Spelling with a developmental language disorder: predictors, strategies and error patterns in French- and English-speaking students at the end of primary school

Nelly Joye

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The present work was conducted under the supervision of Professor Julie Dockrell and Professor Chloë Marshall, Department of Psychology and Human Development, Institute of Education,

University College London

For my father Jean-Claude and my niece Eulalie

I, Nelly Joye confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Developmental Language Disorder (DLD) affects the development of phonological, semantic, morphological and syntactic aspects of language, putting children with DLD at risk of spelling difficulties. Despite a growing literature on the literacy outcomes of children with DLD, spelling difficulties in children with DLD and their underlying mechanisms are still under-researched. Furthermore, research in this population has largely focused on word-level spelling skills, on English spelling and on children who are in the early stages of learning to spell.

In the present study, the spelling skills of 17 English children with DLD in grades 3-6 were compared to those of 17 children matched on chronological age (CA), and 17 children matched on spelling ability (SA). Likewise, 17 French children with DLD in grades 3-5 were compared to 17 CA and SA peers. The two language groups were also compared overall. Spelling was measured using a task of word dictation and a task of text production. The spelling errors and strategies of children with DLD were analysed quantitatively and qualitatively to identify potential markers of languages difficulties in their spelling. Another aim of the study was to characterise the skills underpinning spelling in these two languages. This was assessed using correlation and regression analyses between spelling skills and proximal measures, within and across languages.

Results point to differences in the rate and type of errors across languages and ability groups. Strategy analysis further supported the hypothesis of differentiated spelling strategies in

French and English and ascertained that children with DLD have difficulties using more elaborate and efficient spelling strategies. Predictor analysis revealed that underlying processes may be similar across languages, despite differences in the linguistic units being processed.

The results are discussed with regards to current theories of spelling development and spelling markers of DLD across languages in late primary school.

Impact statement

Although children with DLD are often reported to experience spelling difficulties, it is still unclear how these difficulties come about and how they could be supported. By using a linguistic framework to analyse the spelling errors and strategies of children with DLD, the present study contributes to the refinement of this issue. The linguistic framework for spelling errors and strategies used in the present study constitutes a tool for a detailed and theory-driven assessment of spelling difficulties, as well as a base for the development of future interventions with this population of students. The identification of specific areas of spelling difficulties in the DLD population further contributes to the literature on potential markers of DLD in late primary school.

Another aim of the study was the refinement of theories of spelling development across languages, as a way to move away from an ‘‘anglocentric’’ view of literacy development (Share, 2008). By identifying mechanisms and linguistic units involved in the spelling of French and English at the end of primary school, the current study explores a gap in the literature. It highlights the importance of considering both word-level and text-level spelling skills and encourages further cross-language investigations, using languages contrasted for phonological and morphological complexity, and looking at spelling skills beyond the first years of instruction.

From a practical perspective, results from the present work may be used to: a) support the identification of DLD using written samples in late primary school in French and English, b)

support the profiling of spelling difficulties, with the use of a linguistic framework for analysing spelling errors and/or strategies, c) provide a base for future interventions based on the weaknesses identified in this population of students. From a theoretical perspective, the present results may be used to: a) inform the theories on developmental language disorders across languages, by describing common and language-specific errors that may index affected linguistic mechanisms; b) inform theories of spelling development across languages by identifying common and language-specific skills determining spelling outcomes.

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Chapter 1. Introduction

1.1. Rationale for the study

Learning to spell requires a range of skills related to linguistic knowledge (Bahr, Silliman, Berninger, & Dow, 2012; Masterson & Apel, 2010; Protopapas, Fakou, Drakopoulou, Skaloumbakas, & Mouzaki, 2013; Wilson & Koutsoftas, 2015). First of all, spelling requires being able to match units of sounds to corresponding letters, by a so-called phonological procedure. This procedure is of use when children spell regular words, that is to say words whose letters and sounds match perfectly (such as *kit* /kɪt/). Second, young spellers might have to use their orthographic knowledge. Sometimes, there is more than one way to spell a sound. Orthographic rules, regularities and representations can help a child choose between possible alternative spellings. For example, rules might help a child choose *receive* over **recieve* (rule 'i before e, except after c'). Regularities might help a child choose *cry* (frequent initial cluster) over **kry* (infrequent initial cluster). When regularities and rules cannot account for the word's spelling, memorization of the orthographic representation might be needed. This is what may be used to remember exception words such as *weird*. Thirdly, knowledge of derivational and inflectional morphology plays a role when spelling a word that has a derived or inflected form. Derivational morphology is involved in the formation of new words from existing ones. For example, the stem *heal* and suffix *-th* generate the noun *health*. Importantly, the spelling of *heal* remains the same in *health* despite a change in pronunciation. By contrast, inflectional morphology is involved in grammatical transformation of words. For example, the suffix *-ed* changes *need* and *work* into their past

tense forms *need**ed*** /niːd**ɪd**/ and worked /wɜːk**t**/. Again, the spelling of the suffix *-ed* is consistent despite pronunciation variations. Finally, semantic knowledge might be required to disambiguate homophones (words that sound the same but have a different meaning, e.g. *allowed*/*aloud*). Figure 1-1 presents the framework for spelling ability used in the present study, and based on the types of knowledge described by Masterson and Apel (2010) and outlined above.

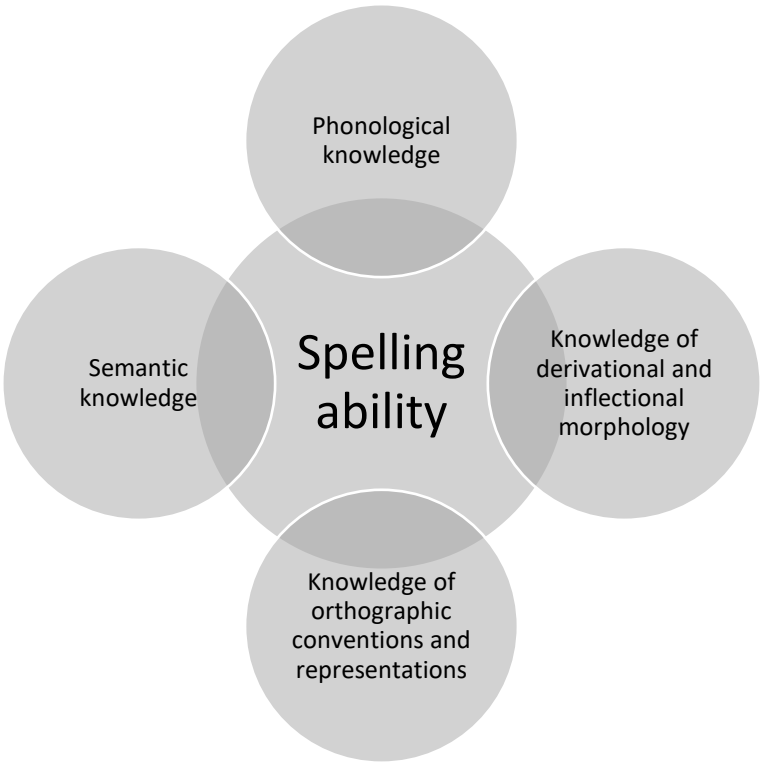

Figure 1-1: Linguistic framework for spelling ability, as described by Masterson and Apel (2010)

Children may use these different types of knowledge depending on the context (e.g. morphological knowledge might be of use to spell *magician*, but not *kit*), and their own skills (e.g. children need to know the suffix *–ian* in order to use it in *magician*). It is likely that both the complexity of the words children are expected to write and their ability to use a wide range of knowledge to do so will evolve with their level of schooling and language abilities (Apel & Masterson, 2001).

What if some of the linguistic information available to children is underspecified, as is the case in Developmental Language Disorder (DLD)? The difficulties of children with DLD for reading accuracy, fluency and comprehension have now been investigated in a large body of studies (Snowling & Hulme, 2005). Fewer studies, however, have investigated their difficulties in the production of written words and texts, despite long-attested difficulties in this area (Dockrell & Connelly, 2015). In order to understand the persisting difficulties experienced by children with DLD at school-age, it is important that research looks closely at their spelling profiles.

Cross-linguistic studies of literacy development have emerged in the last few decades, often with a focus on the impact of orthographic consistency on reading and spelling development. Orthographic consistency - that is to say the consistency with which a speech sound is represented by the same letter(s), and the same letter(s) represent(s) the same speech sounds - has indeed been found to affect the rate at which reading develops. In the middle of the first year of formal reading instruction, students learning to read consistent languages such as Greek, Finnish, German, Italian and Spanish were fully proficient at reading a list of words and non-words representative of their orthographic system. By contrast, children learning to read less consistent languages such as French, Danish, Portuguese, and most strikingly English, achieved lower reading accuracy (Seymour, Aro, Erskine, & collaboration with COST Action A8 network, 2003). When it comes to spelling beyond grade 2 however, English is less strikingly an "outlier" (Share, 2008). In a large cross-linguistic European study, English and French children in grade 3-7 performed in line with their European peers considered to be learning more consistent languages (Moll et al., 2014). This result suggests that more than sound-to-letter correspondences are involved in learning to spell inconsistent languages such as French or English beyond grade 2. Other types of abilities, such as morphological knowledge, knowledge of orthographic conventions and representations, might be more important in these inconsistent languages as children get older.

The present study will exploit the inconsistencies of French and English orthographic systems to assess the contribution of a wide range of linguistic knowledge to spelling performance at the end of primary school. It will use three different methods to do so: spelling error analysis, spelling strategy analysis, and analysis of the role of metalinguistic skills in predicting spelling performance. This will be done with the ultimate goal of 1) informing theoretical frameworks for spelling development in two different orthographic systems, both considered to be inconsistent; and 2) assessing potential markers of DLD in English and French spelling, in late primary school.

1.1. Outline of the thesis

The thesis will be organised in two parts, covering in turn theoretical perspectives and experimental studies.

Part I will cover literature on French and English orthographic and linguistic characteristics (Chapter 2), define and characterise Developmental Language Disorder (Chapter 3), and present a range of methodologies available to assess spelling processes in typical and atypical populations (Chapter 4), leading to the research questions (Chapter 5).

