Spelling Errors in French Elementary School Students: A Linguistic Analysis

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Conflict of interest statement. There is no conflict of interest to report.

Funding statement. This study was designed and planned with support from a UCL Institute of Education PhD scholarship to the first author, and written with support from the Heather van der Lely Foundation awarded to the third author.

Abstract

Purpose. The present study offers the first description of misspellings across elementary school using the Phonological, Orthographic and Morphological Assessment of Spelling (POMAS), a linguistic framework based on Triple Word Form Theory (Bahr et al., 2012), adapted for French (POMAS-FR). It aims to test the 'universality' of POMAS, and its suitability to track development in French spelling.

Method. One hundred and ninety-four typically-developing French children (Grade 1-5) produced a written narrative and words-to-dictation. These were analyzed for productivity and accuracy. Misspellings were then analyzed, using POMAS-FR.

Results. Productivity and accuracy were better in the later grades. POMAS-FR provided a novel framework for tracking error types in our French sample. The data showed a linear trend for text production, whereby the proportion of phonological errors decreased rapidly in the early grades, whilst orthographic errors decreased and morphological errors increased throughout elementary school. Words-to-dictation showed a more stable pattern, with a steady decrease in phonological errors, and a stable proportion of orthographic and morphological errors. The specific error types found within each linguistic category are described for both tasks.

Conclusions. The POMAS-FR allowed for the characterization of linguistic knowledge involved in learning to spell French across elementary school. Interplays between different types of linguistic knowledge were evident at all grades. In comparison with other writing systems, French text spelling competence relied heavily on morphological knowledge. These results suggest POMAS may be applied to other orthographic systems. It also highlights the importance of task and word selection for the qualitative evaluation of spelling.

Keywords: French, Triple Word Form Theory, Spelling, Qualitative analysis, POMAS

Introduction

Despite a growing research base in spelling development, English remains the predominant focus of investigations and the basis for current theories of spelling development. If we are to develop *universal* theories of spelling development and disorders, models have to be tested in a range of languages of varying characteristics, and not only in the exceptionally opaque English orthography (Seymour et al., 2003). Reading researchers have already contested the 'anglocentricity' of reading research and the need for evidence and theories stemming from less opaque orthographies (Share, 2008). Spelling research would similarly benefit from evidence in a broader range of orthographies, and from cross-language theory testing to identify different patterns in development. The present paper contributes to this endeavor by testing the relevance of the Phonological, Orthographic and Morphological Assessment of Spelling (POMAS) framework. The framework was initially developed in English and based on the Triple Word Form theory (Bahr et al., 2012). Here we examine whether the framework is sensitive to the nature and development of spelling errors in French elementary school students.

Triple Word Form theory posits that spelling is a linguistic activity, relying on phonological, but also orthographic and morphological, knowledge of words (Bahr et al., 2009). These different types of knowledge develop and interact early on, to build spelling knowledge and accuracy. The role of phonology in starting to spell is well-documented: we know that phonological awareness is an important predictor of spelling in a range of languages (Caravolas et al., 2012, 2013; Moll et al., 2014), and that learning to parse phonemes and map them to graphemes is an essential step in learning to spell (Castles et al., 2018). Importantly, phonology is not the only skill young spellers rely on. Sensitivity to both morphological parsing (Pacton & Deacon, 2008) and orthographic conventions (Cassar & Treiman, 1997; Pacton et al., 2001; Treiman, 1993) for spelling have been demonstrated in

both French and English. Morphological parsing strategies have also been observed early on in children's spelling of word endings. For example, American first graders were more likely to represent two morphemes in their spelling of the final consonant cluster */nd/* if the word could be parsed morphologically (e.g., *tuned*) than if it could not (e.g., *brand*) (Treiman & Cassar, 1996). In French, Sénéchal (2000) showed that children's spelling of silent letter endings was better when the silent letter could be predicted by morphologically-related words (e.g., chan*t* (song)– chan*t*er (to sing)) than when it could not (e.g., taba*c* (tobacco)). This sensitivity to morphological information was present as early as age seven, but was more prominent in older children (Sénéchal et al., 2006). Orthographic sensitivity is also present early on in children's spelling choices. Cassar and Treiman (1997) showed a preference for doublets in legal (final - pe*ss*), rather than in illegal (initial – *pp*es), position in American first graders). Similarly, Pacton et al. (2001), in French, showed a preference for consonants which could legally be doubled (*l*, *m* and *s*), over consonants that could not (*c*, *d* and *v*), as early as the first year of formal literacy instruction. Altogether, this body of work suggests an early and growing sensitivity to morphological and orthographic knowledge in learning to spell both French and English throughout elementary school. However, how this knowledge develops across the school grades is not fully understood in different languages.

French orthography differs in a number of ways from English orthography. The Triple Word Form Theory can be used as a base for this comparison. Phonologically, French words are typically made of open syllables (e.g., CV [Consonant + Vowel], CCV), which are roughly equally stressed. English, by comparison, has a majority of closed syllables, with word-specific stress patterns (McLeod, 2007). The few available direct comparisons of French and English spelling have suggested this might have an impact on the nature of spelling errors produced by children in the two languages. Caravolas et al. (2003) showed that 8-9-year-old English poor spellers were less likely than their French poor-speller

counterparts to produce a correct word skeleton, that is, to represent all consonants and vowels within a word, an idiosyncrasy attributed to English stress patterns. Orthographically, French and English are both considered to be on the opaque end of the orthographic consistency spectrum (Seymour et al., 2003; Ziegler et al., 1996, 1997). However, the nature of the rules and regularities which affect this orthographic opacity may differ.

Kessler and Treiman (2001) analyzed vowel spelling consistency in a set of 914 English monosyllabic words, either independent of the syllabic context (preceding and succeeding sounds) or depending on the context. Within this set of monosyllables, they found that vowel sound-to-spelling consistency was 52.9% when context was ignored. However, knowing the end of the word increased consistency to 69.7%. For example, knowing that the sound */ɛ/* is followed by */d/* makes it much more likely to be spelt *ea* (as in *bread*, *spread*, *head*, *dead* or *instead*). Similarly, Peereman et al. (2007) analyzed a set of 1.9 million French words, including complex words with derived and inflected forms. With this set of longer words, they found that sound-to-spelling consistency in French was higher for graphemes in initial (91%) and middle position (75%) than in final position (46%). In a later study, the same research team re-analyzed a subset of these inconsistent endings after sorting them by grammatical category. By doing so, Peereman et al. (2013) increased consistency counts of these word final graphemes. For example, the final phoneme */ɑ̃/* had an overall consistency of 43%. However, its consistency increased to 100% as a present participle (always spelt *ant*). Together, these studies suggest that sources of orthographic regularities differ across languages. For example, in French, *morphosyntactic* rules (i.e., grammatical rules that affect morphological segments in words) may play an important role in determining spelling of word endings. By contrast, in English, *orthotactic* regularities (i.e., the regularities in the way letters are arranged together in words) may play a major role in spelling English vowels.

