to a root. Prefixes are added to the beginning of words and suffixes are added to the end of words. Suffixes are of two types: inflectional or derivational. Inflectional suffixes have a grammatical function in that they modify certain characteristics of an existing word, such as number, gender or tense. Derivational suffixes enable new words (lexemes) to be created from an existing word, such as *musical* or *musician* from the root word *music*. Hence, whereas inflections preserve lexical meaning and the grammatical class of the word, derivations introduce semantic changes and can modify the grammatical class. Combining a root and a suffix can change the pronunciation of the root morpheme but, with a few exceptions, the spelling of the root morpheme is preserved in morphologically related words (e.g., *electric – electricity*, *heal – health*). Reliance on the principle of root consistency can help spell *health* with *ea* as in *heal*, rather than with *e* as in *bed*, and *musician* with a *c* as in *music*, rather than with a *t* as in *nation*.

Referring to the root morpheme to spell inflected and derived forms

Treiman et al. (1994) examined how children wrote the flap, a sound often spelled *-t* but pronounced more like /d/ than /t/ in American English, in the word-medial position in two- and one-morpheme words, such as *dirty* and *duty*, respectively. The spelling of this sound can be determined by referring to the roots in two-morpheme words (e.g., *dirt* in *dirty*), unlike in one-morpheme words for which no such roots exist. The two-morpheme words included both derived and inflected forms (e.g., *dirty* and *cuter*). Treiman et al. found that 5- to 8-year-old children were more likely to use the correct letter to spell the medial flap of inflected and

derived two-morpheme words (e.g., *-t* in *cuter* and *dirty*) than they were for one-morpheme words (e.g., *-t* in *duty*, see Rubin, 1988, and Treiman & Cassar, 1996 for similar results with inflected forms only). Furthermore, there was no difference in performance between inflected and derived forms. Although the size of the morphological effect increased with grade level, across all grade levels, children were less accurate in spelling the word-medial flap in the inflected and derived items than in the root words (e.g., *-t* was better spelled in *dirt* than in *dirty*), indicating that children did not take maximum advantage of the principle of root consistency (see also Kemp, 2006, Experiment 1).

Kemp (2006, Experiment 2) asked 7- to 9-year-old children to spell inflected nonwords such as *meases* and derived nonwords such as *kaisy*, after having read a sentence including either the morphologically complex nonword itself (e.g., *meases* or *kaisy*) or the base nonword (e.g., *mease* or *kaise*). Children were just as likely to use the spelling of the root in both conditions, and to the same extent for inflected and derived forms. However, providing children with the spelling of the base, either alone or embedded within two-morpheme nonwords, may explain the high accuracy rates (approximately 85%), the lack of difference between the two conditions, and the lack of difference between inflected and derived forms.

Two studies involving 6- to-8-year-old children (Deacon & Bryant, 2006) and 7- to-9-year-old children (Deacon, 2008) compared how children spelled the same initial letter-sound sequence in two-morpheme words and in one-morpheme control words. The initial letter-sound sequence corresponded to the base morpheme of derived words (e.g., *free* in *freely*) or to the base morpheme of inflected words (e.g., *rock* in *rocked*). One-morpheme control words and two-morpheme words were matched on the initial letter-sound sequence (e.g., *freeze* for *freely* and *rocket* for *rocked*). In both studies, accuracy for the initial letter-sound sequence was higher for two-morpheme forms than for one-morpheme forms, suggesting that children

are sensitive to the role of roots in spelling. Whereas the size of the morphemic effect was similar for inflected and derived words in Deacon and Bryant's (2006) study, it was greater for the inflected than for the derived words in Deacon's (2008) study.

Importantly, however, an effect of similar size was observed between the matched one-morpheme control of the derived words and the matched one-morpheme control of the inflected words. This highlights the importance of matching inflected words, derived words, and one-morpheme control words on the initial letter sequences (e.g., *rock*, *rocks*, *rocky* and *rocket*). Under these conditions, the impact of root consistency on spelling was identical for inflected and derived forms (Deacon & Dhooge, 2010; Deacon et al., 2014). In Deacon and Dhooge (2010), children in Grades 2 to 4 were more accurate in spelling inflected and derived forms than one-morpheme control items, they were just as accurate in spelling inflected as derived forms, and they were as likely to use the same (correct or incorrect) spelling for the base word and its inflected form as for the base word and its derived form.

To sum up, in most of the studies reviewed in this section, children relied on the principle of root consistency to spell the root of morphologically complex words to the same extent for inflected and derived forms. Deacon's (2008) study, in which the morphological benefit was greater for inflected than for derived forms, appears to be an exception. All the studies reviewed so far focused on whether children refer to the root morpheme to spell inflected or derived words. The influence of morphological relatedness can also be considered in the opposite direction by examining whether the spelling of morphologically simple words benefits from the existence of morphologically related words.

Referring to inflected and/or derived forms to spell morphologically simple words

In French, many words end with a silent letter that is motivated by morphology. Taking into account how the root morpheme is pronounced in inflected or derived forms can help to determine whether the one-morpheme word ends with a silent letter and, if so, which letter. For example, the masculine noun/adjective *bavard* (/bavaR/ ‘a talkative man’) has a final silent *-d*. The feminine noun/adjective *bavarde* (/bavaRd/ ‘a talkative woman’) and the verb *bavarder* (/bavaRde/ ‘to chat’) guide spellers to use a silent *-d* at the end of *bavard*¹. The prevalence of these cases is confirmed by an analysis conducted on the Manulex-Morpho database, which describes the morphological characteristics of the written vocabulary encountered by French elementary school children (Peereman et al., 2013). Among the 5,716 nouns and adjectives of Manulex-Morpho, 890 include a final silent letter that is neither a gender inflection, such as the *e* at the end of *amie* (/ami/ ‘female friend’), nor a plural inflection, such as the *s* at the end of *amis* (/ami/ ‘friends’). These 890 forms can be divided into three categories: 539 words (60.6%) ending with a silent consonant that is morphologically motivated, as in *bavard*; 193 words (21.7%) ending with a silent consonant that is not morphologically motivated, as in *foulard* (/fulaR/ ‘scarf’), which have no morphologically related word; and 158 words (17.8%) ending with a silent *-e*, as in *magie* (/mazi/ ‘magic’).

¹ Although the principle of root consistency works well most of the time, some words do not adhere to this principle. For example, the French noun *numéro* (/nymero/ ‘a number’) does not include a final silent consonant even though the French verb *numéroter* (/numerote/, to number) suggests the presence of a silent *-t*.