Part II will detail the methodology of the study conducted (Chapter 6), and present its main results: with regards to spelling error analysis (Chapter 7), spelling strategy analysis (Chapter 8) and predictors of spelling (Chapter 9). The results are discussed in Chapter 10.

Figure 1-2 illustrates the thesis structure. The thesis assesses how orthographic characteristics (top-left box) and participant characteristics (top-right box) affect spelling products, strategies and predictors (bottom box). Each theoretical chapter reviews the literature on one box of the diagram, whilst results chapters focus on the impact of orthographic and participants characteristics on the three outcome measures of interest (products, strategies and predictors).

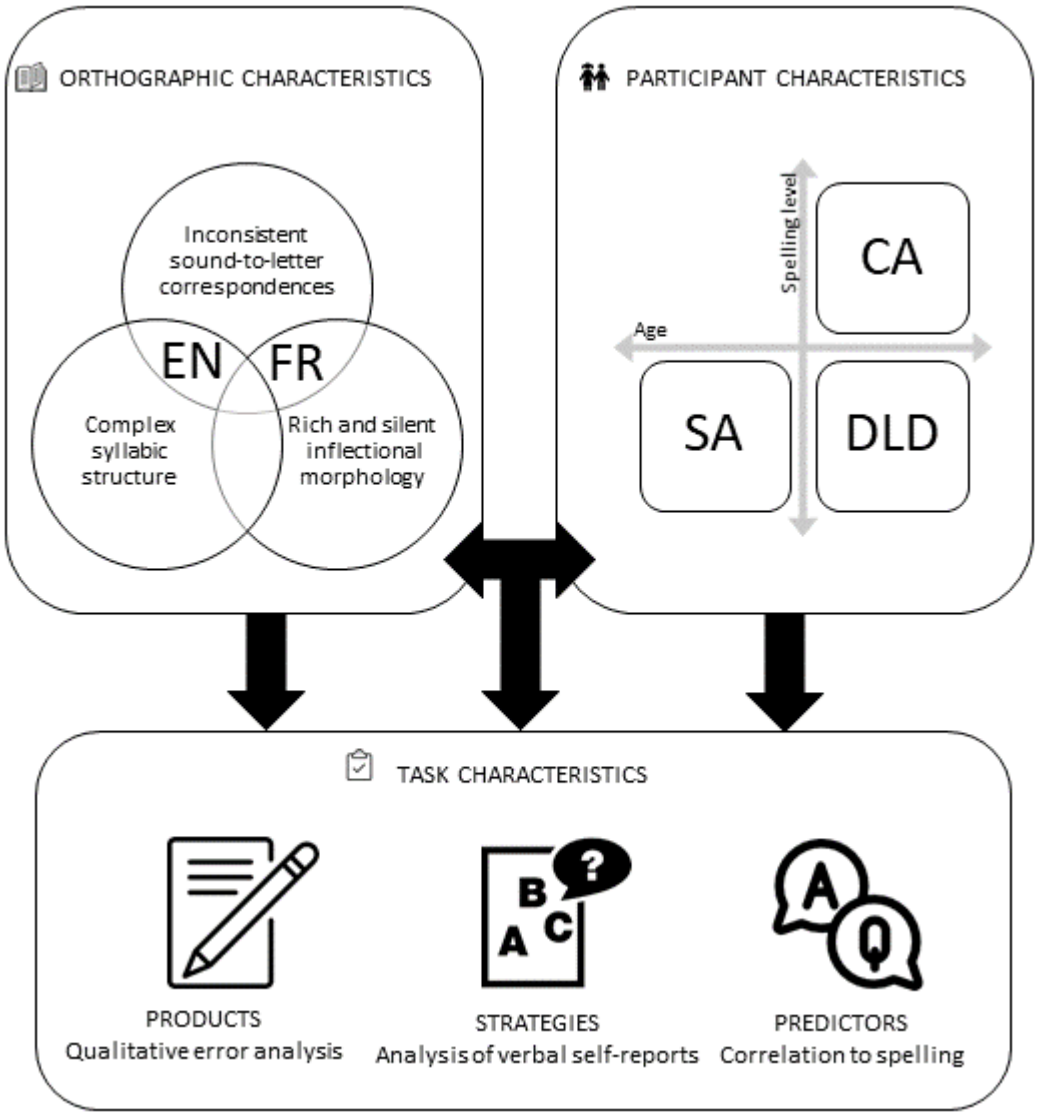

Figure 1-2: Study design with orthographies, participants and tasks characteristics.

Part I. Theoretical perspectives

Chapter 2. Characteristics of the French and English writing systems, spelling development and instructions

This chapter will focus on a) the specific features of the French and English orthographic and linguistic systems, b) school systems and spelling instruction, and c) theories of spelling development. Implications of the literature reviewed for the current study will be discussed. Figure 2-1 summarises the main themes addressed in Chapter 2.

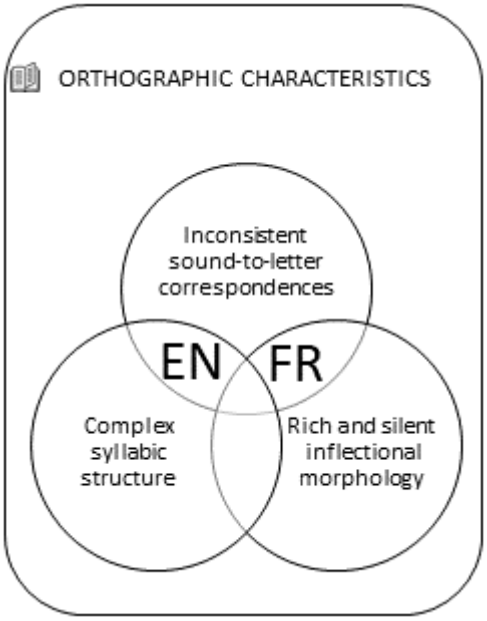

Figure 2-1: French and English orthographic characteristics as outlined in Chapter 2

2.1. The English and French writing systems

French and English are alphabetic writing systems, meaning that sounds of the language (or phonemes) are represented by letters (or graphemes). They are both represented by the Latin or Roman alphabet. The sections below provide an overview of the constituents of French and English that are represented orthographically, and that can impact spelling development.

2.1.1. Orthographic consistency

French and English are both considered to be inconsistent orthographies. They both rely on the same 26 letters of the Latin alphabet to represent the 39 sounds of French and the 44 sounds of English (Sprenger-Charolles, 2003). In a hypothetical perfectly consistent alphabetic system, it would be expected that 26 letters represent 26 sounds in a one-to-one match, and vice-versa. However, it is estimated that French has around 130 different graphemes (sets of letters to represent a sound), and English has about 1120. Furthermore, the mapping between these letters and sounds (further referred to as graphemes and phonemes) differs very much between the two languages. Attempts have been made to quantify the ambiguity of spellings for a phoneme (phoneme-to-grapheme consistency, PGC), and the ambiguity of readings for a grapheme (grapheme-to-phoneme consistency, GPC). Phoneme-to-grapheme consistency is measured by counting the number of times a phoneme is represented by a grapheme (e.g. /f/ by <f>[1]), and the number of times a particular phoneme (e.g. /f/) is found, whatever its spelling. If all occurrences of the sound /f/ were represented by the grapheme <f>, consistency would equal 100%. However, as there are other infrequent grapheme associations (<ph> and <ff>) for the phoneme /f/, consistency for this association drops to 98% in French (Peereman, Lété, & Sprenger-Charolles, 2007).

[1] Throughout the thesis // indicate a phonemic transcription using the International Phonetic Alphabet, whilst <> indicate specifically the written form of a word. An asterisk before the word indicates an erroneous form (e.g. <*helth>).

Similarly, grapheme-to-phoneme correspondence is measured by counting the number of times a grapheme represents a phoneme and the number of times this particular grapheme is found, whatever its pronunciation.

Two parallel studies in French and English have attempted to map graphemes and phonemes of French and English orthographic systems in both directions (i.e. phoneme to grapheme and grapheme to phoneme, Ziegler, Jacobs, & Stone, 1996; Ziegler, Stone, & Jacobs, 1997). In both orthographic systems, consistency is higher in the reading (grapheme to phoneme) than in the spelling direction (phoneme to grapheme). However, the two studies report an asymmetry of the French and English systems, French being more consistent than English in the reading direction (87.6% consistency as opposed to 69.3% in English), but less consistent in the spelling direction (20.9% as opposed to 27.7% in English). It is to be noted that this mapping was based on monosyllabic words only, which are unrepresentative of the breadth and complexity of written words in both languages, and possible other regularities (such as morphological or orthographic regularities). In an attempt to refine these consistency counts, Kessler and Treiman (2001) analysed the spelling consistency of a set of 914 English monosyllabic words (accessible to both adults and children), either regardless 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) analysed 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 authors re-analysed a subset of these inconsistent-endings after sorting them by grammatical category. By doing so, Peereman, Sprenger-

Charolles, and Messaoud-Galusi (2013) increased consistency counts of these word final graphemes, sometimes dramatically. For example, the phoneme /ɑ̃/ has an overall consistency of 43%. However, its consistency increases to 100% when it is a present participle (always spelt <ant>). These later studies highlight the importance of considering regularities beyond one-to-one sound-letter relations, but with regards to surrounding orthographic and syntactic constraints.

There is evidence suggesting the role of orthographic consistency in the rate of literacy development. In a study across 12 European countries, (Seymour et al., 2003) showed that by the end of the first year of literacy instruction, children learning to read an orthography that is relatively transparent in the letter-sound direction (such as Finnish, Greek, Spanish, Italian, German, Norwegian, Icelandic, Swedish, or Dutch) reached near-perfect proficiency (above 90% accuracy) in reading high frequency words of their language, whilst in less transparent languages, such as Portuguese (74%), Danish (71%), French (79%) and most strikingly English (34%), children reached much lower levels of proficiency. In fact, it took the French and Danish students two years to reach a level of proficiency similar to that of Finnish or Norwegian first-graders, whilst in English, accuracy scores still averaged 76% on the list of frequent words even at the end of the second year of literacy instruction. Similarly, studies comparing the rate of word and pseudoword spelling errors at the end of the first year of schooling in English-Czech (Caravolas & Bruck, 1993), and French-Portuguese-Spanish (Serrano et al., 2011) have shown an advantage of the more transparent languages (i.e. Czech and Spanish) over the less transparent languages (English, Portuguese and French). Studies in later grades in English-German (Wimmer & Landerl, 1997), and English-Italian (Marinelli, Romani, Burani, & Zoccolotti, 2015) confirm the long-lasting influence of English inconsistency on spelling accuracy beyond the fourth year of formal schooling. Surprisingly, even learning French gives an advantage in word and pseudoword spelling compared to English in mid-primary school (Caravolas, Bruck, & Genesee, 2003). Remember French sound-

to-spelling consistency is lower (20.9%) than that of English (27.7%), but its spelling-to-sound consistency is higher - 87.6% against 67.3%. Canadian students in their third year of schooling obtained, on average, scores 30% higher on spelling a set of matched words and pseudowords if they learned to spell in French than if they learned to spell in English (Caravolas, 2004). Together these studies suggest a long-lasting impact of sound-to-spelling consistency, but also spelling-to-sound consistency, on acquiring phonological as well as conventional spelling. Importantly, all these studies assess phonological procedures in spelling (with pseudowords) and conventional spelling at word level.