Spelling error analysis presents an opportunity to assess how these linguistic constraints affect spelling across development. There have been a range of different coding systems characterizing spelling attempts in several languages (see Treiman et al., 2019 for a recent review and systematic comparison of some of those). Spelling error coding schemes vary in nature and focus, from the characterization of the phonological or orthographic plausibility/legality or visual similarity of early or atypical spellings (see, for examples, Bishop & Clarkson, 2003; Bruck & Waters, 1988; Masterson & Apel, 2010; Protopapas et al., 2013; Treiman, 1993), to more comprehensive schemes also considering the representation of morphological components in spelling (Apel & Masterson, 2001; Bahr et al., 2012; Daffern & Ramful, 2020; Salas, 2020). Because of the developmental focus of the current study, a comprehensive scheme based on the Triple Word Form theory was chosen, based on the seminal work of Bahr et al. (2012). Bahr et al. (2012) provided a comprehensive description of the spelling errors produced by American English typically-developing spellers in grades 1-9, using the framework of the Triple Word Form theory to describe spelling attempts. They used a cross-sectional design and a short free writing task (following the prompt 'One day, ... had the best day at school.'), to identify the nature of spelling errors produced by children across the school years. Errors were analyzed as either phonological, orthographic or morphological in nature, depending on whether they violated primarily phonological (e.g., *bet* for *belt*), orthographic (e.g., *wat* for *what*) or morphological (e.g., *wantid* for *wanted*) rules and regularities. Using this Phonological, Orthographic and Morphological Assessment of Spelling (hereafter referred to as POMAS), they found that the majority of errors across all grades were orthographic in nature, with orthographic errors constituting 36%-59% of the total number of errors. They also found that the proportion of each spelling error type followed a linear trend, whereby phonological and orthographic errors reduced in proportion across the years (from 26% to 12% and from 52% to 36%,

respectively), whilst the proportion of morphological errors increased, from 7% to 22%, reaching a plateau of around 20% of all errors from grade 5. These data suggest an early reliance on all knowledge types from grade 1, with errors found in all categories, but with a sharp decline in the production of phonological errors between grade 1 and 2, and the emergence of orthographic and morphological knowledge throughout elementary school. More specifically, the errors highlighted difficulties with representing long and unstressed vowels, as well as inflections, throughout the elementary school years. However, errors evolved in the sense that they tended to apply to more complex words in the later grades compared to the early grades (e.g., children might omit the final *e* in *pal* for *pale* in grade 1-4, whereas an older student might only omit it at the junction between morphemes, e.g., *lonly* for *lonely*). Bahr et al. (2012) also showed that children wrote more as they got older. So, despite longer texts, older children produced fewer spelling errors: on average, Grade 1 students produced eight misspelling per sample (representing 24% of the words in the sample), whereas Grade 5 students produced four misspellings per sample (representing just 3% of the words in the sample).

Whilst naturalistic samples of writing provide a window into the type of misspellings children produce as their writing ability grows, more constrained spelling tasks might also provide a different insight. It can be argued that, ultimately, children choose the words they spell when they are given a free writing task, whereas dictation tasks allow researchers to control the spelling targets more carefully. On the other hand, it can also be argued that higher-level processes in free writing tasks (e.g., planning, revising, Flower & Hayes, 1981) and the attention required for those processes may interfere with the spelling process (Fayol et al., 1994). Although it is not the purpose of the present paper to directly compare constrained and unconstrained spelling tasks (this is assessed systematically in other studies – see for example Bigozzi et al., 2017; Magalhães et al., 2020), we included both a free writing

and a controlled word dictation task in the present qualitative analysis, so as to account for the kind of spelling errors that may be found for both these tasks.

The time course for the development of phonological, orthographic and morphological errors in languages other than English still needs to be investigated. The POMAS represents a promising tool for tracking these developmental changes. A Spanish adaptation of this scheme was used in one study, where it allowed the authors to highlight cross-language similarities and differences in the linguistic knowledge of bilingual students learning to spell both Spanish and English (Bahr et al., 2015). The study revealed that orthographic errors were the most frequent error type in both Spanish and English, despite the transparency of Spanish as compared to English, and specifically that errors with word boundaries, capitalization of proper nouns and silent letters occurred at a high rate in both languages. However, there were also language-specific errors, such as ambiguous letters (e.g., the letter *c,* which may be pronounced as either /k/ or /s/*)* or syllable synthesis in Spanish (e.g., *te nia* for *tenía*), and unstressed vowels or consonant doubling in English (Bahr et al., 2015). Similarly, Llaurado and Tolchinsky (2016) conducted a linguistic analysis of spelling errors in Catalan, a semi-transparent writing system with a rich and transparent morphology. They highlighted the weight of orthographic and word-specific spelling knowledge on spelling performance across elementary grades, whilst morphological and phonological errors represented only a small proportion of errors in their corpus. For French, typological work on the French spelling system was conducted by Catach et al. (1995), providing a repertoire of orthographic patterns and their relationships to corresponding sounds and morphemes. A large corpus of words correctly spelled by most French elementary school students is also recorded in the EOLE database by Pothier and Pothier (2004), providing useful benchmarks for teaching typically-developing students age-appropriate words. This body of work recognizes the importance of all three linguistic knowledge sources

in spelling French. However, to our knowledge, the respective weight of phonological, orthographic and morphological errors in the elementary grades has not yet been systematically assessed in French. This is a significant omission for several reasons: 1) for practical reasons, it is important that teachers recognize errors that are typical of a developmental stage of learning to spell French, and those that may be indicative of difficulties in particular areas of the curriculum (e.g. the application of specific phonological, orthographic or morphological knowledge), 2) for clinical reasons, it is important that qualitative spelling error analysis frameworks and benchmarks are available in a range of languages, to serve the assessment of clinical populations (see Broc et al., 2021 for a recent review), and 3) for theoretical reasons, it is important that frameworks and theories are tested in a range of languages, to test their universality and specificities – in our case, to test whether the POMAS and Triple Word Form Theory are applicable to describe spelling errors and track changes in French spelling development.