Sénéchal (2000) asked 7- and 9-year-old French-speaking children to spell three types of non-suffixed words with a final silent consonant. The first two types, called morphological words, have at least one morphologically related form that indicates how to spell the word-final silent consonant (e.g., *bavard*). Interestingly, Sénéchal distinguished two subcategories of morphological words: feminine and nominal. Words in the feminine category have at least one gender-inflected form (e.g., *bavard* and the feminine *bavarde*) in the morphological family whereas words in the nominal category have only derived words (e.g., *retard* (/RɛtɑR/ ‘a delay’) and the verb *retarder* (/RɛtɑRde/ ‘to delay’)). The third type of words does not have a related word (e.g., *jument* /ʒymɑ̃/ ‘mare’). Sénéchal found that children made more mistakes on this last type of word than on the morphological words, suggesting that children referred to related words in determining the spelling of the silent endings (see also Sénéchal et al., 2006). In addition, there were more accurate spellings for the morphological words whose final silent consonant can be revealed by a feminine form than for the morphological words that do not have a feminine form. The stronger effect of morphological relatedness for inflected forms than for derived forms should nevertheless be treated with caution for at least two reasons. First, the silent letters were not matched across the three word sets and there is clear evidence that spelling performance is impacted by certain properties of silent letters, such as their frequency of occurrence (Gingras & Sénéchal, 2019 Pacton et al., 2019; Sénéchal et al., 2015). Second, it cannot be excluded that the differences found between the two types of root words (feminine and nominal) originate from differences in the frequency of occurrence of the root, which is partially determined by the size of the morphological family.

In the context of studies that involve real words, it is clearly impossible to control for all variables that could account for the above-mentioned differences. Conversely, using nonwords, as in studies examining orthographic learning via self-teaching, allows researchers

not only to control for the number of presentations of the items (e.g., Share, 1999; Nation et al., 2007; Wang et al., 2011) but also to control for their constituent elements (Pacton et al., 2013, 2018). Taking advantage of this possibility, Pacton et al. asked children to read stories in which the same base nonwords, whose meaning was defined by the semantic context, ended in a final sound that could be spelled in more than one way. The base nonwords were presented either in a morphological condition or in a non-morphological condition. In the morphological condition, there were five occurrences of the base nonword and a single occurrence of two morphologically related forms that justified the spelling of the final sound of the base nonword. For example, the complex forms *coirarde* and *coirardage* justified the final silent *-d* of *coirard*, exactly in the same way that the words *bavarder* and *bavardage* justify the final silent *-d* of the word *bavard*. In the non-morphological condition, base nonwords occurred seven times, without any related forms. In an surprise test conducted after the stories had been read, children in Grades 3 and 5 were more accurate at choosing the correct spelling for the base nonwords among three phonologically plausible alternatives (e.g., *coirars*, *coirard*, and *coirar*) in the morphological condition than in the non-morphological condition. Pacton et al. (2018) further showed that this benefit of morphological relatedness cannot be reduced to orthographic relatedness given that no benefit was observed in an orthographic condition in which the morphologically related forms such as *coirarde* and *coirardage*, were replaced by non-suffixed related forms such *coirardume* (/kwaRaRdym/) and *coirardore* (/kwaRaRdoR/).

The present study

In the *morphological* condition of the studies by Pacton et al. (2013, 2018), the spelling of the final sound of the base nonword (e.g., *coirard*) was typically justified by two morphologically complex forms, one inflected form (*coirarde*) and one derived form

(*coirardage*). As both inflected and derived forms occurred together in the same texts, it could not be determined whether the morphological benefit varied as a function of the type of morphological relation, inflectional or derivational. Therefore, using an orthographic learning situation similar to that used by Pacton et al. (2013, 2018), the current study examined whether third and fifth graders benefit from morphological relatedness in the same way for inflectional and derivational morphology. The implicit learning situation of novel spellings is especially well-suited to address this issue since the same root can be used for inflected and derived forms. This is an appreciable advantage because previous studies have led to different outcomes according to whether inflected and derived forms were matched or mismatched for spelling difficulty (Deacon, 2008 vs. Deacon & Dhooge, 2010). In the morphological condition, the base nonword appeared four times in the story, but instead of being presented along with one instance of the inflected form and one instance of the derived form, as in Pacton et al. (2013, 2018), it was presented either with two instances of the gender-inflected form (for the inflectional group) or with two instances of one derived form (for the derivational group). The inflected form (e.g., *clirote* pronounced /kliRot/) and the derived form (*clirotage* pronounced /kliRotaz/) provided the same cue for the spelling of the final sound of the base nonword (*clirot* with a final silent *-t*, pronounced /kliRo/). In the non-morphological condition, the base nonword occurred six times in the story without any related forms.

The present study had a second, subsidiary, aim. Most of the nonwords (12 out of 16) used by Pacton et al. (2013, 2018) ended with a final silent consonant, a specific and rather artificial situation, which could have led children to develop sensitivity to this characteristic. This sensitivity could have influenced orthographic learning and/or spelling performance when orthographic learning is assessed with a spelling task, and perhaps even more when

assessed with a choice among three alternatives, two of which end with a silent letter. To increase ecological validity and to prevent the use of spellings with a final silent letter from being strategically encouraged, an additional set of nonwords without silent letters was also used. These items occurred six times in the story, without any related forms, like the items with a silent letter presented in the non-morphological condition.

Orthographic learning is expected for nonwords including a final silent letter, as observed in Pacton et al. (2013, 2018), as well as for nonwords without silent letters. The level of orthographic learning should be similar in the inflectional and derivational groups for nonwords without silent letters and for nonwords with a silent letter presented in the non-morphological condition, as these items were common to the two groups. In the inflectional group, the presence of inflected forms should facilitate orthographic learning, potentially with the same magnitude in Grades 3 and 5, as in Pacton et al. (2018). This prediction is based on evidence that appreciation of inflections is observed early in language development (e.g., Berko, 1958, Brown, 1973) and that orthographic learning is facilitated when one of the two complex forms is an inflected form Pacton et al. (2018).

Predictions are less straightforward when morphologically complex forms correspond to derived forms. On the one hand, in most studies conducted in English (e.g., Deacon & Dhooge, 2010), the principle of root consistency seems to be used to the same extent in the case of inflectional and derivational morphology. On the other hand, a key difference with these studies is that they used real words whereas we examine the learning of novel spellings formed by combining new base nonwords with real suffixes. This could modify the relative contribution of the root morpheme and of the suffix in the appreciation of the morphological structure of words.

When the base form is known and even more when it is frequent, the analysis of the morphological structure of the word could be initiated by the recognition of the root morpheme of the complex form. For example, in naming new suffixed forms, as early as Grade 2, performance is better when the new word is composed of a real root word and a suffix (e. g., English: *fooder*, French: *chature*) than when it is composed of a nonword and a suffix (English: *rinter*, French: *choture*; Colé et al., 2012; Laxon et al., 1992; Marec-Breton et al., 2005; Mousikou et al., 2020; Traficante et al., 2011). In addition, in children naming accuracy is higher when the root of morphologically complex words is frequent than when it is rare (Burani et al., 2018; Deacon & Francis, 2017; Goodwin et al., 2013; Mann & Singson, 2003).