2.1.2. Syllabic structure and units of metalinguistic awareness

Another distinctive feature of the French and English language systems is to do with their oral syllable structure. Forty nine per cent of French oral syllables follow a CV[2] structure, with another 21% following a CVC structure (Deacon, Desrochers, & Levesque, 2017). Syllable length in French spans from one to six phonemes with a mean of 3.5 (Chetail & Mathey, 2010). English syllables, by contrast, are assumed to be mostly closed, structured around an onset (an initial consonant or cluster of consonants) and a rime (formed of a peak: the vowel, and a coda: the final consonant or cluster of consonants) (Perfetti & Harris, 2017). Figure 2-2 represents the typical syllable structure in English, as described above. In her international manual of speech development, (McLeod, 2007) documents an English oral syllable length of up to seven phonemes, with the most complicated structure being CCCVCCC.

Because the structure of English syllables is marked by Germanic influences (typically closed with many initial and final consonant clusters and unclear syllable boundaries), whilst French typically has a Romance CV syllable structure (with clearer boundaries and a regular timing), English syllable structure has been described as complex whilst French syllable structure has been described as simple (Seymour et al., 2003).

[2] In all sections related to syllable structure, C stands for consonant, and V for Vowel.

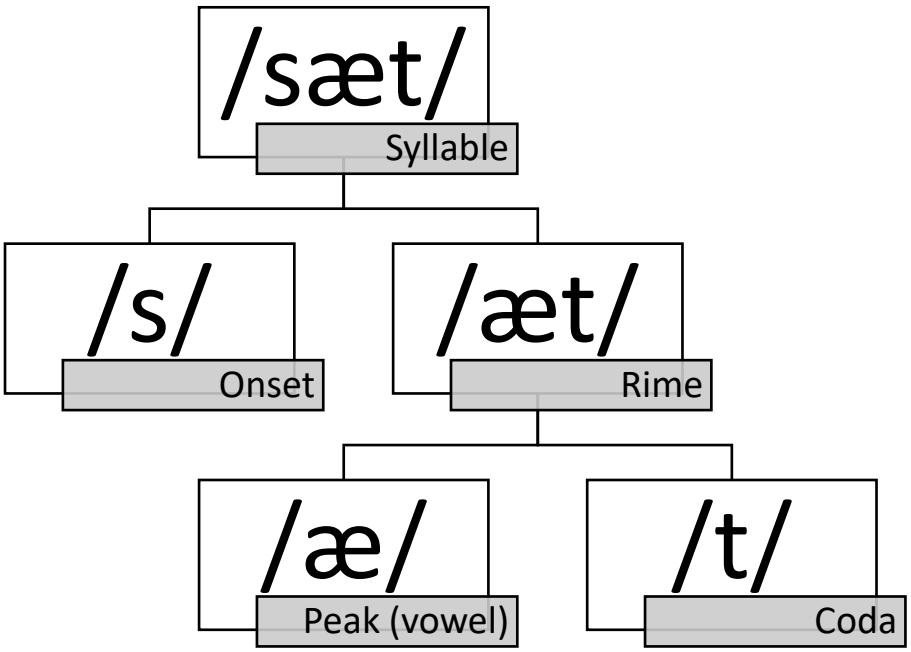

Figure 2-2: Syllabic structure in English, adapted from Perfetti and Harris (2017)

Early cross-linguistic studies of phonological awareness in French and English have shown differences in the units recruited for word segmentation in the two languages: Bruck, Genesee, and Caravolas (1997) and Duncan, Colé, Seymour, and Magnan (2006) have compared the performance of French- and English-speaking children on tasks of metalinguistic awareness involving either syllables, phonemes, onset or rimes. Bruck et al. (1997) showed that Canadian French-speaking students in nursery, pre-school and grade 1 performed significantly better than their English-speaking peers on the task involving syllable counting, whereas English-speaking students performed significantly better on the rime, onset and phoneme manipulations. Further, Duncan et al. (2006) determined that this pattern was mediated by literacy instruction, with phoneme manipulations improving dramatically in both languages with the introduction of literacy. These two studies suggest that before literacy instruction, French students preferably segment words into syllables, whilst English students may have an enhanced sensitivity to rimes and onsets. In both languages, the start of reading and writing reinforces phoneme awareness skills (Cunningham & Carroll, 2011; Ecalle & Magnan, 2002).

2.1.3. Prosodic and phonological structure

French and English differ in the way speech is timed and in the nature of the units used for word segmentation. French has often been described as a syllable-timed language, whereas English is often described as a stress-timed language (Frost, 2011). Indeed, in French, syllables come at a roughly regular pace, whereas in English, it is stress that comes at a roughly regular pace. In French, the eight syllables of the utterance

"C'est absolument ridicule"

are all equally spread across the few seconds it takes a speaker to pronounce them. In English however, in the eight-syllable utterance

"'This is the 'house that 'Jack has 'built ",

the three syllables *'this is the'* and the two syllables *'house that'* are roughly equal in duration, as the utterance is divided according to stress patterns (see Roach, 1982, for a discussion of these examples). The consequence of stress timing is that most unstressed syllables are reduced in English (e.g. the reduction of the unstressed middle vowel to a short schwa in <caravan> /ˈkærəˌvæn/) (Roach, 2000). By contrast, syllable timing has three consequences worthy of note in French connected speech (Spinelli, Cutle, & McQueen, 2002): **elision** (e.g. *le* + *avion* = ***l'a****vion* /**la**.vjɔ̃/ - *the plane*), **enchainment** (e.g. *chaque* + *avion* = *cha**que a**vion* /ʃa**.ka**.vjɔ̃/ - *each plane*) and **liaison** (e.g. *un* + *avion* = *u**n a**vion*, /œ̃**na**vjɔ̃/ - *a/one plane* - where the /n/, unheard in /œ̃/, is pronounced). This last phenomenon, combined with the majority CV syllable structure in French (see section 2.1.2), leads to well-documented developmental errors at word junctions in young speakers of French (e.g. **un l'avion* /œ̃**l**avjɔ̃/, instead of *un avion* /œ̃**n**avjɔ̃/, see Dugua & Chevrot, 2015, for a review of the evidence in 2-6 year-old French speakers).

At the phonological level, the English system is marked by the presence of a complex vowel system. In the French phonemic repertoire, 16 vowels, three semi-consonants and 20

consonants are usually referenced, with some degree of regional variation (Deacon et al., 2017). The picture is rather less clear with English, where regional variations are numerous and sometimes quite dramatic, especially for vowels (Roach, 2000). The present study having been conducted in the South-East of England, the "Received Pronunciation" or "BBC English" pronunciation has been chosen as the reference here. According to Roach (2000), this system comprises a set of seven simple vowels, five long vowels, eight diphthong vowels (= 20 vowels altogether), 21 consonants and three approximants (or semi-consonants). One reason for this complex English vowel system is documented in Perfetti and Harris' book chapter (2017). The authors explain that between the fifteenth and eighteenth century, English phonology was reshaped by what is known as the Great Vowel Shift. In a number of English words, some of the vowels progressively changed to different long vowels and diphthongs (e.g. the vowel /ɛː/ becoming a long /iː/ as in *east*, or the German *name* /naːmə/ becoming the English *name* /neɪm/). Because the vowel change partially overlapped with attempts at standardising English spelling, the vowel shift was inconsistently reflected in spelling (Upward & Davidson, 2012). For example, at the end of the 15th century, there was a tendency to use the diagraph <ea> to represent the long sound /ɛː/ but as it shifted to /iː/, some words retained the ancient sound-spelling correspondence (e.g. *bread*), whilst others evolved with the shift (e.g. *east*). Other inconsistencies stem from the adoption of words after the standardisation (e.g. *police*, introduced in the 18th century, retained the French /iː/, whilst *polite*, introduced in the 16th century, evolved to the diphthong /aɪ/). Many digraphs of English originate from this shift and the concurrent attempts at standardising spelling (e.g. the split digraph <i_e> or <a_e> as in <t**i**m**e**> or <n**a**m**e**>) (Upward & Davidson, 2012). Many inconsistencies in vowel spelling also originate from this shift, which has consequences for the development of vowel spelling in English.

Prosodic and phonological differences between French and English have been related to specific spelling errors. For example, Caravolas et al. (2003) directly compared Canadian

French- and English-speaking students' spelling on a word dictation task in grade 3 and report different errors in each language: Consistent with previous studies, the majority of the omission errors produced by English children involved vowels (Stage & Wagner, 1992; Treiman, 1993), whilst they involved consonants in French (Sprenger-Charolles & Siegel, 1997). Furthermore, English-speaking children frequently omitted unstressed vowels in their spelling of the dictated words (40% of unstressed vowels omitted, against 23% of stressed vowels omitted), an error absent in French, whereas the syllable structure of the word was represented in most French spellings. In contrast, Broc (2015) suggested that segmentation errors found in young French spellers (e.g. <*alecole> for <à l'école>) could be related to the absence of a fixed lexical stress in French and the co-articulation phenomena of elision, enchainment and liaison, which would make it more difficult for French children to perceive word boundaries and represent them in their written language (Jaffré & Fayol, 1997, cited by Broc, 2015). As in other Romance languages (Portuguese: Correa & Dockrell, 2007; Guimarães, 2013; Spanish/Catalan: Tolchinsky, Liberman, & Alonso-Cortes Fradejas, 2015), segmentation errors have been observed in the written corpuses of children learning to write in French, in the early years (Fraquet & David, 2013), first years of primary school (David & Doquet, 2016) and in the texts of children with Developmental Language Disorder (Broc, 2015). However, to our knowledge, no exploration of the potential drivers of this phenomenon has been attempted in French. Importantly, such explorations would need to consider writing beyond word level, as difficulties with word segmentation can only appear in the context of a sentence or text.