Aims of the present study. The present study aims to address this gap, by providing developmental benchmarks for the qualitative analysis of spelling errors in French-speaking elementary school students. It extends previous typological work on the French spelling system, as well as previous work on Triple Word Form Theory, and contributes to recent efforts in characterizing spelling mechanisms in a range of orthographies (Desoete & Van Vreckem, 2018; Limpo et al., 2020). Specifically, we aimed to address the following research questions:

1) Does the POMAS lend itself to a French adaptation (POMAS-FR), which would reflect the linguistic sources of misspellings in elementary students' written text production and words-to-dictation? More specifically, do the linguistic sources of misspellings occur in French at similar rates and ages as observed in English (Bahr et al., 2012)?

2) What specific subcategories of errors are found at different grades in French elementary school samples?

On the basis of previous evidence of phonological, orthographic and morphological sources of knowledge involved in French spelling, we hypothesized that POMAS would provide an accurate categorization of misspellings in French. Given the morphological complexity of the French spelling system compared to English, we expected morphological knowledge to be a particular source of misspellings in French, and aimed to explore the progression and distribution of this and other error types across the French elementary grades. More specifically, based on previous typological work, we also expected morphological inflections, silent letters, diacritics (e.g., accents) and some complex grapheme-phoneme correspondences to be important sources of misspellings in French.

Methods

Ethics

Ethical approval was obtained from (blinded for review) before the study could be conducted. Permission to approach schools was also obtained from the school administrative superintendent (‘Recteur d’academie’) in the two localities where the study took place. Participant-friendly written information about the study and consent forms were distributed to families via teachers. Written consent was obtained from both parents and children on this form.

Participants.

Participants were recruited from three public urban and suburban elementary schools in the Paris region and the South-East of France, representative of the diversity of ethnic and socio-economic backgrounds for the French population. Their age ranged from 6 to 11, covering all French elementary grades, from the start of formal reading and writing instruction to the end of elementary school. Two hundred and ninety-three children were

initially tested as part of a wider project on the spelling of French and English children with DLD (blinded for review). Data from all monolingual French participants who were performing within average range on measures of spelling and non-verbal ability, and for whom no educational or developmental concerns were reported by the school and parents, were included in the present study. This sampling resulted in a pool of 194 participants. Table 1. presents the characteristics of the participants.

Please insert Table 1. here.

Measures.

Non-verbal ability. Raven's colored progressive matrices was used to check non-verbal reasoning (Raven et al., 1998) as a background measure. This test has a reliability of .80 and a concurrent validity of .91. Children were presented with a pattern to complete, and they had to choose one out of six options to complete it. Patterns and response options were presented in a colored booklet, and children recorded their response with a pencil on the response sheet.

Word spelling. Single word spelling was tested using the standardized 'Orthographe' subtest of the Wechsler Individual Achievement Test – Second Canadian French version (WIAT-II CDN F, Wechsler, 2005). This test has a reliability of .91. Children were provided with a word within a sentence, which they had to spell on a lined response sheet. The word list increased in difficulty and the task was discontinued after six consecutive word errors, as per the test manual instructions. For this reason, only the first 17 words of this task were analyzed qualitatively here, as they were spelled by all children who performed this task. The list of 17 words and their characteristics is provided in supplementary material S1. They were representative of a range of phonological, orthographic and morphological challenges of the French spelling system. Cronbach's alpha the 17 words was 0.98, indicating strong internal consistency for this short list. Children's raw score on the full list of words correlated poorly

with their raw score on the 17 words (r = -0.07, p = .37) but moderately with the number of spelling errors coded on the 17 words (see data coding procedure below - r = -0.41, p < .001). The spelling standard scores obtained from the full list of words attempted is reported in Table 1.

Text sampling. Personal narrative texts were collected using a French adaptation of the prompt from the study by Bahr et al. (2012). Children had half a minute to choose one of the following prompts: “Un jour à l’école, j’ai eu la pire des journées. ...” (“One day, at school, I had the worst day ever.”) or “Un jour, à l’école, j’ai eu la meilleure des journées. ...” (“One day, at school, I had the best day ever.”). They then wrote for five minutes to the chosen prompt. At the end of the five minutes, they were asked to finish their sentence and put their pens down. They were able to make corrections by crossing out only, within the five given minutes. Only the final (uncrossed) words were analyzed.

Procedures.

Administration. All children were administered the tasks in small groups of up to eight students, in a quiet room within their school. They were administered the word spelling task, followed by the Raven’s matrices, and the narrative writing task. Altogether, the session lasted 25-35 minutes.

Data coding. All words produced within the dictation and narrative tasks were transcribed into a spreadsheet, one line per word. Each word spelling was coded as either correct or incorrect, as a first step, before qualitative analysis. The Phonological, Orthographic and Morphological Assessment of Spelling (POMAS) coding scheme was adapted from Bahr et al. (2012) in a three-step iterative process. An initial adaptation of the coding scheme was produced inductively for French, using a subsample of 10 texts per year group, and with reference to previous typological work from Catach et al. (1995), and to the coding scheme from Bahr et al. (2012). Each spelling error from the words identified as

incorrect was assigned to one of the three categories from POMAS, depending on whether it affected primarily the phonological, orthographic or morphological form of the word. There could be more than one spelling error per word, and thus more than one error type coded for a given word. Spelling errors were also given a subcategory relevant to the French spelling system (e.g., cluster reduction within the phonological category, or word boundary error within the morphological category), which allowed for a fine-grained description of the common errors found in our French sample. These subcategories also stemmed from previous typologies in both French and English, and aimed to capture the specific sources of potential difficulties for French spelling, and errors that might be language-specific (e.g., accent-based errors) and errors that might be found in other languages (e.g., phonological cluster errors). This was done jointly by two French Speech and Language Pathology (SLP) masters students, with regular input from the first author, leading to discussions, coding decisions and adaptations to the coding scheme. Another 10 samples per year group were then further coded blindly by each of the SLP students using this adapted French POMAS. This second round of coding was then discussed with the first author, disagreements resolved, and further adjustments made to the coding scheme. Interrater agreement on this subsample, which represented over 25% of the total sample, was .79 (Cohen's Kappa). The remaining texts were randomly assigned to the two students to code following the agreed coding scheme, with any remaining problematic exemplars discussed between the two students and first author, and final coding decisions on those were agreed within the team.

This coding scheme was then applied to the 17 first words obtained from the dictation. A new team of French coders was involved, including a SLP masters student and a research assistant. Each coder was trained to use the scheme with a subset of two dictation samples per year group (N = 10 dictation samples per coder). This round of coding was then discussed with the first and second author, and understanding of the coding scheme was

refined and decisions recorded for future application to the rest of the data. A second round of coding on another two samples per year group (N = 10) allowed for further refinement and decisions to be made with the first and second author. At this point it was agreed that the coders felt confident enough applying the coding scheme, and the rest of the data was then coded independently. Only problematic exemplars were discussed with the first and second authors at this final round of coding, and decisions made on those after discussion. In order to check inter-rater reliability, the first author also coded ten randomly-selected samples from this last round of coding from each coder. Cohen's Kappa between Coder 1 and the first author reached 0.92, whilst Cohen's Kappa between Coder 2 and the first author reached 0.95.