When the base form is new, the identification of the suffix and its characteristics could play a major role. Thus, morphological analysis may be easier for inflected forms than for derived forms, especially for younger children. They may have encountered simple and complex inflected forms such as *bavard* (/bavaR/ ‘a talkative man’) and *bavarde* (/bavaRd/ ‘a talkative woman’), or *blond* (/blõ/ ‘a blond man’) and *blonde* (/blõd/ ‘a blond woman’) much more often than simple and complex derived forms such as *bavard* and *bavardage* (/bavaRdaz/ ‘a chat’) or *vagabond* (/vagabõ/ ‘vagabond’) and *vagabondage* (/vagabõdaz/ ‘wandering’). Because of this familiarity difference, the younger children may be more inclined to break down into morphemes an inflected nonword such as *clirote* (/kliRot/) than a derived nonword such as *clirotage* (/kliRotaz/), which may rather be processed holistically (/kliRotaz/) or broken down into syllables (/kli/ + /Ro/ + /taʒ/). If younger children do not process *-age* as a suffix, the learning of the spelling of a morphologically simple form such as *clirot* should not benefit from the presence of a morphologically complex form such as *clirotage*. Thus, we predict that, if third graders have not yet encountered enough complex

forms with derivations like *-age* to recognize it as a bound morpheme in complex forms, the morphological benefit may be more pronounced in Grade 5 than in Grade 3, or may even be observed only in Grade 5.

Method

Participants

The children were recruited from two French primary schools located in an area of average socio-economic status in Paris, France. There were three classes in Grade 3 and three classes in Grade 5. In each class, children were randomly assigned to the inflectional and derivational groups. Data from 56 third graders (13 females in both the inflectional and derivational groups) and 56 fifth graders (14 females in the inflectional group and 15 females in the derivational group) were used in the analyses, so that for each grade level, the children in the inflectional and derivational groups were matched on scores on the standardized reading and spelling tests described below. Children were tested near the end of the school year. All children were native speakers of French and provided parental consent for participation in the study. Table 1 shows the mean ages of the children in the different groups.

Standardized reading and spelling tests

General reading ability was assessed with a test consisting of 36 sentences with a missing word where children had to choose the correct word from among five alternatives (Lobrot, 1973). Participants completed as many sentences as they could in 5 minutes and the reading score is the number of correct responses in this period of time. For spelling, we used the Corbeau spelling subtest (Chevrier-Muller et al., 1997), which provides a global spelling score that reflects children's ability to produce spellings that are phonologically plausible,

even though not necessarily orthographically correct, children's use of word-specific spelling knowledge, and children's correct use of grammatical markers. Following the guidelines for this test, Grade 3 children were given the short version and Grade 5 children were given the long version, which includes an additional sentence.

Stimuli

Nonwords

Twelve base nonwords were created, all bisyllabic and phonologically legal in French. Half of them included a final silent letter, and the other half did not. The base nonwords were the same in the inflectional and derivational groups. Their phonological endings were /aR/, /i/, or /o/. As Appendix A shows, for each participant, each of these three target sounds was spelled with a final silent letter in two base nonwords and without a final silent letter in two other base nonwords (*ard* and *ar* for /aR/; *is* and *i* for /i/; *ot* and *o* for /o/). For each of the three target sounds, one of the nonwords with a final silent letter was used in the morphological condition, and the other in the non-morphological condition. Two different lists were created so that base nonwords with a final silent letter used in the morphological condition in list A were reassigned to the non-morphological condition in list B, and vice versa. For each of the three target sounds, the two base nonwords without silent letters were used in both lists. For example, *clirot* was a base nonword with a final silent letter in the morphological condition in List A and in the non-morphological condition in List B, while *toibot* was a base nonword with a final silent letter in the non-morphological condition in List A and in the morphological condition in List B, and the base nonwords without a silent letter *figo* and *vouno* were used in List A and in List B. When assigned to the morphological condition, the base nonword with a final silent letter was accompanied by a morphologically

complex form in which the final silent letter of the base nonword was pronounced. The morphologically complex forms were obtained by adding the feminine inflection *-e* in the inflectional group or a derivational suffix in the derivational group. For example, the inflection *-e* and the derivation *-age* were added to the base nonword *clirot* (/kliRo/) to build the gender-inflected form *clirote* (/kliRot/) and the derived form *clirotage* (/kliRotaz/).

Stories

There were six stories, a sample of which is given in Appendix B. The average length was 156 words (range 139 - 178). Each story included a base nonword without a final silent letter (e.g., *jouvi*) and a base nonword with a final silent letter (e.g., *clirot*). Base nonwords with a final silent letter were presented in the morphological condition in three stories and in the non-morphological condition in three other stories. The two base nonwords of a story never ended with the same sound. For example, *rouvard* (/ruvaR/) and *nolar* (/nolaR/), or *clirot* (/kliRo/) and *vouno* (/vuno/) were never embedded in the same story. The base nonword without a final silent letter appeared six times in the text. In the non-morphological condition, which was similar for the inflectional and derivational groups, the base nonword with a final silent letter appeared six times in a story. The story context provided semantic information, but the base nonwords were not accompanied by morphologically related forms that could justify the final silent letter of the base nonword. In the morphological condition, the base nonword occurred four times in the text, along with two instances of morphologically related forms, such as *clirote* or *clirotage*, that can justify the final silent letter of base nonwords such as the final *-t* in *clirot*. In the inflectional group, the morphologically related form was the gender-inflected form. In the derivational group, the morphologically related form was a derived form. The stories were roughly similar in the inflectional and derivational groups. They were modified slightly in order to embed either the inflected or the derived forms. For

example, in the inflectional group, the following sentences included the inflected form *clirote* “Après une journée à conduire des embarcations pour les touristes, un clirot rejoint ses collègues dans un chalet au bord du lac. C’est un métier généralement masculin mais une clirote fait partie de ce groupe. Elle raconte sa journée” (“After a day of driving boats for tourists, a clirot joins his colleagues in a cottage by the lake. This is a generally a male job, but a clirote is part of this group. She tells us about her day”). In the derivational group, these sentences were modified to include the derived form *clirotage*: “Après une journée à conduire des embarcations pour les touristes, un clirot rejoint ses collègues dans un chalet au bord du lac. Il parle souvent de son travail, le clirotage. Là, il raconte sa journée.” (“After a day of driving boats for tourists, a clirot joins his colleagues in a cottage by the lake. He often talks about his job, clirotage. There, he tells the story of his day.”)

Each story was printed on a single page of a booklet. Test questions were printed on the other side of the page so that children could not see the story when answering the questions. The first question about each story required children to select an appropriate title from a list of three. This was followed by three true/false questions which could be answered on the basis of the story content. The order of the stories was randomized across participants.

Nonword spelling test

For the final forced-choice test used to assess orthographic learning, two phonologically plausible spelling alternatives were constructed for each base nonword, such as *cliros*, and *cliro*, which differed only in the spelling of the final sound from the base nonword *clirot*. Among the two incorrect spelling alternatives of the final sound, one occurred in two other nonwords appearing in the stories. For example, for the nonword *clirot*, one incorrect spelling was *cliro*, ending with the *-o* which was the correct ending in two other nonwords, *figo* and *vouno*. Likewise, for a correct spelling such as *figo*, one incorrect spelling was *figot*, ending

with the *-ot* which was the correct ending in two other nonwords, *clirot* and *toibot*. The ending of the second incorrect spelling alternative, *cliros* or *figos* did not appear in any nonword in the stories. The position of the spelling alternatives on the page (left, middle, or right) was randomly determined.