2.1.4. Morphological structure

French and English are both described as morphophonemic writing systems, that is to say systems where both phonemic and morphological units are represented. Indeed, it is estimated that around 55% of the words regularly encountered by English-speaking school-aged children, and 75% of the words in the French dictionary, are composed of more than

one morpheme (Casalis, Quémart, & Duncan, 2015). Morphemes may be qualified as derivational (if they combine to produce a new word), or inflectional (if they combine to produce a grammatical variation of the same word). Both derivational and inflectional morphemes are found in French and English.

Many inconsistencies at the phonological level are consistent at the morphological level in both languages (Deacon et al., 2017; Perfetti & Harris, 2017). Indeed, many historic shifts in pronunciation during word formation are not reflected in spelling, so that words like *health* may be phonologically inconsistent, but morphologically consistent (with the stem *heal* still represented in the spelling of the derived form). These consistencies are perceived and used, to an extent, by children learning to spell English and French. In English, Treiman, Cassar, and Zukowski (1994) have shown that American children as young as 6 were more likely to spell <dirty> than <*dirdy>, consistent with the root word <dirt>, but not with the American phonological realisation /ˈdɝ.ɾi/ where the /t/ sound resembles a /d/. Similarly, in French, children as early as the second year of primary school are more likely to spell correctly silent letters if they mark a morphological relation (e.g. the silent <d> in <blond>, heard in the derivative <blonde>) then if they don't (e.g. the silent <d> in <foulard>, which has no derivatives) (Sénéchal, 2000; Sénéchal, Basque, & Leclaire, 2006). However, there is also contrasting evidence showing that older spellers of English (grade 3-6) were not able to use more advanced morphological knowledge (such as the relation between *sign* and *signal* or *know* and *knowledge*) to spell these words correctly (Waters, Bruck, & Malus-Abramowitz, 1988). This was the case even amongst the good spellers in these age groups. For these more advanced morphological words, explicit morphological training may be needed. Several studies in both English and French have highlighted the positive impact of morphological training on spelling. For example, Devonshire & Fluck (2010) have shown the benefits of training morphological (e.g. *magic*/*magician*) and etymological relationships (e.g. *sign*/*signal*/*design*) with typical 7- to 9-year old English children on their spelling of both

morphologically-complex words and a standardised word dictation. In French, Casalis, Pacton, Lefevre, and Fayol (2018) showed the beneficial effect of a morphological training on the morphological spelling of typical French third-graders. The effect of the training on spelling was maintained even after the summer break, five months after training. Intervention and experimental research thus provide a solid base for the role of derivational morphology in efficient spelling in both French and English, whether they stem from explicit teaching or implicit learning (Pacton & Deacon, 2008).

The degree to which derivational morphology (i.e., the morphology that allows the formation of new words) impacts differently on literacy development in the two languages has been explored in two studies. To our knowledge, they are the only direct cross-linguistic comparisons of morphological effects on French and English metalinguistic and literacy skills. One examined the ability to derive words and pseudowords orally (morphological awareness task) in grade 1-3 French and English children (Duncan, Casalis, & Colé, 2009). The other assessed word decoding in a set of words and pseudowords that were or were not derived, in a population of grade 4 French and English students (Casalis et al., 2015). Taken together, their results suggest that French children have an earlier and more proficient awareness of derivation processes in word formation than their English peers. They were more likely to successfully use this process to produce derived words and pseudowords orally and judge their acceptability in grades 1-3 (Duncan et al., 2009) or to decode them in grade 4 (Casalis et al., 2015). To our knowledge, however, the comparative role of derivational morphology in spelling French and English has not been explored.

The richness of the French morphology might be an advantage in awareness of word formation, however other aspects of French morphology may be a constraint on spelling. Indeed, inflectional morphology is richer in French than in English. Nouns are inflected not only for number (final *-s*, exceptionally *-x*), but also for gender (feminine *-e*). Verbs are

inflected for all tenses and persons in French (as opposed to just the third person, past tense and present progressive in English). As an example, the French present for verbs ending in *–er (*e.g. *chant**er,** to sing)* has no less than five different inflections (*-e, -es, -ons, -ez,* and *-ent*): *Je chant**e** (I sing), tu chant**es** (you sing), il chant**e** (he sing**s**), nous chant**ons** (we sing), vous chant**ez** (you (pl.) sing), ils chant**ent** (they sing)*. Inflectional morphology in French is not only rich, but also largely silent (in the previous example, the first person *chante*, second person *chantes* and third person plural *chantent* are all pronounced /ʃɑ̃t/, the inflections being silent), except in the case of the "liaison" described in section 2.1.3 of this chapter. Spelling of these final silent inflections is known to remain a common error even in skilled French adults (Fayol, Largy, & Lemaire, 1994), and the learning curve for these inflections is rather slow, as it takes the whole of primary school to master just the noun-verb plural agreement (Fayol, Hupet, & Largy, 1999). By contrast inflectional morphology in English is comparatively simple. There is no gender marking in the noun phrase, only the plural, marked by a regular *-s* ending, (which is heard as /z/, /s/, /ɪz/ or /əz/ depending on the phonological context) and possessive marking (using the apostrophe – *'s* or – *s'* and realised phonologically like a plural). In a few irregular cases plural may provoke a phonological change in the stem as in *foot*/*feet*, *woman*/*women, scarf/scarves* or *stimulus/stimuli*. The past tense for verbs is marked by *-ed* (heard as /t/, /d/, or /ɪd/ depending on the context), except for a set of irregular verbs, which also see their stem altered (e.g. *buy*/*bought*, *stand*/*stood*). The present progressive is marked by *-ing* and the third person present by *-s*. Inflectional morphology in English is introduced early in the curriculum, and largely mastered within the first year of schooling. For example, the plural -s is mastered as early as the first semester of grade 1 in English-speaking children (Treiman, 1993; Turbull, Deacon, & Kay-Raining Bird, 2011).

Both French and English rely on the accurate representation of morphological units for spelling, despite rather different morphological structures. However, few studies have compared the differential impact of morphological skills on literacy development across

these two languages. Specifically, to our knowledge, no research has assessed the spelling of both derivational and inflectional morphemes, in French and English concurrently.

Table 2-1 summarises the main characteristics of the French and English oral and written language systems as discussed in the above section.

Table 2-1: Characteristics of the French and English orthographies

Characteristics	**French (France)**	**English (UK-Received Pronunciation)**
Consonant sounds (McLeod, 2007)	21 Consonants (18 consonants and 3 semi-consonants) /p, b, t, d, k, g, l, m, n, ɲ, ŋ, r, f, v, s, z, ʃ, ʒ, j, ɥ, w/	24 consonants (22 consonants and 2 semi-consonants) /p, b, t, d, k, g, m, n, ŋ, θ, ð, f, v, s, z, ʃ, ʒ, h, ʧ, ʤ, j, w, ɹ, l/
Vowel sounds (McLeod, 2007)	14-16 vowels (11-12 non-nasal and 3-4 nasal vowels) /i, e, ɛ, a, (ɑ), ɔ, o, u, y, ø, œ, ə, ɑ̃, ɛ̃, (œ̃), ɔ̃/	20 vowels (7 short monophthongs, 5 long monophthongs and 8 diphthongs) /ɪ, ɛ, æ, ʊ, ɒ, ə, ʌ, i, u, ɔ, ɑ, ɜ, aɪ, aʊ, ɔɪ, eɪ, oʊ, ɪə, ɛə, ʊə/
Writing system (McLeod, 2007)	Latin alphabet (26 letters) Accents over vowels (*é, è, ê, ë, à, â, ô, û, î, ï*) and cedilla under *c* (*ç*) Vowel digraphs (e.g. *ou, au, eau, eu, oeu, oe, ai, ei, et, oi, ui, un, on, en, in, oin, ien, ill, aill, ouill, euill, eill, ay, oy, uy, ey)* Consonant digraphs (e.g. *ph, ch, gu, qu, sc, gn)* Apostrophes for elisions (*l'enfant*, for **le enfant*)	Latin alphabet (26 letters) No accents (except in words of foreign origins) Vowel digraphs (e.g. *ai, ay, a-e, ea, ee, ey, er, ar, or, ur, ir, ure, are, air, ear, eer, oor, igh, oa, o-e, ow, oi, oy, oo, ew, ue, aw, ou)* Consonant digraphs (e.g. *ck, qu, ch, tch, ph, dge, kn, wr, sh, ch, th, wh, ng)* Apostrophes for elisions (*isn't* for *is not*)
Estimation of the number of graphemes	130 graphemes (Catach, 1986, cited in Sprenger-Charolles, 2003)	1120 graphemes (Coulmas, 1996, cited in Sprenger-Charolles, 2003)
Estimation of phoneme-to-grapheme consistency for monosyllabic words (mapping of phonology-to-spelling)	87.6% (Ziegler et al., 1996)	69.3% (Ziegler et al., 1997)
Estimation of grapheme-to-phoneme consistency for monosyllabic words (mapping of spelling-to-phonology)	20.9% (Ziegler et al., 1996)	27.7% (Ziegler et al., 1997)
Syllable shape (McLeod, 2007)	C(0-3)VC(0-3) The smallest syllable is V (*à*) and the largest is CCCVCC (*splatch*). Most syllables are open (CV).	C(0-3)VC(0-4) The smallest syllable is V (*a*) and the largest is CCCVCCCC (*strengths*). Most syllables are closed (CVC).