The French POMAS coding scheme resulting from this procedure is provided in supplemental material S2, with a description and examples for each fine-grained error type, for future replications and adaptations.

Results

Analytical approach

Text productivity (measured in the number of words produced in a text) and spelling accuracy (measured as the proportion of correctly spelled words within the texts or the 17 words-to-dictation) are considered in the first instance. Phonological, orthographic and morphological errors (out of the total number of misspellings) are then compared across grades, following the POMAS-FR coding. Finally, a qualitative description of the different types of errors found in French elementary school is provided. For all quantitative grade comparisons, robust one-way ANOVAs with linear contrasts were computed, using the t1way() and lincon() functions from the WRS2 package in R (R Core Team, 2020). Effect sizes are reported using a robust explanatory measure of effect size from the same package, with ξ-values of 0.10, 0.30, and 0.50 indicative of small, medium, and large effects (Mair &

Wilcox, 2020). Robust methods were used to account for some degree of skewness in the phonological errors and productivity variables and for unequal variance in the phonological errors, productivity and accuracy variables.

Productivity and accuracy This section considers changes in productivity and spelling accuracy across grades, to account for the expected spelling growth within our sample, before proceeding to qualitative error analysis using the POMAS-FR. There were significant and large differences between grades in productivity ($F(4, 50.99) = 43.66$, $p < .001$, $\xi = 0.66$) for the texts and in spelling accuracy for both the texts ($F(4, 51.28) = 31.75$, $p < .001$, $\xi = 0.85$) and the 17 words-to-dictation ($F(4, 49.81) = 116.92$, $p < .001$, $\xi = 0.84$). More specifically, productivity and accuracy increased between Grade 1 and 2, between Grade 2 and 3 and between Grade 4 and 5, but not between Grade 3 and 4, as shown in Table 2

Table 2. Number of words misspelled, number of words produced (productivity), percentage of words correctly spelled (accuracy) and results of the linear contrasts between grades for productivity and accuracy.

Of the 194 children, two children produced no misspelling in their texts: one child in Grade 1, who produced nine words and one child in Grade 4, who produced 10 words, all correctly spelled. The dictation task was not attempted by two children in Grade 1, who were not included in any of the dictation analyses. Of the remaining 192 children, all produced at least one error on the target 17 dictated words, except one child in Grade 3, five children in Grade 4 and seven children in Grade 5, who spelled all 17 words correctly.

Please insert Table 2

Table 2. Number of words misspelled, number of words produced (productivity), percentage of words correctly spelled (accuracy) and results of the linear contrasts between grades for productivity and accuracy.

here.

POMAS-FR

In this section, we aim to address our first research question and test the suitability of the POMAS-FR to track developmental changes in linguistic sources of spelling knowledge in French. The mean proportion and mean number of each error type per grade is provided in Table 3.

Texts

The two children who had produced no errors in their texts were not included in the qualitative analysis. One child in Grade 1, whose misspellings were all illegible, was also excluded. For the remaining 191 children, there were significant and large differences between grades in the proportion of phonological ($F(4, 50.8) = 11.05$, $p < .001$, $\xi = 0.49$), orthographic ($F(4, 51.19) = 7.02$, $p < .001$, $\xi = 0.44$) and morphological errors ($F(4, 51.49) = 14.05$, $p < .001$, $\xi = 0.56$). The proportion of phonological and orthographic errors decreased in the older grades, whilst the proportion of morphological errors increased.

More specifically, as shown in Table 3

Table 3. Record of each error type in proportion of total errors and in raw numbers.

, a significant decrease in the proportion of phonological errors was recorded between Grades 1 and 3 (from 15% to 2%, $\Psi = 13[5 ; 22]$, $p = .005$, $\xi = 0.94$), followed by a plateau in Grades 3 to 5 (around 1-5%$\Psi = 1[-5 ; 7]$, $p = .58$, $\xi = 0.12$). The proportion of orthographic errors decreased steadily between Grades 1 and 5 (from 42% to 21%, $\Psi = 21[6 ; 37]$, $p = .003$, $\xi = 0.59$), with no significant single grade-on-grade decrease. Finally, the proportion of morphological errors increased steadily in proportion between Grades 1 and 5 (from 40% to

383 74%, Ψ = -34[-51 ; -18], $p < .001$, ξ =0.96), with a sharp increase between Grade 2 and 3
384 (from 47% to 63%, Ψ = -17[-33 ; 0], $p = .02$, ξ = 0.50).

385 **Dictation**

386 The children who had not attempted the dictation task or who did not produce any
387 errors on this task were excluded from the present qualitative analysis. For the remaining 179
388 children, there were significant and large differences between grades in the proportion of
389 phonological errors ($F(4, 46.33) = 9.76$, $p < .001$, ξ = 0.39) but not in the proportion of
390 orthographic ($F(4, 45.59) = 1.81$, $p = .14$, ξ = 0.37), or morphological errors ($F(4, 44.01) =$
391 1.91, $p = .12$, ξ = 0.36) produced in the first 17 words-to-dictation.

392 More specifically, as shown in Table 3, there was a significant and steady decrease in
393 the proportion of phonological errors between Grades 1 and 5 (from 20% to 1%, Ψ = 18[9;
394 28], $p < .001$, ξ = 0.98), with no significant single grade-on-grade decrease, whilst the
395 proportion of orthographic (from 62% to79%, Ψ = -17[-37; 3], $p = .17$, ξ = 0.34) and
396 morphological errors (from 17% to 8%, Ψ = 8[-10; 27], $p = .75$, ξ = 0.21) remained relatively
397 stable between Grades 1 and 5.

398 Please insert Table 3

399 *Table 3. Record of each error type in proportion of total errors and in raw numbers.*
400 here

401 **Fine-grained description of French misspellings across elementary school years**

402 This section provides a qualitative description of the specific error types found in each
403 category of the POMAS-FR, in response to our second research question. A complete table of
404 the frequency and percentages for each error type, per grade, is available in supplementary
405 material S3 (for the texts) and S4 (for the words-to-dictation).