Table 1

Mean (standard deviations) ages, scores on standardized reading and spelling tests, and number of correct responses to the questions asked after text reading

Measure	Grade 3		Grade 5	
	Inflectional group	Derivational group	Inflectional group	Derivational group
Mean age (years)	9.03 (0.25)	8.99 (0.38)	11.27 (0.52)	10.99 (0.38)
Reading test (max = 100)	70.44 (13.12)	71.22 (13.40)	80.67 (11.45)	77.89 (10.63)
Spelling test short version (max = 50)	35.93 (5.85)	35.71 (7.13)	41.50 (5.11)	41.89 (5.12)
Spelling test long version (max = 70)	--	--	54.75 (5.36)	55.61 (5.43)
Title selection (max = 6)	4.07 (1.59)	4.39 (1.52)	5.14 (1.01)	5.39 (0.74)
True/false questions (max = 18)	14.04 (2.57)	15.07 (2.19)	15.71 (2.43)	16.04 (2.17)

Procedure

The procedure was the same in the inflectional and derivational groups. The children were told that they would receive booklets that included stories and questions about each story. They were asked to silently read one story and move to the next page to answer questions about it, without rereading the story, then go on to the next story, and so on. The children were not told that they would be later asked about the nonword spellings and were not told to pay particular attention to the spellings. After this, participants performed letter cancellation tasks. About 30 minutes after having read the stories, the children took the final forced-choice spelling test in which they were asked to circle the correct spelling of each item that appeared in the story from the three choices provided. Finally, the next day, children were given the standardized reading and spelling tests.

Results

Matching of participants and story comprehension

Table 1 shows children's scores on the standardized reading and spelling tests. An analysis of variance (ANOVA) with grade (3 or 5) and group (inflectional or derivational) revealed better performances in Grade 5 than in Grade 3, as expected, for both the reading test ($F(1, 108) = 13.37, p < .001, \eta_p^2 = .11$) and the short version of the spelling test ($F(1, 108) = 28.15, p < .001, \eta_p^2 = .21$), but no group effect and no grade x group interaction (reading test: $ps > .44$; short version of the spelling test: $ps > .78$). Thus, children in the inflectional and derivational groups were well matched on reading and spelling abilities. This was confirmed by a *t*-test on the scores obtained by the fifth graders in the two groups on the long version of the spelling test ($t(54) = .59, p = .55, \text{Cohen's } d = .16$).

Table 1 also provides information about the children's performance on the questions about the stories. The rate of correct responses for selecting an appropriate title and for answering true/false questions indicates that the children were fairly successful in reading and understanding the stories. *T*-tests showed that performance was significantly above the level expected by chance in the two groups in both grades for title selection ($ts(27) > 3.58$, $ps < .001$, Cohen's $ds > .68$) and true/false questions ($ts(27) > 10.35$, $ps < .001$, Cohen's $ds > 1.96$). An ANOVA on the number of correct responses for selecting an appropriate title and for answering true/false questions revealed better performances in Grade 5 than in Grade 3, as expected, for both types of questions (title selection: $F(1, 108) = 18.79$, $p < .001$, $\eta_p^2 = .15$; true/false questions: $F(1, 108) = 8.87$, $p = .004$, $\eta_p^2 = .08$) but no group effect and no grade x group interaction ($ps > .23$).

Memory for spellings

The percentages of correct spellings selected in each grade level are reported in Table 2 for items that included a final silent letter (SL+) when presented in the morphological condition and when presented in the non-morphological condition, as well as for items that did not include a final silent letter (SL \emptyset). *T* tests were used to assess whether orthographic learning had taken place. In both grades, the selection rate of correct spellings was above chance (33.3%) for the three types of items (SL \emptyset : $ts(27) > 4.41$, $ps < .001$, Cohen's $ds > .83$; SL+ presented in the morphological condition: $ts(27) > 6.43$, $ps < .001$, Cohen's $ds > 1.22$, except $t(27) = 2.42$, $p = .02$, Cohen's $d = .46$ for the third graders in the derivational group; SL+ presented in the non-morphological condition: $ts(27) = 2.17$, $ps < .039$, Cohen's $ds > .41$ except $t(27) = 1.99$, $p = .057$, Cohen's $d = .38$ for the fifth graders in the derivational group).

Table 2

Percentages (standard deviations) of correct choices as a function of group, condition, and grade

Grade	Inflectional group			Derivational group		
	SL+	SL+	SL \emptyset	SL+	SL+	SL \emptyset
	morphologi- cal condition	non- morphologi- cal condition		morphologi- cal condition	non- morphologi- cal condition	
3	57.14 (17.82)	45.24 (17.82)	52.98 (23.59)	45.24 (26.00)	44.05 (20.39)	54.17 (21.58)
5	60.71 (22.32)	47.62 (33.25)	61.31 (19.80)	61.90 (23.51)	45.24 (31.71)	58.33 (23.79)

Note. SL+ are items with silent-letter endings. SL \emptyset are items without silent-letter endings.

Two separate sets of analyses were carried out to investigate whether children benefit from related inflected and derived forms when they learn to spell new words. First, we compared the level of orthographic learning for items with a final silent letter according to whether they were presented in the morphological or non-morphological condition. These analyses were conducted separately for the two groups as the variables group and condition were not completely crossed. Indeed, for the items with final silent letters presented in the morphological condition, the two groups differed (the gender inflection *-e* added to the stem in the inflectional group vs. a derivational suffix added to the stem in the derivational group), but for the items with final silent letters presented in the non-morphological condition and the items without silent letters, the two groups were identical. Second, we further examined

whether any difference in the benefit of morphological relatedness between the inflectional and derivational groups could be attributed to differences in overall orthographic learning of nonwords. To this end, we examined whether the inflectional and derivational groups performed similarly on items with a silent letter presented in the non-morphological condition and on items without a final silent letter, which were common to both groups.

Items with a final silent letter (SL+) presented in the morphological or non-morphological condition

In the inflectional group, both third and fifth graders were more likely to select the correct spellings for SL+ items presented in the morphological condition than for SL+ items presented in the non-morphological condition, thus showing the same pattern that Pacton et al. (2018) observed for third and fifth graders. However, in the derivational group, a morphological benefit was observed only in Grade 5. An ANOVA was conducted on the number of correct selections for SL+ items with grade (3 or 5) and list (A or B) as between-participant variables and condition (morphological or non-morphological) as a within-participant variable for each group. In the inflectional group, there was a main effect of condition, with greater accuracy in the morphological condition than in the non-morphological condition (58.92% vs. 46.43%, $F(1, 54) = 12.85$, $p = .001$, $\eta_p^2 = .19$), and no other significant effects (all $ps > .63$). t -test comparisons confirmed the higher rate of correct choices in the morphological condition than in the non-morphological condition in each grade (Grade 3: $t(27) = 2.42$, $p = .022$, Cohen's $d = .46$; Grade 5: $t(27) = 2.65$, $p = .013$, Cohen's $d = .50$). In the derivational group, there was a main effect of condition, with higher scores for SL+ items presented in the morphological condition than for SL+ items presented in the non-morphological condition (53.57% vs. 44.63%, $F(1, 54) = 6.79$, $p = .012$, $\eta_p^2 = .11$), no effect of grade ($p = .14$) but a condition x grade interaction ($F(1, 54) = 5.10$, $p = .028$, $\eta_p^2 = .09$). This

interaction indicates that only fifth graders chose the correct spelling more often in the morphological condition than in the non-morphological condition (Grade 5: $t(27) = 3.81$, $p = .001$, Cohen's $d = .72$; Grade 3: $p = .82$).