Characteristics	French (France)	English (UK-Received Pronunciation)
Stress pattern (Frost, 2011)	No fixed lexical stress: stress comes on the last syllable of a prosodic group	Fixed lexical stress: stress can differentiate two words (e.g. noun '*permit* VS verb *per'mit*)
	Relatively non-prominent distinction between stressed and unstressed syllables	Prominent distinction between stressed and unstressed syllables (with a vowel reduction in the unstressed syllables)
Phonotactic restrictions (McLeod, 2007)	Many silent letters (or mutograms) at the end of words Final silent letters are only heard when followed by a vowel sound, this is called a liaison (*un enfant* is pronounced [ɛ̃nɑ̃fɑ̃], whereas the N is unheard in un chat [ɛ̃ʃa])	Few silent letters (or mutograms) at the beginning (knight, psychology), in the middle (vehicle) or at the end of words (autumn)
Derivational morphology: productivity	75% of words from a French dictionary are morphologically-complex (Rey-Debove, 1984, cited by Casalis, Quémart, & Duncan, 2015)	55% of the words in the CELEX database are morphologically-complex (Casalis et al., 2015)
Inflectional morphology: richness and characteristics	Verb phrase: Verbal inflections for all persons and tenses in French. Due to phonotactic restrictions, many of these inflections are silent.	Verb phrase: Verbal inflections for the third person singular present (-s), all persons past tense (-ed), and progressive (-ing)
	Noun phrase: Inflection of the determiner, adjective and noun for gender and number. Due to phonotactic restrictions, many of these inflections are silent.	Noun phrase: Inflection of the noun for number, possessive 's/s'

2.2. Literacy instruction in England and France

2.2.1. The curriculum for spelling

Literacy instruction in England follows the National Curriculum (Department for Education, UK, 2013), and in France a similar syllabus (“programmes d’enseignement”, Ministère de l’Education Nationale, de l’enseignement supérieur et de la recherche, 2015)[3]. In England, primary schooling is divided in “Key Stages”. Key stage 1 starts at age 5 and includes the first and second years of primary education and literacy instruction. By the end of Key stage 1,

[3] Specific recommendations for literacy teaching have been published by a new scientific committee, for implementation in September 2018. As the children tested in the present study were tested in the school year 2016-2017, the 2015 syllabus is discussed instead.

English children should be taught to use phoneme-to-grapheme correspondences, common irregular words, some homophones, contracted and possessive forms, plural, third person *-s* and past tense *-ed*, and frequent derivational suffixes such as *–ment*, *–ness*, *–ful*, *–less*, or *–ly*, to spell short dictated sentences. Key stage 2 covers the remaining years of primary education (years 3 to 6), when pupils are taught to use a wider range of prefixes and suffixes, homophones, and common difficult words (including words with silent letters), to use the dictionary, and to spell in the context of sentence dictation or text writing (Department for Education, UK, 2013). In France, primary schooling is divided into 2 "cycles": cycle 2 starts at age 6, after the early years – "maternelle"- cycle, and marks the beginning of formal reading and writing instruction. By the end of cycle 2 at age 9, French children are expected to gain good copying strategies (beyond letter-to-letter copying), know phoneme-grapheme correspondences including contextual ones (such as <s>, <c>, <g> or <en/em>, <an/am>), and memorise lists of frequent, morphologically/semantically related or irregular words. They are also introduced to simple verb and noun agreement rules (e.g. *-nt* for verb plural marking, *-s* for nouns, person marking), common simple and compound verb forms and frequent homophones (e.g. *à/a*, *et/est*), and encouraged to use them during proof-reading, in order to copy or generate an accurate text of about half a page. Cycle 3 covers the last two years of primary and the first year of secondary school. By the end of cycle 3, children are expected to know all phoneme-to-grapheme correspondences, but also regular inflectional and derivational variations of words, a set of Greek and Latin stems, orthographic and grammatical rules for simple and compound verb inflections and gender and number marking, applied to text writing in a range of contexts (Ministère de l'Education Nationale, de l'enseignement supérieur et de la recherche, 2015). Constraints of each orthographic system are apparent in both curriculums: whilst emphasis is put on word-level difficulties in English, there is a large emphasis on syntactic components in French, and especially on verb inflections. Commonalities are also obvious: mastering phoneme-grapheme

correspondences is a foundation skill in both languages, and the emphasis on derivational morphology in both countries highlights the productivity of this process for spelling in both systems. The age group for the experimental sample in the present study spans from 8.5 to 12 years, which corresponds to key stage 2 in English (year 3, 4, 5, 6) and the end of cycle 2 and the beginning of cycle 3 in French (year 3 to 5: CE2, CM1, CM2). By defining the age group for the current study in the last years of primary school, it is hoped to capture skills beyond phoneme-to-grapheme correspondences and largely taught in the second half of primary school, such as morphology (derivational and inflectional), orthographic rules and homophony.

2.2.2. Differences in handwriting instruction

One further difference in the teaching of written French and English needs to be highlighted: French students learn to copy and write using cursive, whilst English students usually learn some joined-up variation of script. In France, the practice of cursive handwriting through copy and text generation is stated in the curriculum, with a specific focus in cycle 2 and the relaxing of an imposed handwriting style as children get older and become more fluent writers, in cycle 3. Although handwriting is now assessed in the UK at the end of Key Stage 1, guidance on the handwriting style to teach is more flexible, with the learning of print letters first and the introduction of joining-up lines later on to promote fluency. Although it is unclear exactly which handwriting style promotes which aspects of literacy, there is some evidence that teaching cursive may enhance the legibility of texts in late primary school, whilst script or mixed handwriting styles may favour handwriting speed. Bara and Morin (2013) showed that French children taught to write solely in cursive were slower at copying than Québec children taught a mixture of cursive and print. This was the case whether or not children had chosen to use a cursive or mixed handwriting style in the task given in years 4 and 5. However, children taught primarily cursive produced more legible samples than their counterparts taught different handwriting styles, regardless of the handwriting chosen in

years 4 and 5. Differential outcomes from different teaching approaches have implications for the current study. On the one hand, if children taught cursive are slower writers, one might expect the French sample to produce shorter texts than the English sample in the present study. On the other hand, if cursive instruction slows down writing, its teaching in combination with script reading may also enhance letter learning and the formation of orthographic representations (Bara & Morin, 2009; Bara, Morin, Alamargot, & Bosse, 2016). Finally, the end of primary school is a critical period for the development of efficient handwriting (regardless of the teaching approach chosen), with handwriting becoming automatic between the age of 8 and 10 (Bara & Morin, 2013; Kandel & Perret, 2015). One can expect the children tested in the present study to be at different stages in the automatisation process. Beyond linguistic constraints of the two orthographic systems considered, handwriting teaching and developmental constraints may also have an impact on the written output of children at the end of primary school.

2.2.3. Special needs education in France and in the UK

Because children with a language disorder are included in the present study, a brief overview of the system of support in place in France and in the UK is provided below. Education for children with special educational needs is regulated by the "LOI n° 2005-102 du 11 février 2005 pour l'égalité des droits et des chances, la participation et la citoyenneté des personnes handicapées (1)" (2005) – Law for disabled people's equal rights and opportunities, participation and citizenship - , and by the Special Education Needs and Disability Code of Practice in the UK (Department for Education & Department of Health and Social Care, 2014). Under the French law, the inclusion of children with special needs is ensured by the school system, in mainstream schools whenever the child can benefit from attending a mainstream setting and/or in a specialist setting as appropriate. Following the 2005 law, special units for the inclusion of children with specific needs were created within mainstream schools ("ULIS-écoles"). Special units are typically small units aimed at supporting the needs of children with

either cognitive functioning difficulties, autistic spectrum disorder or language and/or learning difficulties. In these units, children receive specialist instruction for some of the curriculum (typically French reading/writing and maths), and are included in the mainstream classroom for the rest of their learning. Children typically enter these units following a formal assessment of their disability and needs by the local office for disability (“Maison Départementale des Personnes Handicapées, MDPH”). Similarly, in England, so-called “language units” exist that have a specialism in supporting children with language and communication difficulties. Entry is also determined by the local authority, following an Education Health and Care Plan (EHC plan). Language units in England function similarly to French “ULIS-écoles”, in that they also aim to promote the inclusion of children in their year-group class for as much as the curriculum as possible and provide specialist support for the rest.

2.3. Spelling development and cross-language considerations

2.3.1. Stage theories of spelling development

Spelling has been described as a process where children develop knowledge through a series of stages. Based on observations of spelling errors produced by young spellers, Gentry (1982) and Ehri (1987) observe that children move on from learning the alphabetic principle and phoneme-grapheme correspondences to progressively applying the orthographic code and morphological regularities in their spelling. In the first pre-communicative phase, children have an awareness of the representative value of script. They may apply characteristics of the object represented to their writing (such as a long series of symbols to represent a train and a short one for a car). Their writing does not however reflect a correspondence with sounds. This comes with the introduction of the alphabetic principle and the writing of their name and first words, at the semiphonetic or letter-name phase. At this stage, children represent only some of the sounds in the words (e.g. <*LK> for *like* or <*DG> for *dogs*). As

they gain more exposure to print, children move on to represent all the sounds in the word, although not necessarily conventionally (e.g. <*lik> for *like* or <*dogz> for *dogs*). When children start using the conventions of the orthographic (e.g. <like> for *like*) and morphological system (e.g. <dogs> for *dogs*) in their spelling, they move to the transitional (Gentry, 1982) or morphological phase (Ehri, 1987). Table 2-2 summarises the stage theories of spelling development as described by Gentry (1982) and Ehri (1987).

Table 2-2: Summary of stage theories of spelling development

Stage	Gentry (1982)	(Ehri, 1987)	Characteristics	Example
1	Pre-communicative		Awareness that writing represents words	LƆГb2
2	Semiphonetic	Semiphonetic	Awareness that letters represent speech sounds	I lk dg
3	Phonetic	Phonetic	All sounds are represented in spelling	I lik dogz
4	Transitional	Morphemic	Progressive application of orthographic and morphological conventions in spelling	I leik dogs
5	Correct/ conventional		Firm knowledge of the orthographic system as a whole	I like dogs

Although the stage models are primarily based on observations of the spellings of English-speaking children, they have found correspondences and applications in a range of other languages, including French (Fayol & Jaffré, 2014). Indeed, they rely on three principles that are common to most alphabetic systems: phonographemic correspondences, representation of orthographic conventions and representation of morphological components. Although individual aspects of the phonological, orthographic and morphological systems of French and English may differ (as highlighted in section 2.1 of this chapter), all three are represented in spelling.