406 **Phonology.** In the texts, whilst the grade comparisons were marked by a decrease in
407 the proportion of phonological errors, the nature of these phonological errors did not change

across grades. In grade 1 and 2, a relatively high frequency of phoneme substitutions (*p**i**tit* for *p**e**tit -little*, N = 71 in total across all grades), phoneme omissions, additions or inversions (*voi* for *voi**r** -to see*, *pla**r**fond* for *plafond -ceiling*, *av**ce*** for *av**ec*** *-with*) N = 70 in total across all grades) and errors with complex and contextual graphemes (*m**ouon**s* for *m**oin**s -less, au**s**i* for *au**ss**i -also*) were found. This last error type was the most frequent type of phonological error across grades (N = 80 in total across all grades). A similar pattern of phonological errors - with a high frequency of phonological omissions, additions and inversions - was observed in the dictation samples, (*tuli* for *tulipe -tulip, acce**s**pte* for *accepte -accepts, d**oir**te* for *d**roi**te -right*, N = 112 across grades), phonological substitutions (*t**i**lipe* for *tulipe -tulip*, N = 95 across grades), and errors on complex (*m**an*** for *m**ain*** *-hand*) and contextual graphemes (*d**ess**igne* for *d**és**igne -refers to*) affecting phonology (N = 88 across grades), all found largely in the first two grades of elementary school.

Orthography. In the texts, the nature of orthographic errors was also consistent across grades, with a decrease in frequency for most error types. Phonologically-plausible grapheme substitutions (*po**nn**ey* for *po**n**ey -pony*, N = 266 in total across all grades) and silent letter omissions/substitutions/additions (*toujour* for *toujour**s*** *-always*, N = 235 in total across all grades) were the most frequent error types across all grades. Errors with accents and other signs (*â* for *à*) were also frequent in the early grades and they remained frequent in later grades (N = 153 in total across all grades). A similar pattern was observed for the dictated words, where errors on silent letters (*plafon* for *plafon**d*** *-ceiling*, N = 406 across all grades) and phonologically-plausible grapheme substitutions (*m**in*** for *m**ain*** *-hand*, N = 385 across all grades) were the most prominent type of orthographic errors, especially in Grades 1 and 2.

Morphology. Morphological errors were dominated by word boundary errors (mostly liaison or contraction, e.g., *mon **n**anniversaire* for *mon anniversaire -my birthday*, or ***jai*** for

j'ai -I have) in Grades 1 and 2 (N = 240 in total across all grades). From Grade 2 onwards, errors with verb agreement (tense, person or gender/number marking in verb phrases, e.g., *je suis tomb**er*** for *je suis tomb**é** -I fell*) became particularly prominent (N = 419 in total across all grades), as well as other -nonverb- agreement errors (number and/or gender marking in noun phrases, e.g., *mes copine* for *mes copine**s** -my friends*, N = 233 in total across all grades), and homophone substitutions (e.g., *on **à** fait* for *on **a** fait*, N = 210 in total across all grades). In the dictation, the pattern of errors was more consistent across grades, with a majority of word boundary errors (*au**'**jour d'ui* for *aujourd**'**hui -today*, N = 88 across grades), and a moderate frequency of errors with verb (*grimpa**t*** for *grimpa – [he] climbed*, N = 69 across grade) and derivational morphology (*commencem**an**t* for *commencem**en**t – [the] beginning*, also N = 69 across grades).

Discussion

The present study used an iterative process to generate an adaptation of the POMAS for French spelling error analysis (POMAS-FR) and to analyze free five-minute written narratives and 17 words-to-dictation from 194 elementary school French students. This process resulted in a 14-category grid, capturing the three linguistic source types of the POMAS and accounting for misspellings found in our French sample. Quantitative analysis of the samples showed, as expected, that older students produced longer and more accurate texts than their younger peers, and more accurate words-to-dictation. The qualitative analysis using the POMAS-FR demonstrated that text misspellings were primarily morphological in nature, from as early as the second year of schooling, whilst orthographic errors dominated in the first year. As seen in English texts (Bahr et al., 2012), phonological and orthographic errors decreased proportionately throughout the elementary grades, whilst morphological errors increased in proportion. A different trend was observed in the words-to-dictation, where only phonological errors decreased in proportion and orthographic errors dominated

across the five elementary grades. Fine-grained analysis of the text misspellings identified that morphological errors were found at word boundaries in first grade, whilst they were affecting mostly verb and non-verb agreement from Grade 2 onwards. Complex and contextual graphemes also appeared to be a source of difficulty in both the texts and words-to-dictation, affecting the phonological plausibility of written words early on, and their orthographic accuracy in late elementary school. Silent letters were also an important source of orthographic misspellings in both the text and dictation samples.

Spelling error analysis as a window into linguistic knowledge involved in French spelling across primary grades

By attempting a direct adaptation of the POMAS to French, the present study aimed to assess the suitability of this three-category linguistic framework for describing French misspellings in elementary school. Of all the spelling errors coded across our sample (N = 3763 in total across both tasks), all could be attributed to one or the other of the three categories, and all three linguistic error types were present across the sample. After discussions about the different subcategories, agreement could be reached, with no overlap between categories. In that sense, our coding scheme differed from that of Bahr et al. (2012), who allowed for between 10% and 20% of errors in their elementary education samples either to be not coded, or to be in mixed/overlapping categories. We made the choice, by contrast, to make these categories mutually exclusive, and to agree on the most suitable category for a given error through discussions within the coding team. These discussions led to the refinement of the coding scheme and to potentially controversial decisions. For example, we posited that errors on complex and contextual graphemes were phonological in nature if they affected the phonological plausibility of a words (e.g., *mian* for *main*, coded as an ‘Error on a complex grapheme affecting phonology”) but orthographic in nature if it did not affect phonological plausibility (*min* for *main*, coded as an “orthographic substitution error”). In

principle, both of these errors likely stem from a lack of knowledge for a complex grapheme (i.e., in this case the trigraph *ain*, representing ɛ̃, which may be spelled in French *in*/*ain* or even *im*/*aim* depending on the context), rather than a misrepresentation of the word's phonological structure within the child's phonological lexicon. Indeed, in other coding schemes, these might both have been coded as orthographic errors (e.g., see for example the 'Mental Graphemic Representation' category of errors proposed by Apel & Masterson, 2001, which could have been applied to both errors above). The strong interrater reliability of our coding in both teams of coders suggests strong commonalities in our understanding of the linguistic knowledge involved in French spelling. And in fact, between-category disagreements were rare once the coding scheme was established and all coders trained.

Another early source of ambiguity during the coding process stemmed from subcategories of errors that could overlap within a category. For example, within the phonological category, a cluster reduction (e.g., *ros* instead of *gros*) could be considered to be both a 'Phonological cluster error' and a 'Phonological omission' error within our scheme. For these errors, we prioritized what we reasoned to be the potential source of the error (e.g., here the cluster, which might be difficult to perceive and represent for some children early on), rather than a descriptive labelling of the error (e.g., an omission). Similarly, within the orthographic category, discussions happened around potentially overlapping categories such as 'Orthographic omissions' and 'Orthographic - silent letters'. Again, an error such as the omission of the silent letter *d* at the end of *plafond* could have been attributed both these codings – and again, we decided to provide a label that would indicate the potential pattern on which the error occurred (e.g., here the final silent letter *d*, which seemed to be a common source of error, and could be replaced by other common silent letters, as well as omitted), rather than describe its nature (the omission per se).