Items common to both groups: With a final silent letter (SL+) presented in the non-morphological condition and without a final silent letter (SL \emptyset)

In order to compare the level of overall orthographic learning in the inflectional and derivational groups, the number of correct selections for SL+ items presented in the non-morphological condition and the number of correct selections for SL \emptyset items were submitted to ANOVAs with grade (3 or 5), list (A or B), and group (inflectional or derivational) as between-participant variables. There was no significant effect for SL+ items presented in the non-morphological condition (all $ps > .75$) and for SL \emptyset items (all $ps > .62$, except $p = .14$ for the grade). It is worth noting that these non-significant differences between the inflectional and derivational groups for SL+ items presented in the non-morphological condition and SL \emptyset items contrast with the results of analyses performed on SL+ items presented in the morphological condition. Correct selections for SL+ items presented in the morphological condition were more common in grade 5 than in grade 3 ($F(1, 108) = 5.61$, $p = .027$, $\eta_p^2 = .08$). There was no main effect of group ($F(1, 108) = 1.57$, $p = .21$, $\eta_p^2 = .014$) but a small trend towards a grade x group interaction ($F(1, 108) = 2.35$, $p = .13$, $\eta_p^2 = .021$). This interaction indicates an higher accuracy in the inflectional than in the derivational group in grade 3 ($t(54) = 2.00$, $p = .05$, Cohen's $d = .53$) but not in grade 5 ($t(54) = .19$, $p = .85$).

Discussion

In French, as in English and other languages, many morphological effects on spelling are captured by the principle of root consistency, which states that the roots of words often retain their spelling in related words. Only three studies have looked at whether children benefit from morphological relatedness when they learn the spelling of new words (Pacton et al., 2013, 2018; Tucker et al., 2016). Exploring the learning of nonword spellings makes it possible to examine the ability to benefit from morphological relatedness in children of different ages / grades while controlling for the amount of exposure to novel words. It also offers the possibility to use the same root only in inflected forms or only in derived forms in order to compare how children benefit from morphological relatedness for inflectional and derivational morphology.

Children had to read stories which included base nonwords with a final silent letter, presented either in a non-morphological condition or in a morphological condition, and their memory of the spellings was tested afterwards. In the non-morphological condition, each base nonword with a final silent letter was embedded in a story that provided semantic information without any morphologically related form that could justify the spelling of the final sound of the base nonword. In the morphological condition, the base nonword with a final silent letter was embedded in a story along with its gender-inflected form (inflectional group) or a morphologically complex form derived from the base nonword (derivational group) justifying the presence of a specific silent letter at the end of the base nonword. This procedure allowed us to determine whether the morphological benefit varies as a function of the type of morphology, inflectional or derivational, a test that was not possible in previous studies by Pacton et al. (2013; 2018) which mixed inflected and derived forms within the same stories. Another difference with previous studies is that each story included the same proportion of

base nonwords with a silent letter and base nonwords without a silent letter. This allowed us to assess orthographic learning and the benefit of morphological relatedness when the material did not encourage the use of silent letters.

The results of the two experiments clearly show evidence of orthographic learning. Children in Grades 3 and 5 learned the spelling of the nonwords both with and without silent letters. This indicates that orthographic learning of spellings with a final silent letter is not restricted to situations in which most items end with a silent letter (e.g., Pacton et al., 2013, 2018), a type of situation that could have encouraged the use of silent letters. Although scores were above chance level for all types of items, the scores were not high even in the morphological condition (between 44% and 62%), as observed in previous studies (between 45% and 57%). To ensure that children acquired word-specific knowledge, the target sound sequences (e.g., /aR/) were written with one spelling in two nonwords (*ard*) and with another spelling in two others (*ars* in Pacton et al., 2018; *ar* in the present study), but the interference that this creates may have made orthographic learning rather difficult. The scores were not high even for items without a final silent letter, with a rate of correct choices ranging from 53% to 61%. This finding contrasts with the results of previous studies in which spelling accuracy was lower for words that end with a silent letter than for words that do not. For example, Sénéchal et al. (2006) reported that children in Grade 4 spelled words without a silent letter better than both morphological and non-morphological words with a final silent letter (respectively 75.0%, 58.1%, and 39.4%). The difference between these two studies may result in part from the tasks used: a production task in Sénéchal et al. and a spelling choice task in our study. Children may be more inclined to choose a spelling with a final silent letter than to produce such a spelling. Furthermore, in both the present study and Pacton et al.'s (2018) study, the fact that the spelling choice test included two spellings with a final silent

letter and one without a silent letter (e.g., *clirot*, *cliros*, and *cliro*) may have encouraged children to choose one of the spellings with a silent letter. This may be particularly true for Pacton et al.'s (2018) study in which most of the target nonwords ended with a silent letter. Clearly, further research should assess orthographic learning with both a spelling choice task and a production task, which may be a more stringent test of orthographic learning.

Regarding children's sensitivity to the morphological relation with gender-inflected forms, orthographic learning was better in the morphological condition than in the non-morphological condition in Grades 3 and 5, without any difference between the two grades for either the level of orthographic learning or the size of the morphological benefit. It is worth noting that this lack of difference between the two grades occurred even though, as expected, the fifth graders performed better on standardized reading and spelling tests than the third graders. By contrast, when the morphological condition provided derivational information, orthographic learning was better in the morphological condition than in the non-morphological condition only in Grade 5. Importantly, the effect of morphological relatedness was observed only for inflectional morphology in Grade 3, even though, for each grade level, the children in Experiments 1 and 2 were matched on standardized reading and spelling scores. The absence of morphological benefit when derived forms are provided in Grade 3 supports the idea that children's better orthographic learning in the morphological condition with gender-inflected forms than in the non-morphological condition reflects a morphological benefit rather than just the result of having been exposed to a greater variety of orthographic forms and/or having been provided with an additional phonological code. Indeed, according to this alternative, not morphologically-based, interpretation, the difference between the non-morphological and morphological conditions should have been the same for the two types of morphology since the same roots were used in the inflected and derived forms. This benefit of

morphological relatedness for inflectional, but not for derivational morphology, in Grade 3 is in line with Pacton et al.'s (2018) finding that the benefit of morphological relatedness (better performance in the morphological than in the non-morphological condition, as in the present study) cannot be reduced to orthographic relatedness.