2.3.2. The overlapping waves model for spelling development

Although phase models detail all the necessary ingredients of learning to spell (phono-graphemic correspondences, orthographic conventions and morphology), there is now a body of evidence suggesting that these skills develop simultaneously rather than in successive phases in French and English. For example, Cassar and Treiman (1997) in English and Pacton, Perruchet, Fayol, and Cleeremans (2001) in French have shown that children as early as the first grade are sensitive to the legality of letter doubling positions, an orthographic convention. Rittle-Johnson and Siegler (1999) propose that children's knowledge and ability develops in a series of waves, as children a) discover new strategies, b) increase their use of these strategies, c) master them and d) choose them appropriately for the task given. A new "wave" appears when a child discovers a new type of knowledge or strategy. The authors test this model in the specific case of spelling, by asking children in first and second grade to verbalise their strategies on spelling a set of age-appropriate words. The results confirm that whilst phonological strategies represent the majority of the strategies used in first grade, other strategies were already reported at this age (such as reliance on known conventional spellings or orthographic rules). In second grade, the rate of use of strategies other than phonological increased, whilst adaptability also increased (a wider range of different strategies were used for the more complex words). Finally, efficiency in strategy use also increased with better word spelling accuracy in second grade, especially for those words where they reported using more conventional or rule-based strategies. Figure 2-3 represents the overlapping waves model described by Rittle-Johnson and Siegler (1999) schematically.

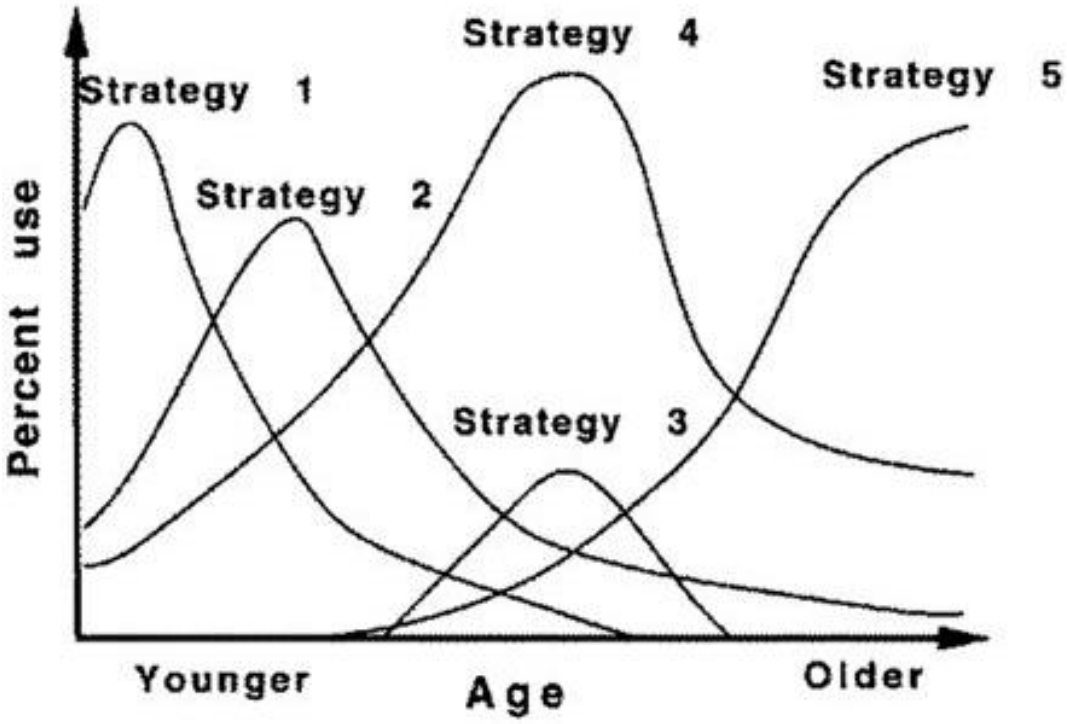

Figure 2-3: Schematic representation of the overlapping waves model, from Siegler (1996)

2.4. Implications for the current study

Whilst considering the principles detailed in the staged theories of spelling development – encoding of phonemes, orthographic conventions and morphemes - as essential to efficient spelling in English and French, the present study also considers the possibility that individual differences may lead to different spelling development pathways (consistent with the overlapping waves model). Differences in developmental pathways may stem from language differences (e.g. the prosodic/phonological, orthographic and morphological constraints of French and English as detailed in section 2.1), but also from developmental difficulties in acquiring these principles. The following chapter focuses on a disorder which affects language development, and which is often associated with spelling difficulties: Developmental Language Disorder (DLD). It describes the oral and written language characteristics of this disorder, with a focus on phenotype and specific markers.

Chapter 3. Characteristics of the oral and written language of children with DLD

This chapter will focus on this thesis' group of interest, children with Developmental Language Disorder (DLD). The terminology will be defined, and identification and co-morbidity issues will be discussed. The characteristics of the oral and written language of children with DLD will also be described, with a focus on developmental issues and implications regarding matching experimental groups. The literature reviewed in this chapter informs the choice of participants in the current study, as outlined in Figure 3-1.

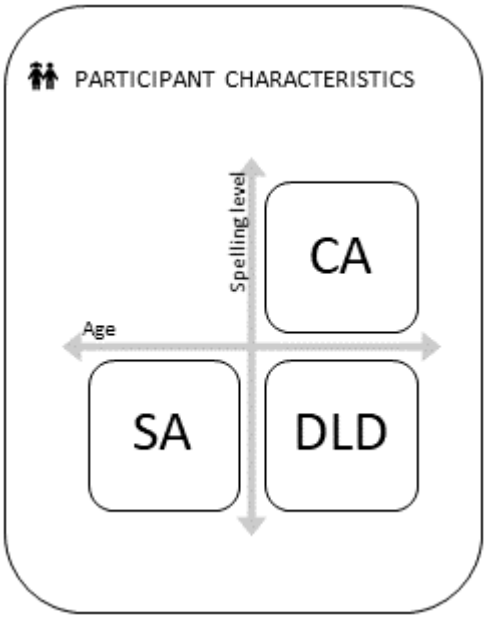

Figure 3-1: Participant characteristics in the current study, as reviewed in Chapter 3

3.1. What is developmental language disorder (DLD)?

There have been over a hundred terms to refer to developmental language difficulties, including Specific Language Impairment (SLI), Primary Language Impairment (PLI), Language Impairment (LI), or Language Learning Disorder (LLD), limiting both research and practice (Bishop, 2014). The terminology and diagnostic criteria for language disorders has been the subject of a recent debate (see special issue of the *International Journal of Language and Communications Disorders*, introduced by Ebbels, 2014). Following from this debate, a Delphi study, gathering advice from a panel of 57 experts (the CATALISE consortium), resulted in recommending the use of the term *Developmental Language Disorder* (DLD, Bishop, Snowling, Thompson, & Greenhalgh, 2017). According to this consensus, DLD describes children whose difficulties with language production and/or comprehension affect everyday living and persist at school age (age 5 and above). *Developmental* Language Disorder typically is not explained by any known biomedical condition, as opposed to language disorders which arise from other known developmental syndromes such as Autism Spectrum Disorder or Down syndrome (see Figure 3-2). It is however acknowledged that DLD may occur alongside other difficulties, such as problems with motor skills, reading, social interactions or behaviour, and the CATALISE consortium summarises studies indicating the high prevalence of such co-occurring difficulties in the profile of children with DLD (Bishop et al., 2017). Consistent with the literature (Norbury et al., 2016), the new consensus also acknowledges that nonverbal ability –outside of the context of an intellectual disability- does not affect the presentation of DLD, and slightly low non-verbal performance should not preclude a diagnosis. This is also in line with the current definition of language and other communication disorders in the new DSM-5, which does not include cognitive referencing as a diagnostic criteria (American Psychiatric Association & American Psychiatric Association, 2013; Dockrell & Joye, 2018). In the section below, the characteristics of this group of children will be discussed, with attention to methods for identification, behavioural traits, academic

outcomes (especially literacy outcomes) and theoretical accounts. Although the studies reviewed in this section may refer to this group of children using a variety of terms, in line with the current consensus and for consistency throughout the thesis, the term DLD will be used thereafter.

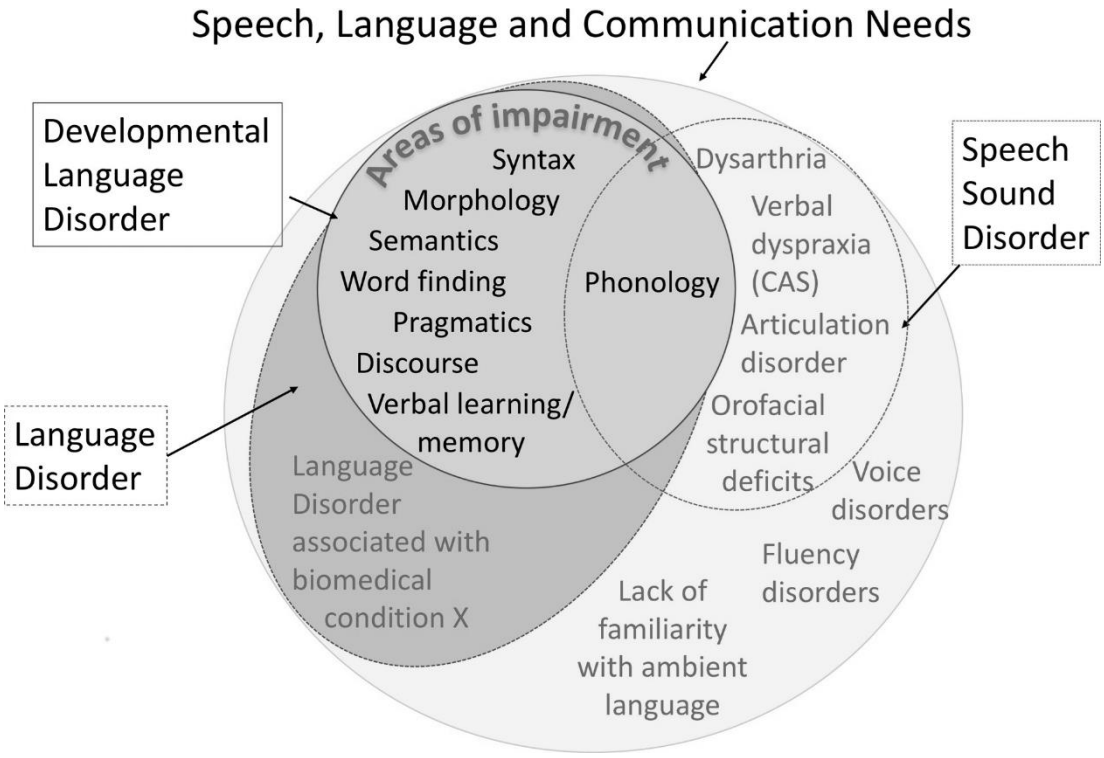

Figure 3-2: Venn diagram showing the relationship of Developmental Language Disorder to other Speech, Language and Communication needs, from Bishop et al. (2017)