The POMAS allowed us to anticipate the type of knowledge that would have led to a correct spelling for the child's attempt, with clear implications for teaching and scaffolding spelling knowledge. For example, a teacher who analyzed the spelling attempts described above might be able to focus their lesson on particular aspects of spelling that remain difficult for their class. Following the examples above, they might focus their lesson on teaching the complex grapheme *ain*. However, for those students who produced *mian* for *main* , they might explicitly teach the strategy of checking phonological plausibility (e.g., does *mian* represent all the sounds for /mɛ̃/ ?). For those students who have produced *min* for *main,* they might specifically teach orthographic strategies (e.g., teaching the analogy between *main,* and *pain, train, grain, gain, nain* or other monosyllabic nouns ending in ɛ̃ with the same spelling pattern). The idea that spelling error analysis can inform teaching is not new. However, often spelling error analysis systems have been applied to early and/or invented spellings (Lee & Al Otaiba, 2017; Stage & Wagner, 1992; Tangel & Blachman, 1992; Treiman et al., 2019), and have not considered the breadth of linguistic knowledge children may develop as they evolve through the elementary years (but see the recent study by Daffern and Fleet (2021), using the Triple Word Form Theory to inform targeted teaching of spelling in Grades 3-6).

Another potential application of the POMAS-FR might be the detection of children with difficulties in specific language domains (e.g. children with DLD, see recent qualitative spelling error analyses for French spellers with DLD by Broc et al., 2014; Godin et al., 2018; Joye et al., 2020, and see Broc et al., 2021 for a review of the type of spelling errors produced by this population in a range of languages). With this French adaptation of the POMAS, we hope to provide a comprehensive system of analysis for the elementary years, that highlights the importance of not only phonological and orthographic but also morphological knowledge in spelling French accurately. We also hope to provide developmental benchmarks against which a range of atypical French-speaking populations may be assessed in future.

Finding a fit-for-purpose spelling task for spelling error analysis

One of the striking findings of the current study was the discrepancy in quantitative spelling results between the dictation and text production tasks. Whilst text length increased with age, so did spelling accuracy, meaning the number of spelling errors remained relatively stable across the elementary ages (between 8 and 12 errors coded across all grades), offering opportunities for a broad range of errors at all grades. On the other hand, accuracy on the 17 words from the dictation reached a ceiling after Grade 3, which left very few spelling errors to code in the later grades (between 2 and 5 errors coded on average in Grades 3 to 5, as opposed to 12 and 20 on average in Grades 1 and 2), and very little scope for tracking trends in the sources of phonological, orthographic and morphological knowledge involved in later grades. This may be overcome in future studies by developing dictation tasks that provide a broader range of opportunities for spelling error across grades. Recent efforts have been made in this direction in English (see for example the pseudoword spelling task developed by Daffern & Ramful, 2020), but are yet to be replicated in French and other languages. Qualitatively, however, there was some consistency between the types of errors found in both tasks, and opportunities for most error types were present in the 17 words selected, as 13 of the 14 categories of the POMAS-FR were applied to code those, and some consistency in the distribution of subcategories of errors across grades for both tasks. This suggests that regardless of the task used, orthographic patterns such as silent letters and complex and contextual graphemes are recurrent and long-lasting sources of difficulties in French spelling, in line with the opacity of the French orthographic system described in introduction.

Why is morphology so difficult in French?

An important aspect of our analysis was the importance of morphological errors. This is in contrast with previous studies in American English (Bahr et al., 2012) and Catalan (Llaurado & Tolchinsky, 2016; Salas, 2020), where orthographic errors represented the

majority of misspellings. Firstly, there is an extensive literature on the role of derivational morphology in learning to spell French (Pacton et al., 2013; Sénéchal et al., 2006). Secondly, there is also evidence suggesting that applying verb agreements in French spelling is a highly demanding activity in terms of attention and cognitive resources, even in skilled French spellers (Fayol et al., 1994). We thus expected morphological knowledge to play an important part in the errors found in our sample. Certainly, our results exceeded our expectations, with over 70% of text errors being classified as morphological in nature in the last year of elementary school (compared to about 20% of errors in the English sample of Bahr et al., 2012). By comparison, orthographic and phonological errors represented a small proportion of the errors encountered in our text samples (around 20% and 1% respectively in Grade 5), compared to their American English sample (around 40% and 15% respectively, also in Grade 5). It is also worth mentioning that although in proportion, morphological errors increased in texts, in relative number, they remained relatively stable (around 6-8 morphological misspellings per sample across the elementary grades). In fact, when opportunities for those morphological errors were constrained to only a couple of words in the dictation task, they remained relatively low, and decreased to marginal levels in the later grades (from 17 to 8% in proportion, from 3 to 0 in raw numbers between Grade 1 and 5).

Their nature, however, changed over time: from segmentation and liaison errors in Grade 1, they became primarily agreement (and in particular verb agreement) errors in later grades. Unconventional segmentations in early spelling have been reported in other languages and they have been related to reading, vocabulary and morphological awareness (Correa & Dockrell, 2007), suggesting that exposure to written language and increasing decoding skills support the development of orthographic and morphological knowledge for early word segmentation -and spelling. In our coding, we had also highlighted specific oral and written conventions (liaisons and contractions) as potential sources of errors. The large number of

582 unconventional segmentations at the point where liaisons happen in oral language seems to
583 reflect refinement mechanisms that happen in French *oral* lexicon development. Indeed,
584 errors such as '*un nèbre*' for '*un zèbre*' (*a zebra*) are still present in 5-6 year olds' oral
585 language, and are relatively common in 4-5 year-olds (Chevrot et al., 2005).
586 The emergence of errors with inflectional morphology in later grades suggests that
587 once children acquire a set of functional words for them to spell -and segment- correctly, they
588 may attempt longer and more complex sentences requiring the application of agreement. This
589 argument is partially supported by the overall increase in text length across elementary
590 grades, and by the comparatively low frequency of these errors in the dictation task in later
591 grades. Analysis of sentence length and complexity might provide further evidence in that
592 direction.
593 The relatively low number of errors with derivational morphemes in the texts is also
594 noteworthy. If inflectional morphology seems to represent a source of difficulty in our
595 sample, derivational morphemes, on the other hand, are a source of consistency that might
596 support rather than hinder French spelling (Casalis et al., 2018). There was a very low
597 occurrence of this error type in our text sample, and we consider this low error rate an
598 indicator of the consistency of these units in spelling French. The inclusion of the derived
599 word '*commencement*' (*the beginning*) in the dictation did result in some errors of this nature,
600 but they were largely restricted to Grade 1 and 2. The inclusion of more morphologically-
601 complex words in future dictation tasks may allow to track the development of a broader
602 range of prefixes and suffixes relevant to learning to spell French.
603 Recently, Weth (2020) called for "syntactic" markers to be distinguished from
604 "morphological" (derivational) markers in spelling (but see also Morin et al., 2018; Van
605 Reybroeck, 2020 for a similar argument). Our data for French also suggests different
606 mechanisms might be at play in the spelling of syntactic and derivational units, with

syntactic/inflectional spelling being a particularly important element of spelling competence in French.