Before considering possible reasons for the discrepancy between the benefit of morphological relatedness for inflectional and derivational forms, it is worth noting that this benefit never exceeded 17%. This weak influence of the complex form on spelling choices can be accounted for in at least two possible ways. First, as we suggested in the introduction, the fact that the roots were new most likely made the analysis of complex items into morphological constituents more difficult for the children. Increasing the familiarity of the root-morpheme before reading the texts, for example through auditory presentations, should facilitate the morphological analysis of complex forms and thus increase the benefit of morphological relatedness. Second, even if the children were able to analyze the morphological structure of complex forms, the association between the root-word and the complex form was new, so that the connection between the two forms may not be sufficiently strong for morphological relatedness to have a significant influence on spelling choices. The latter hypothesis leads to the prediction that the influence of the complex form should increase if children were reminded of the complex form and its semantic relationship with the root during the spelling choice test.

The difference in sensitivity between inflected and derived forms in third graders might reflect differences in the distributional properties of inflectional and derivational suffixes. A potentially critical factor in morphological segmentation is suffix frequency (Schreuder & Baayen, 1995). Among the 9,500 most frequent word forms encountered by French readers from Grade 1 to Grade 5 (Lété et al., 2004) and analyzed in the Manulex-Morpho database

(Peereman et al., 2013), the inflectional suffix *-e* appears in 605 word forms while the most frequent derived suffix used in the study (*-age*) appears in only 61 word forms. Several results in adults and children suggest that lexical decision and naming performance on morphologically complex words and morphologically complex pseudowords is modulated by the frequency of suffixes (Burani et al., 1997, 2018; Burani & Thornton, 2003; Mailhot et al., 2020). In our study, the lower frequency of derivational suffixes compared to the inflectional gender suffix may have rendered the morphological structure of derived words less salient in third-grade children, and therefore reduced the morphological benefit. Interestingly, using an artificial learning situation of new suffixes in adult participants, Tamminen et al. (2015) showed that affix discovery in complex words and their generalizations to new words are modulated by the number of different root words preceding a single suffix (i.e., suffix family size or suffix frequency per type). They suggested that the diversity of contexts preceding the suffix facilitated the extraction of a context-independent representation of the suffix, which therefore can be identified in new words (see also Laudanna & Burani, 1995). Increasing reading experience and frequent encounters with a suffix appearing in various derived forms should strengthen the representation of the bound morpheme and increase sensitivity to the morphological structure of derived forms, as observed in Grade 5 children.

Another difference between inflectional and derivational morphology is the degree of semantic change resulting from the affixation process (Bybee, 1985). While, for example, gender or number inflections have little effect on the meaning of nouns, derivational affixes can significantly alter the meaning of the root word. Furthermore, some derivational suffixes have several different meanings, as *-ful* in the English words *cupful* and *helpful* or *-y* in *fruity* and *sticky*, which could make their acquisition even more difficult. Similarly, in French, the suffix *-age* used in the present study can indicate a whole (*feuillage* “foliage”, *plumage*

“plumage”) or a state (*esclavage* “slavery”, *veuvage* “widowhood”) when the root is nominal, and an action when the root is verbal (*lavage* “washing”, *doublage* “doubling”). Using an artificial language learning task, Tamminen et al. (2015) found that novel affixes were better learned when the meaning of the affix in complex forms was held constant during training than when the affix was associated with multiple different meanings. In the present study, differences in the semantic interpretability of the two types of suffixes may have contributed to the greater sensitivity to the morphological structure of inflectional forms than of derived forms in young third-grade readers.

Limitations, further directions, and educational implications

In the present study, orthographic learning was assessed with a spelling choice task. It will be important to replicate these results using spelling production tasks because several studies show different patterns of results with spelling production tasks versus spelling choice tasks (e.g., Ouellette & Fraser, 2009; Wegener et al., 2022). For children, and especially for the youngest ones, this may often result from differences in the cognitive demands of the tasks (e.g., Totereau et al., 1997). However, besides the cognitive demands of the tasks, different strategies could be adopted for the two tasks, as suggested in studies investigating adults’ spelling performance (Treiman et al., 2015; 2021). For example, Treiman et al. (2021 Experiment 1) examined whether US university students were sensitive to the fact that content words are typically spelled with at least three letters. Adults’ sensitivity to this graphotactic pattern showed up more strongly in a choice task than in a production.

Another limitation is that all the complex forms included the gender-inflected suffix in the inflectional group, while the complex forms included three different derivational suffixes in the derivational group. This difference between the two types of suffixes, inflectional and

derivational, was present in Pacton et al. (2018) and we wanted to use a situation as close as possible to this previous study. However, the fact that complex forms with a gender inflectional suffix were more frequently encountered in the stories than complex forms with a given derivational suffix could have made the inflectional suffix more salient than the derivational suffix, thus increasing participants' tendency to rely on the principle of root consistency in the inflectional group. This limitation could be overcome by using a single derivational suffix such as the diminutive suffix /ɛt/ which is well-mastered even by second graders (Pacton et al., 2005).

The generalizability of our results could also be limited by the fairly small number of items in the morphological and non-morphological conditions. There were two main reasons for this. First, it was necessary to keep the number of new spellings relatively low to avoid making the learning task too demanding for the children. Second, the inclusion of non-words without a final silent letter led us to reduce the number of non-words with a final silent letter that were used in the morphological and non-morphological conditions. This limitation could be overcome by using a longer learning schedule, spread over several sessions, in which children would be exposed to both novel and previously encountered nonwords. This would also allow us to use a larger number of different derivational suffixes than in the present study.

A direct educational implication of the present results is that activities should involve the morphological analysis of inflected words from the early stages of spelling acquisition in order to promote the development of sensitivity to the principle of root consistency. The derivational suffixes could be gradually introduced to children. To make a derivation salient, this derivation should be presented in association with many different roots, with an initial emphasis on frequent and semantically transparent derivations. Further studies are needed to

examine whether children's ability to segment words into morphemes and to apply the principle of root consistency tends to generalize over time to suffixes not encountered during learning.

To conclude, the current results confirm previous studies showing that children use morphologically complex forms in the implicit learning of new spellings and that the benefit of morphological relatedness cannot be reduced to orthographic relatedness. They also extend previous findings by showing that children seem to rely on the root consistency principle earlier for inflectional than for derivational morphology.