3.2. Identification of DLD

3.2.1. Clinical thresholds and cognitive referencing

The most often quoted prevalence figure for DLD is 7.4% (Tomblin et al., 1997). It is based on a threshold of -1.25 SD and below on at least two out of five language measures and a nonverbal ability score above -1 SD. It seems obvious that different selection criteria will impact prevalence and the profiles of the children recruited. However, few studies have actually assessed in what way. One recent UK study formally tested the impact of different selection criteria (including those from Tomblin's study) on both prevalence and functional

outcomes of DLD. Norbury et al. (2016) assessed the language of 529 children in kindergarten on a set of five language composite scores (vocabulary, grammar, narrative, expressive and receptive scores) and nonverbal performance (block design and matrices) in their first year of primary education. They also collected information about emotional functioning using the Strength and Difficulties questionnaire (Goodman, 2006), and academic attainment using the UK Early Years Foundation Stage Profile (EYFSP). "Good level" on the EYFS meant children achieved UK targets on 12 areas of the curriculum. Using their sample of 529 children, stratified by age group, as the norm-reference, and selection criteria of -1.5 SD and below on two out of the five language composites and -2 SD and above on nonverbal ability, the authors reported a DLD prevalence of 7.58%. When the threshold of Tomblin's study was applied for language measures (-1.25 SD), this figure increased to 11.11%. Of the children identified, only 11.80% reached the expected level on the EYFS. Crucially, whether they met Tomblin's nonverbal ability criterion (above -1 SD) or not, the children identified were at risk of academic failure and emotional functioning difficulties. The application of more stringent criteria, such as the ICD-10 threshold of -2 SD on two out of five language measures and a nonverbal ability above -1 SD, led to even more important functional difficulties (no child reaching the expected EYFS level), but also much lower prevalence rates (1.07%). Table 3-1 presents an overview of these results.

Table 3-1: Results from the DLD prevalence study of Norbury et al. (2016), evaluating the impact of different recruitment criteria on prevalence and functional impact

	Prevalence in Norbury et al.'s (2016) sample	**Functional impact: Children achieving 'good level' on EYFSP**
Language disorder of unknown origin (total) [1]	7.58%	11.80%
If NVP score between 0 and -1 SD	4.80%	9.00%
If NVP score between -1 and -2 SD	2.78%	16.62%
'Specific Language Impairment' (Tomblin et al., 1997 criteria) [2]	7.74%	27.60%
'Developmental Language Disorder' (ICD-10 criteria) [3]	1.07%	0%

NVP: Non-verbal performance. EYFSP: Early Years Foundation Stage Profile. [1] DSM-5 criteria: Language scores −1.5 SD or more below normative mean on 2/5 language composite scores. No known medical diagnosis. [2] Tomblin et al. (1997) criteria: Language scores −1.25 SD or more below normative mean on 2/5 language composite scores. NVIQ > -1 SD. No known medical diagnosis. Note: inclusion of children with NVIQ > -2 SD increases prevalence estimate to 11.11%. [3] ICD-10 criteria: Language scores −2 SD or more below normative mean on 2/5 language composite scores; NVIQ > -1 SD, and no known medical diagnosis. Note this creates a significant (1 SD) discrepancy between verbal and nonverbal ability.

Inclusion criteria need to be balanced to account for both severity of language difficulties (as attested by language scores) and their functional impact. As suggested above, even milder language difficulties (-1.25 SD and below on language scores) may have functional impact. Similarly, nonverbal scores just above the threshold for intellectual disability (-2 SD) produce similar functional outcomes to those of more stringent criteria used in previous studies of DLD (-1 SD). There is thus no evidence to support cognitive referencing or highly stringent language thresholds in studies interested in the literacy or academic skills of children with DLD. Another important finding of Norbury and colleagues pertains to the mismatch between their identification and referral to school support or professional services. Less than half of the children they identified as having DLD were receiving extra support either at school or in speech and language therapy services, suggesting their needs had not been prioritised in their educational context. Recent evidence suggests that this lack of recognition of language needs in the UK education system may continue -and accentuate- until the end of primary school (Dockrell & Hurry, 2018).

To our knowledge, no diagnostic or prevalence studies of DLD have been conducted in the French context, and no statutory consensus could be found, that reflected either the new DSM-5, or the recent debates over diagnostic criteria in language disorders. In fact, according to statutory documents, the diagnostic criteria that prevails in French speech and language therapy practice still distinguishes between "dysphasies", which ties in with the conservative ICD-10 definition of language disorders and involves cognitive referencing and language scores at the very extreme end of the distribution (-2 SD), and other language and communication delays and disorders of unknown origins, whose diagnosis is made on the basis of the functional complaint and language scores (JO du 13/06/18, 2018, sec. TITRE IV-

CHAPITRE II-Article 2-Rééducation des troubles de la voix, de la parole, la communication et du langage). Because of the potential mismatches between current recognition and actual language needs on the one hand, and between the definition of language needs in the French and English contexts on the other hand, it was necessary to define a set of uniform criteria for the identification of DLD in the current study. They are informed by the evidence gathered in the present section and will be detailed in section 6.2.1 of the methods chapter.

3.2.2. Taxonomy of DLD

Another matter of importance is the choice of language measures (expressive and/or receptive, at word and/or sentence and/or discourse level) in identifying children with DLD. A number of research studies have attempted to characterise language profiles, or taxonomy, in DLD. Early characterisations include that of Rapin and Allen (1987), and its adaptation by Rapin (1996). Rapin and Allen's taxonomy comprises six subgroups of children with speech and language disorders: Verbal Auditory Agnosia, Verbal Dyspraxia, Phonological Programming Deficit Syndrome, Phonological-Syntactic Deficit Syndrome, Lexical-Syntactic Deficit Syndrome, and Semantic-Pragmatic Deficit Syndrome. These groups were formed based on spontaneous language measures of phonology, syntax, semantics, and pragmatic skills. Other taxonomies have been proposed, but Rapin and Allen's clinical characterisation is unique in that it has been supported by psychometric evidence from a sample of 242 children aged 7 (Conti-Ramsden, Crutchley, & Botting, 1997). The authors of this study used cluster analysis and interviews with professionals to test whether clinical judgements combined with standardised measures of phonology, syntax, vocabulary, narrative, number skills, reading and nonverbal ability allowed for the distinction between different language profiles. Their results supported at least five of the categories defined by Rapin & Allen (1987) (see Table 3-2 for an elicitation of the language profiles observed in the study). However, in a follow-up study one year later, only 55% of children remained in the same clinical cluster (Conti-Ramsden & Botting, 1999). This was despite the fact individual measures' contribution

to the cluster was very stable over time. Using a simpler classification (into either Expressive, Mixed Expressive-receptive or Complex language profiles, Rapin, 1996), the same pattern was observed, whereby measures loaded onto the different cluster similarly at both times, but children moved from one cluster to another at a relatively high rate (35%). Similarly, on the same sample of children followed up at age 11, Law, Tomblin, and Zhang (2008) showed that language growth followed the same pattern, regardless of the clinical category considered. In all profiles, language scores increased between the age of seven and eight before plateauing towards the language levels of age 11 (similar to the growth curves of typical children, Tomblin & Zhang, 2006).

Although language profiling may have a clinical value, there is thus no evidence to support its diagnostic value, either as an indicator of later language outcomes, or as a marker of distinct cognitive or linguistic deficits. There is on the contrary an emerging body of evidence pointing to the unidimensional nature of language across the early years, with the progressive emergence of vocabulary and grammar as distinct constructs during primary school (Language and Reading Research Consortium, 2015; Tomblin & Zhang, 2006). Interestingly, in these studies, expressive and receptive dimensions of language do not emerge as distinct factors at any time in development.

Table 3-2: Classification of language profiles based on the cluster analysis of Conti-Ramsden et al. (1997) and the taxonomy proposed by Rapin & Allen (1987)

	Conti-Ramsden et al. (1997) description			
Cluster (N children)	**Test results**	**Common difficulties identified by teachers**	**Rapin and Allen's classification**	**Classification from Rapin (1996)**
1 (N = 52)	Good: Articulation Fair: Naming vocab. Poor: All other tests	Just syntax/morphology Not phonology Receptive only	Lexical-syntactic deficit syndrome	Complex
2 (N = 16)	Fair-good: All tests except word reading Poor-fair: Word reading	Just phonology Expressive only	(No match)	(No match)

	Conti-Ramsden et al. (1997) description			
Cluster (N children)	**Test results**	**Common difficulties identified by teachers**	**Rapin and Allen's classification**	**Classification from Rapin (1996)**
3 (N = 29)	Good: Naming vocab. Poor: All other tests	Articulation and phonology only Expressive only	Verbal dyspraxia	Expressive
4 (N = 23)	Good: TROG Fair: Bus Story, Naming vocab., Number skills, Articulation Poor: Word reading	Articulation and phonology only Expressive only	Phonologic programming deficit syndrome	Expressive
5 (N = 84)	Fair: Articulation Poor: All other tests	All 3 (articulation, phonology, syntax/morphology), or phonology and syntax/morphology only Expressive only, or expressive and receptive	Phonologic-syntactic deficit syndrome	Expressive-receptive
6 (N = 25)	Good: Articulation, Word reading, Naming vocab. Fair: TROG, Bus Story Poor: Number skills	Semantic-pragmatic Receptive only Not phonology	Semantic-pragmatic deficit syndrome	Complex

3.2.3. Which measures should be used to assess language skills?

If language is a unidimensional construct with a range of symptomatic linguistic manifestations, one question of importance is the choice of appropriate measures for its assessment. Recent research has focused on potential markers that may facilitate its identification. Specifically, this trend of research has been interested in the sensitivity and specificity of several tasks for the diagnosis of children with DLD. A task's sensitivity can be defined as its ability to correctly identify children *with* difficulties, whilst specificity is its ability to rule out children *without* difficulties.