Spelling developmental trajectories: teaching/learning phases or interplay between different linguistic knowledge sources at all grades?

In terms of the trends observed across elementary school, there were some similarities between our results and those of the American study by Bahr et al. (2012). In both our study and theirs, the proportion of morphological errors in texts increased linearly throughout the elementary grades, whilst orthographic and phonological errors decreased. It was the rate of each of these error types that differed in the two languages (orthographic errors being the main source of errors in English, whilst morphological errors were the main source of errors in our French data). This overall trend in results suggests a development of spelling competence relying more and more on morphological knowledge as children get older. There are several possible interpretations to these data. On the one hand, this seems consistent with phase theories of spelling development, which consider morphology to be a later acquired spelling skill, whilst the early stages of learning to spell focus primarily on phonological and orthographic mappings (Ehri, 1987; Frith, 1980). On the other hand, this is also consistent with the French curriculum. –Because French includes many (and often silent) morphological markers on verbs, the teaching of inflectional morphology spelling only starts at grade 2 and continues until the end of middle school (Ministère de l'éducation nationale, 2020), well beyond the age range for this study. The more inflectional markers children know, the more they try to use them and the more mistakes are made initially.

Nevertheless, our fine-grained analysis of errors also suggests some interplay between the different knowledge sources early on. For example, morphological segmentation and word boundary errors often related to the application of phonological (e.g. *mon nanniversaire* (my birthday), where the liaison is phonologically represented) or orthographic knowledge

(e.g. *ma méière à mi [ma meilleure amie] (my best friend)*, where word segmentation likely reflects the child's sensitivity to frequent words they have read or seen in writing *-à-*, as well has their use of phonological information, *-mi-*). Similarly, morphological errors with word agreement, already present in the earliest spellers' data, also reflected young children's sensitivity to common orthographic patterns (e.g. *on écrie* (we write), where the final silent letter *-e* likely reflects the child's orthographic sensitivity to the frequent final silent letters of French). So, if different developmental moments seem to represent specific challenges, it also seems that the full range of linguistic knowledge types are present and interacting early in the spelling of French students (consistent with Bahr et al., 2012; Llaurado & Tolchinsky, 2016; Salas, 2020).

The importance of looking across languages to identify the markers of development in spelling and writing competence

The patterns of development in each linguistic error type described above needs to be considered in the context of the overall development of spelling and writing. In our French sample, children's text production increased from an average of 11.05 words per text in 5 minutes, with 6.65 misspelled words in Grade 1, to writing an average of 40.74 words per text and 6.89 misspelled words in Grade 5. It is worth noting that in the English study of Bahr et al. (2012), productivity and accuracy were much higher (from 7.88 misspelled words out of 34.1 produced in grade 1 to 3.91 misspelled words out of 127.6 in grade 5). So effectively, productivity and accuracy levels were similar in Grade 1 of the first (English) study, and in Grade 5 of our (French) study.

There may be a number of methodological and contextual explanations for this difference in productivity and accuracy (e.g., the fact that accuracy and productivity were averaged across two different writing tasks in the American sample, and the fact that there is little focus at present on writing practice in the French curriculum). Nevertheless, our result

seems consistent with direct comparisons of French and English written samples from children with DLD (assessed on the same task and in the same conditions, blinded for review), which have shown discrepancies between productivity and accuracy rates in writing tasks across French and English, with the English students producing more writing overall and more accurate texts. This suggests that French inflectional morphology may not only represent a constraint for spelling, but for writing more generally. This is also in line with at least one previous study contrasting English (orthographically opaque and morphologically-simple and transparent), Catalan (semi-transparent and morphologically-rich and transparent) and Spanish (transparent, both orthographically and morphologically) on a comparable writing task (Llaurado & Dockrell, 2020). Only in the most opaque orthography (English) was spelling predictive of writing quality, whilst reading skills and handwriting determined text quality and productivity in the more transparent languages. With its high orthographic and morphological opacity, French writing productivity and quality may also well be hindered by spelling (and particularly morphological spelling), even in comparison to English.

Limitations and recommendations

Despite the unique contribution of our study there are a number of limitations which impact the conclusions. Participants were drawn from only three schools, just under 200 participants in the sample, and only monolingual students were included in the current analysis. Future studies may consider both bilingual and monolingual learners in separate analyses (see Salas, 2020, for an example of such analyses). Furthermore, the words from the dictation task, whilst representative of a range of spelling difficulties of the French orthographic system, was not balanced for opportunities in each linguistic knowledge type. Future studies may address this by providing a controlled set of words or pseudowords (see Daffern & Ramful, 2020 for an example in English). Similarly, whilst ecologically valid, our

writing task was free and so gave children the opportunity to choose the words they spelled. Finally, the overall relationship between linguistic spelling-related skills, spelling and writing was not formally explored in the present study. We restricted our analysis to the development of the coding scheme and its use to provide a linguistic snapshot of the spelling errors produced in French for each year group. Further studies may want to explore this link further, as a way to further investigate the linguistic skills underpinning spelling and writing in French.

Conclusion

The present study offers a characterization of the spelling errors produced by French children across elementary grades. It adapts and uses a linguistic coding scheme, based on Triple Word Form Theory, POMAS, for French. The resulting coding scheme (POMAS-FR) is available in this paper and open to further adaptations and applications to a range of clinical populations. In the present analysis, it allowed us to highlight the weight of morphological knowledge (and especially knowledge and application of verb agreements) in spelling competence in French. It also showed the progressive shift in spelling competence, from relying on phonological and orthographic knowledge in the early phases of spelling, to relying more heavily on morphological knowledge as sentences become more complex. There are some commonalities and differences between the present results and those of previous studies in either more or less transparent languages. The combined evidence indicates that spelling competence draws on a growing range of linguistic skills as children become more proficient spellers. However, the type of linguistic skills children rely on at the different stages may vary, depending on the opacity and morphological complexity of the language considered.