References

- Berko, J. (1958). The child's learning of English morphology. *Word*, *14* (2-3), 150–177.
<https://doi.org/10.1080/00437956.1958.11659661>
- Brown, R. (1973). *A first language: The early stages*. Harvard University Press.
- Burani, C., & Thornton, A. M. (2003). The interplay of root, suffix and whole-word frequency in processing derived words. In R. H. Baayen & R. Schreuder (Eds.), *Morphological structure in language processing* (pp. 157–208). Mouton de Gruyter
<https://doi.org/10.1515/9783110910186.157>
- Burani, C., Dovetto, F. M., Thornton, A. M., and Laudanna, A. (1997). Accessing and naming affixed pseudo-words. In G. Booij & J. von Marle (Eds.), *Yearbook of Morphology 1996* (pp. 55-72). Kluwer Academic. https://doi.org/10.1007/978-94-017-3718-0_5
- Burani, C., Marcolini, S., Traficante, D., & Zoccolotti, P. (2018). Reading derived words by Italian children with and without dyslexia: The effect of root length. *Frontiers in Psychology*, *9*, 647. <https://doi.org/10.3389/fpsyg.2018.00647>
- Bybee, J. L. (1985). *Morphology: A study of the relation between meaning and form*. Benjamins.
<https://doi.org/10.1075/tsl.9>
- Chevrier-Muller, C., Simon, A. M., & Fournier, S. (1997). *Batterie ‘Langage oral, langage écrit, mémoire, attention’, L2MA (Manuel, matériel, cahier d’enregistrement)* [Oral and written language battery, memory, attention, L2MA (manual, material, logbook)]. Editions du Centre de Psychologie Appliquée.

- 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* (1), 97–120. <https://doi.org/10.1017/S0142716411000282>
- Deacon, S. H. (2008). The metric matters: Determining the extent of children's knowledge of morphological spelling regularities. *Developmental Science*, *11* (3), 396–406. <https://doi.org/10.1111/j.1467-7687.2008.00684.x>
- Deacon, S. H., & Bryant, P. (2006). 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. <https://doi.org/10.1017/S0305000906007409>
- Deacon, S. H., & Dhooge, S. (2010). Developmental stability and changes in the impact of root consistency on children's spelling. *Reading and Writing*, *23*, 1055–1069. <https://doi.org/10.1007/s11145-009-9195-5>
- Deacon, S. H., & Francis, K. A. (2017). How children become sensitive to the morphological structure of the words that they read. *Frontiers in Psychology*, *8*, 1469. <https://doi.org/10.3389/fpsyg.2017.01469>
- Deacon, S. H., Cleave, P. L., Baylis, J., Fraser, J., Ingram, E., & Perlmutter, S. (2014). The representation of roots in the spelling of children with specific language impairment. *Journal of Learning Disabilities*, *47* (1), 13–21. <https://doi.org/10.1177/0022219413509965>
- Deacon, S. H., Conrad, N., & Pacton, S. (2008). A statistical learning perspective on children's learning about graphotactic and morphological regularities in spelling. *Canadian Psychology*, *49* (2), 118–124. <https://doi.org/10.1037/0708-5591.49.2.118>

- Gingras, M., & Sénéchal, M. (2019). Evidence of statistical learning of orthographic representations in grades 1–5: The case of silent letters and double consonants in French. *Scientific Studies of Reading*, 23, 37–48. <https://doi.org/10.1080/10888438.2018.1482303>
- Goodwin, A. P., Gilbert, J. K., & Cho, S. (2013). Morphological contributions to adolescent word reading: An item response approach. *Reading Research Quarterly*, 48 (1), 39–60. <https://doi.org/10.1002/rrq.037>
- Hanna, P. R., Hanna, J. S., Hodges, R. E., & Rudorf, E. H. (1966). *Phoneme-grapheme correspondences as cues to spelling improvement*. U.S. Office of Education Cooperative Research Program Monograph 16. U.S. Government Printing Office.
- Kemp, N. (2006). Children's spelling of base, inflected, and derived words: Links with morphological awareness. *Reading and Writing*, 19, 737–765. <https://doi.org/10.1007/s11145-006-9001-6>
- Laudanna, A., and Burani, C. (1995). Distributional properties of derivational affixes: implications for processing. In L. B. Feldman (Ed.), *Morphological Aspects of Language Processing* (pp. 345-364). Lawrence Erlbaum Associates.
- 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>
- Lété, B., Sprenger-Charolles, L., & Colé, P. (2004). MANULEX: A lexical database from French readers. *Behavioral Research Methods, Instruments and Computers*, 36, 156-166. <https://doi.org/10.3758/BF03195560>

- Lobrot, M. (1973). *Lire avec épreuves pour évaluer la capacité de lecture* [Reading with tests to assess reading ability]. OCDL/ESF.
- Mailhot, H., Wilson, M. A., Macoir, J., Deacon, S. H., & Sánchez-Gutiérrez, C. (2020). MorphoLex-FR: A derivational morphological database for 38,840 French words. *Behavior Research Methods*, 52, 1008–1025. <https://doi.org/10.3758/s13428-019-01297-z>
- Mann, V., and Singson, M. (2003). Linking morphological knowledge to English decoding ability: large effects of little suffixes. In E. Assink & D. Sandra (Eds.), *Reading Complex Words: Cross-Language Studies* (pp. 1-25). Springer. https://doi.org/10.1007/978-1-4757-3720-2_1
- Marec-Breton, N., Gombert, J.-E., & Colé, P. (2005). Traitements morphologiques lors de la reconnaissance des mots écrits chez des apprentis lecteurs. *L'Année Psychologique*, 105 (1), 9–45. <https://doi.org/10.3406/psy.2005.3818>
- 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). <https://doi.org/10.1111/desc.12952>
- Nation, K., Angell, P., & Castles, A. (2007). Orthographic learning via self-teaching in children learning to read English: Effects of exposure, durability, and context. *Journal of Experimental Child Psychology*, 96 (1), 71–84. <https://doi.org/10.1016/j.jecp.2006.06.004>
- Ouellette, G., & Fraser, J. R. (2009). What exactly is a *yait* anyway: The role of semantics in orthographic learning. *Journal of Experimental Child Psychology*, 104 (2), 239-251. <https://doi.org/10.1016/j.jecp.2009.05.001>

- Pacton, S., & Deacon, S. H. (2008). The timing and mechanisms of children's use of morphological information in spelling: A review of evidence from English and French. *Cognitive Development, 23* (3), 339–359. <https://doi.org/10.1016/j.cogdev.2007.09.004>
- Pacton, S., Afonso Jaco, 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. <https://doi.org/10.1016/j.jecp.2018.02.003>
- Pacton, S., Fayol, M, Nys, M. & Peereman, R. (2019). Implicit statistical learning of graphotactic knowledge and lexical orthographic acquisition. In C. Perret and T. Olive (Eds.), *Spelling and writing words. Theoretical and methodological advances* (pp. 41-66). Brill. https://doi.org/10.1163/9789004394988_004
- Pacton, S., Fayol, M., & Perruchet, P. (2005). Children's implicit learning of graphotactic and morphological regularities. *Child Development, 76* (2), 324–339. https://doi.org/10.1111/j.1467-8624.2005.00848_a.x
- 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>
- Peereman, R., Lété, B., & Sprenger-Charolles, L. (2007). Manulex-infra: Distributional characteristics of grapheme—phoneme mappings, and infralexical and lexical units in child-directed written material. *Behavior Research Methods, 39*, 579–589. <https://doi.org/10.3758/BF03193029>