Acknowledgements

We would like to thank the schools and children who participated to this study. We would also like to thank Ruth Bahr and Elaine Silliman for providing an American English version of POMAS for the present French adaptation, and Jeanne Lebrun, Pamela Parent, Charlotte Texier and Sandrine Belkadi for their help with data coding.

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Supplemental material provided

Supplemental material S1 provides a table detailing the characteristics of the 17 words used from the WIAT dictation task.

Supplemental material S2 is a table describing the French POMAS (POMAS-FR) coding scheme, with examples of errors for each category, from both tasks.

Supplementary material S3 provides a contingency table for the number and proportion of each fine-grained spelling error type across grades in text production.

Supplementary material S4 provides a contingency table for the number and proportion of each fine-grained spelling error type across grades in the WIAT dictation task.

Tables

Table 1.

Table 1. Characteristics of the participants

Grade	N (girls)	Mean age (SD)	Mean Raven (SD)	Mean WIAT (SD)
1	32 (19)	6.8 (0.4)	105.2 (15.6)	110.7 (11.2)
2	54 (40)	7.7 (0.3)	102.8 (18.5)	106.8 (7.6)
3	24 (15)	8.6 (0.3)	119.0 (11.8)	105.7 (7.6)
4	41 (23)	9.7 (0.3)	111.0 (12.8)	99.7 (9.9)
5	43 (24)	10.7 (0.4)	109 (11.9)	100.3 (10.8)

Notes. The Raven's Coloured progressive matrices assess non-verbal performance, whilst the Wechsler Individual Achievement test (WIAT) assesses word spelling. Each group's performance on these tests is expressed in standard scores, which have a mean of 100 and a standard deviation of 15. Age is given in years.

Table 2

Table 2. Number of words misspelled, number of words produced (productivity), percentage of words correctly spelled (accuracy) and results of the linear contrasts between grades for productivity and accuracy.

	Grade (N)	Number of words misspelled[1]	Productivity - Number of words produced[1]	Productivity - Comparison to previous grade[2]	*p*[3]	ξ[4]	Accuracy - Percentage of words correctly spelled[1]	Accuracy - Comparison to previous grade[2]	*p*[3]	ξ[4]
Texts	1 (32)	6.65 (0.85)	11.05 (0.86)				37.87 (4.91)			
	2 (54)	8.00 (0.93)	19.21 (1.50)	-8 [-13 ; -3]	<.001***	0.62	56.48 (2.51)	-19 [-35 ; -3]	.005**	0.48
	3 (24)	8.69 (1.09)	28.63 (3.10)	-9 [-19 ; 0.3]	.01**	0.43	69.16 (2.85)	-13 [-23 ; -2]	.004**	0.59
	4 (41)	7.16 (0.61)	28.68 (2.63)	0 [-11 ; 11]	.99	0.14	72.97 (2.23)	-4 [-14 ; 6]	.27	0.15
	5 (43)	6.89 (0.91)	40.74 (2.58)	-12 [-23 ; -2]	.007**	0.46	81.35 (1.58)	-8 [-16 ; -0.5]	.007**	0.52
Dictation	1 (30)	11.5 (0.49)	17 (0)				32.35 (2.86)			
	2 (54)	7.79 (0.38)	17 (0)				54.15 (2.23)	-22 [33 , -12]	<.001***	0.96
	3 (24)	4.13 (0.40)	17 (0)				75.74 (2.38)	-22 [-31 ; -13]	<.001***	1.13
	4 (41)	2.96 (0.41)	17 (0)				82.13 (2.40)	-7 [-16 ; 3]	.04	0.33
	5 (43)	1.52 (0.22)	17 (0)				91.07 (1.29)	-8 [-16 ; 0]	<.007*	0.54

Notes. [1]Robust Mean (Standard Error) per grade, computed with 20% trimming, [2]Robust paired mean differences Ψ with 95% confidence interval, adjusted for multiple testing, [3] significance levels at * $p < .05$, ** $p < .01$, *** $p < .001$, *p*-values are also adjusted for multiple testing, [4]robust measure of effect size, with ξ-values of 0.10, 0.30 and 0.50 indicative of small, medium and large effect sizes.

Table 3

Table 3. Record of each error type in proportion of total errors and in raw numbers.

	Grade (N)	Proportion of phonological errors in total errors[1]	Raw number of phonological errors[1]	Proportion of orthographic errors in total errors[1]	Raw number of orthographic errors[1]	Proportion of morphological errors in total errors[1]	Raw number of morphological errors[1]	Total number of all errors produced[1]
Texts	1 (30)	15.27 (2.16)	1.72 (0.25)	42.40 (2.91)	4.39 (0.72)	39.94 (2.88)	4.39 (0.71)	10.83 (1.31)
	2 (54)	10.63 (2.16)	1.32 (0.25)	40.90 (2.94)	4.94 (0.64)	46.62 (3.07)	5.18 (0.70)	12.06 (1.34)
	3 (24)	1.97 (1.86)	0.19 (0.16)	32.28 (4.98)	3.19 (0.70)	63.33 (4.98)	6.75 (0.84)	10.38 (1.44)
	4 (40)	5.19 (1.69)	0.54 (0.21)	24.90 (3.46)	2.00 (0.34)	65.72 (4.17)	5.58 (0.43)	8.71 (0.83)
	5 (43)	0.84 (1.17)	0.11 (0.11)	21.23 (4.56)	1.74 (0.41)	74.33 (5.05)	5.11 (0.61)	7.59 (1.00)
Dictation	1 (30)	19.63 (2.60)	3.94 (0.53)	61.67 (2.31)	11.72 (0.58)	16.83 (0.95)	3.28 (0.15)	19.61 (0.63)
	2 (54)	16.31 (2.61)	1.94 (0.27)	62.75 (2.44)	7.91 (0.36)	18.53 (1.15)	2.24 (0.18)	12.24 (0.75)
	3 (23)	12.17 (5.48)	0.67 (0.31)	71.34 (8.94)	3.67 (0.54)	10.65 (3.76)	0.60 (0.18)	5.33 (0.65)
	4 (37)	12.16 (5.71)	0.50 (0.14)	61.46 (4.78)	2.32 (0.35)	13.66 (4.35)	0.64 (0.22)	3.91 (0.43)
	5 (36)	1.17 (1.96)	0.09 (0.12)	78.73 (6.37)	1.41 (0.23)	8.44 (5.92)	0.27 (0.14)	1.86 (0.34)

Notes. [1]Robust Mean (Standard Error) per grade, computed with 20% trimming