- Peereman, R., Sprenger-Charolles, L., & Messaoud-Galusi, S. (2013). The contribution of morphology to the consistency of spelling-to-sound relations: A quantitative analysis based on French elementary school readers. *Année Psychologique*, *113* (1), 3–33. <https://doi.org/10.3917/anpsy.131.0003>
- Pollo, T. C., Treiman, R., & Kessler, B. (2007). Three perspectives on spelling development. In E. J. Grigorenko & A. Naples (Eds.), *Single- word reading: Cognitive, behavioral, and biological perspectives*. Erlbaum.
- Rubin, H. (1988). Morphological knowledge and early writing ability. *Language and Speech*, *31* (4), 337–355. <https://doi.org/10.1177/002383098803100403>
- Schreuder, R., & Baayen, R.H. (1995). Modeling morphological processing. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 131–154). Erlbaum.
- Sénéchal, M. (2000). Morphological effects in children's spelling of French words. *Canadian Journal of Experimental Psychology*, *54* (2), 76– 85. <https://doi.org/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* (4), 231–254. <https://doi.org/10.1016/j.jecp.2006.05.003>
- Sénéchal, M., Gingras, M., & L'Heureux, L. (2015). Modeling Spelling Acquisition: The Effect of Orthographic Regularities on Silent-Letter Representations. *Scientific Studies of Reading*, *20* (2), 155–162. <https://doi.org/10.1080/10888438.2015.1098650>
- Sénéchal, M., & Kearnan, K. (2007). The role of morphology in reading and spelling. In R. V. Kail (Ed.), *Advances in child development and behavior*, Vol. 35 (pp. 297–325). Elsevier Academic Press. <https://doi.org/10.1016/B978-0-12-009735-7.50013-X>

Share, D. (1999). Phonological recoding and orthographic learning: A direct test of the self-teaching hypothesis. *Journal of Experimental Child Psychology*, 72 (2), 95–129.

<https://doi.org/10.1006/jecp.1998.2481>

Tamminen, J., Davis, M. H., & Rastle, K. (2015). From specific examples to general knowledge in language learning. *Cognitive Psychology*, 79, 1–39.

<https://doi.org/10.1016/j.cogpsych.2015.03.003>

Totereau, C., Thevenin, M. G., & Fayol, M. (1997). The development of the understanding of number morphology in written French. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages* (pp. 97–114). Lawrence Erlbaum.

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., & Cassar, M. (1996). Effects of morphology on children's spelling of final consonant clusters. *Journal of Experimental Child Psychology*, 63 (1), 141–170.

<https://doi.org/10.1006/jecp.1996.0045>

Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, 65 (5), 1318–1337.

<https://doi.org/10.2307/1131501>

- Treiman, R., Jewell, R., Berg, K., & Aronoff, M. (2021). Word class and spelling in English. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 47 (6), 1027-1035. <https://doi.org/10.1037/xlm0000969>
- Treiman, R., Seidenberg, M. S., & Kessler, B. (2015). Influences on spelling: Evidence from homophones. *Language, Cognition, and Neuroscience*, 30 (5), 544-554. <https://doi.org/10.1080/23273798.2014.952315>
- Tucker, R., Castles, A., Laroche, A., & Deacon, S. H. (2016). The nature of orthographic learning in self-teaching: Testing the extent of transfer. *Journal of Experimental Child Psychology*, 145, 79–94. <https://doi.org/10.1016/j.jecp.2015.12.007>
- Wang, H. C., Castles, A., Nickels, L., & Nation, K. (2011). Context effects on orthographic learning of regular and irregular words. *Journal of Experimental Child Psychology*, 109 (1), 39–57. <https://doi.org/10.1016/j.jecp.2010.11.005>
- Wegener, S., Wang, H.-C, Beyersmann, E., Nation, K., Colenbrander, D., & Castles, A. (2022). The effects of spacing and massing on children’s orthographic learning. *Journal of Experimental Child Psychology*, 214. <https://doi.org/10.1016/j.jecp.2021.105309>

Appendix A

Nonwords (NW) in stories and pronunciations

List	Morphologically Simple NW			Morphologically Complex NW		
	Silent Letter	No Silent Letter		inflected	Derived	
	Morpho. Condition	Non-morphological Condition				
/aR/	A	rouvard	jensard	nolar, midar	rouvarde	rouvardise
		/RuvaR/	/ʒãsaR/	/nolaR, midaR/	/RuvaRd/	/RuvaRdiz/
	B	jensard	rouvard	nolar, midar	jensarde	jensardise
		/ʒãsaR/	/RuvaR/	/nolaR, midaR/	/ʒãsaRd/	/ʒãsaRdiz/
/i/	A	lurdis	boumis	duti, jouvi	lurdise	lurdiseau
		/lyRdi/	/bumi/	/dyti, ʒuvi/	/lyRdiz/	/lyRdizo/
	B	boumis	lurdis	duti, jouvi	boumise	boumiseau
		/bumi/	/lyRdi/	/dyti, ʒuvi/	/bumiz/	/bumizo/
/o/	A	clirot	toibot	figo, vouno	clirote	clirotage

	/kliRo/	/twabo/	/figo, vuno/	/kliRot/	/kliRotaz/
B	toibot	clirot	figo, vouno	toibote	toibotage
	/twabo/	/kliRo/	/figo, vuno/	/twabot/	/twabotaz/

Appendix B

Sample story and questions

The target nonwords of the non-morphological condition are shown in italics, the target nonwords of the morphological condition are shown in bold, and the morphologically related nonwords are underlined. All the words were in normal font when the story was presented to participants.

Durant mon voyage en Afrique, j'ai rencontré un **lurdis** du désert ! Au départ, je l'ai confondu avec un chameau, mais sa troisième bosse m'a étonné. On m'a expliqué qu'il s'agissait d'un **lurdis**, un animal rare que peu de gens connaissent. Son cri s'appelle le *nolar*. Le *nolar* est très utile car il permet au **lurdis** d'envoyer un signal à [inflection : sa femelle, la lurdise][derivation : son petit, le lurdiseau]. En effet, le *nolar* a une telle puissance que [inflection : la lurdise][derivation : le lurdiseau] peut le détecter de très loin. Il faut faire attention car le *nolar* n'est pas un son agréable à entendre pour l'homme. Écouté de trop près, le *nolar* peut même rendre sourd. Le petit de cet animal apprend très jeune à maîtriser le *nolar* pour signaler à ses parents qu'il est en danger. A la fin de mon voyage, je suis retourné voir le **lurdis**, pour le prendre en photo et le montrer à mes amis en France.

*During my trip to Africa, I met a desert **lurdis**! At first, I mistook it for a camel, but its third hump surprised me. It was explained to me that it was a **lurdis**, a rare animal that few people know. Its cry is called the *nolar*. The *nolar* is very useful because it allows the **lurdis** to send a signal to its [inflection: female, the lurdise] [derivation: baby, the lurdiseau]. Indeed, the *nolar* is so powerful that the [inflection: lurdise] [derivation: lurdiseau] can detect it from far away.*

*You have to be careful because the nolar is not a pleasant sound for humans to hear. Listened to too closely, the nolar can even cause deafness. The young of this animal learns very early on to master the nolar to signal to its parents that it is in danger. At the end of my trip, I went back to see the **lurdis**, to take a picture of it and show it to my friends in France.*