Conti-Ramsden, Botting, and Faragher (2001) assessed the potential of four tasks to determine language status in a group of 160 children with identified DLD at age 11: two sentence completion tasks involving either third person singular or past tense inflections, a nonword repetition task, and a sentence repetition task. The best accuracy value (88%) was obtained by the sentence repetition task, which reached a sensitivity of 86% and a specificity of 92% at the 10th percentile cut-off (-1.28 SD). By comparison, the nonword repetition task had an overall accuracy of 82%, the past tense task 80% and the third person singular 74%. It is also important to note that the sentence repetition task correlated highly with all other measures (respectively .55, .62, and .57), suggesting it tapped into common mechanisms. The authors of this study argue that the sentence repetition advantage as a predictive measure at this age stems from its high reliance on both short-term memory (as the nonword repetition task) and prior language knowledge (as the sentence completion tasks). This result was reproduced in French by Leclercq, Quémart, Magis, and Maillart (2014). They recruited a sample of 34 children aged 7-12 with DLD and 34 typically-developing controls and assessed their ability to repeat 13-15 sentences of increasing length. The sensitivity of the test was 97% and its specificity 88% at the 10th percentile cut-off point (1.28 SD). Thanks to a finer-grained scoring system accounting for the accuracy at the syntactic, lexical, function word and verbal morphology levels, they also showed that scores on the sentence repetition tasks could be accounted for by two factors: a lexical (or vocabulary) factor, and a grammatical (or syntax) factor.

Other tasks (nonword repetition and tasks assessing verbal morphology) have been considered as good markers of DLD across a range of languages (Archibald & Joanisse, 2009; Conti-Ramsden, 2003; Conti-Ramsden et al., 2001; Oetting & McDonald, 2001; Rice & Wexler, 1996; Stokes, Wong, Fletcher, & Leonard, 2006). However, the sentence repetition task has a number of advantages over nonword repetition or sentence completion tasks: a relatively quick administration and scoring procedure, the ability to pick up on both procedural and

linguistic limitations, and the ability to target both lexical and grammatical components at the same time. For this reason, the sentence repetition tasks of Leclercq et al. (2014) in French and of Conti-Ramsden et al. (2001) in English were used for the identification of the experimental sample, using their best cut-off point of -1.28 SD. Consistent with the recent literature on the emergence of vocabulary and syntax as two distinct language constructs in the primary years on the one hand, and the lack of empirical support for expressive/receptive distinctions in school-age children's language on the other hand (Language and Reading Research Consortium, 2015; Tomblin & Zhang, 2006), the sentence repetition task was combined with two receptive tasks of vocabulary and grammar, also relatively simple to administer. Details of the identification criteria (6.2.1) and specific tasks used (6.3.1) are provided in the methods chapter.

3.3. Characteristics of children with DLD

3.3.1. Comorbidity in children with DLD

There is a high comorbidity between DLD and other neurodevelopmental disorders, with particularly high rates of associated Attention Deficit and Hyperactivity Disorder (ADHD) and social-emotional difficulties (Yew & O'Kearney, 2013), Developmental Coordination Disorder (DCD, Flapper & Schoemaker, 2013), and literacy difficulties (Botting, Simkin, & Conti-Ramsden, 2006; Catts, Fey, Tomblin, & Zhang, 2002; Dockrell, Lindsay, Connelly, & Mackie, 2007; Messaoud-Galusi & Marshall, 2010). Such comorbidity raises questions as to the distinctiveness of underlying mechanisms for these difficulties (Williams & Lind, 2013).

In particular, there has been an on-going debate about the nature of the relationship between language and reading disorders. One epidemiological study estimated that about a third of a sample of 106 children with DLD also performed below -1 SD on a measure of word reading (Catts, Adlof, Hogan, & Weismer, 2005), a co-morbidity that clearly exceeds the general population prevalence. In order to explain this partial overlap, Bishop and Snowling

(2004) have suggested that performance on language and literacy tasks is underpinned by two distinct cognitive mechanisms: phonological processing and non-phonological language processing. Phonological processing would be essential to decoding and building accurate orthographic representations, whilst non-phonological language skills would intervene in the processing of oral and written language at the semantic, syntactic and discourse level. Figure 3-3 presents this model schematically.

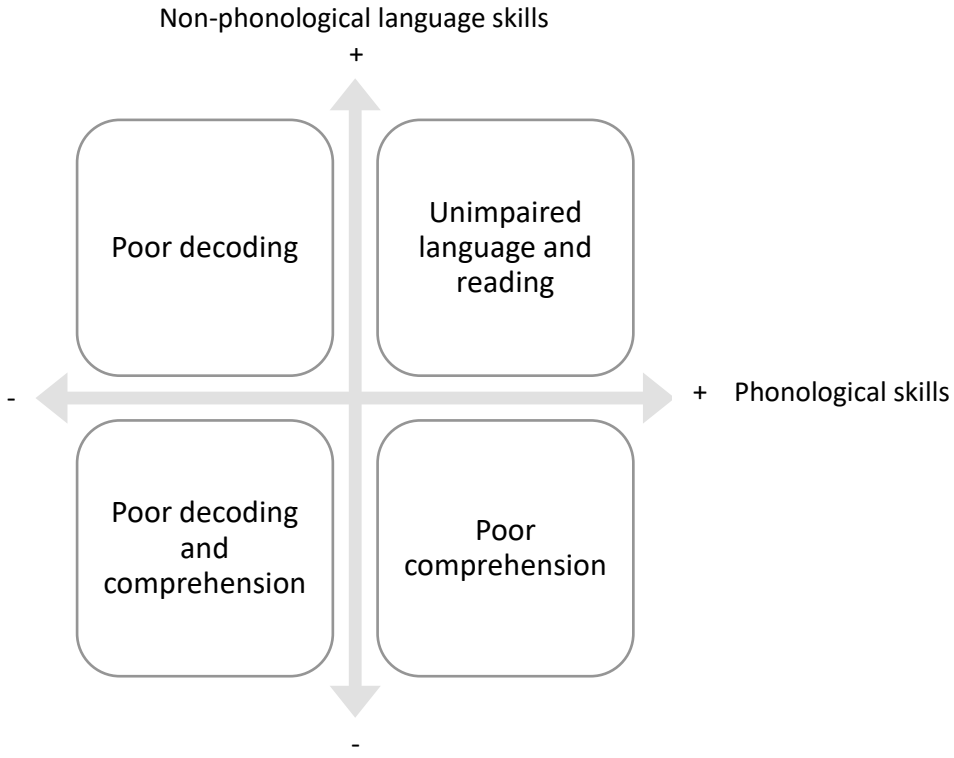

Figure 3-3: Conceptualisation of oral and written language skills in two dimensions, adapted from Bishop & Snowling (2004)

Several studies have attempted to further investigate the overlap between language and literacy disorders, with phonological skills being at the centre of investigations (Messaoud-Galusi & Marshall, 2010). Phonological skills is an umbrella term to define a set of skills involved in the formation, retrieval and manipulation of speech sounds. Difficulties with phonological skills can be evident, early on, in the speech production of young children. Difficulties with phonological skills are often part of the profile of young children with DLD. It has been hypothesised that these difficulties with expressive phonology (variously referred to as speech sound disorder, articulation disorder, or speech disorder) may impact the

development of literacy by impairing the mapping of sounds and letters, and be at the core of the literacy difficulties observed in children with DLD. This hypothesis has been tested in a series of studies assessing the literacy skills of children with either an isolated phonological difficulty, or phonological difficulties *plus* DLD (Bird, Bishop, & Freeman, 1995; Bishop & Clarkson, 2003; Brizzolara et al., 2011; Lewis, O'Donnell, Freebairn, & Taylor, 1998; see meta-analysis combining these results for spelling in Joye, Broc, Olive, & Dockrell, 2018; for reading, see also Carroll, Mundy, & Cunningham, 2014; Hayiou-Thomas, Carroll, Leavett, Hulme, & Snowling, 2016; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Pennington & Bishop, 2009). Altogether, these studies point to literacy difficulties in children with an isolated phonological difficulty, compared to typical children matched on age. Furthermore, the occurrence of difficulties in other language domains is a factor of severity: overall, children with phonological difficulties *plus* DLD obtained lower spelling scores than their peers with an isolated phonological difficulty (Joye et al., 2018).

More recently, with the refinement of the concept and measures of phonological skills, studies have attempted to unpack these skills and test whether the patterns of phonological difficulties observed in children with DLD and reading disorders are different. These studies examined which skills, if any, may protect children with DLD from developing literacy difficulties. Bishop, McDonald, Bird, and Hayiou-Thomas (2009) assessed a range of phonological skills in English, in three groups of children with an isolated DLD, an isolated reading disorder, or a combined DLD *plus* reading disorder. They found that children with DLD who had typical literacy skills performed better on a task of rapid automatic naming (RAN) than their peers who had developed reading difficulties, all other phonological measures being equal. RAN assesses a child's ability to quickly and repeatedly retrieve picture, colour or number names. It has been argued to tap into fluency mechanisms as well as phonological retrieval. The result of Bishop et al. (2009) was reproduced in Russian (Rakhlin, Cardoso-Martins, Kornilov, & Grigorenko, 2013) and Dutch (De Groot, Van den Bos,

Van der Meulen, & Minnaert, 2015), indicating similar mechanisms in a range of orthographies contrasted for consistency. With a wider battery of phonological and language tests, Ramus, Marshall, Rosen, and van der Lely (2013) further divided phonological skills into skills involving retrieval and manipulation of phonemes on the one hand, and skills involving the formation of accurate phonemic representations on the other hand. They found that English children with DLD *plus* decoding difficulties were affected on both dimensions, whilst children with DLD-only tended to be more impaired on the phonological representation dimension, and children with isolated decoding difficulties were more likely impaired on the phonological manipulation component (see also Carroll & Breadmore, 2018, for evidence of contrasted perceptual and manipulation skills of children with Otitis Media and dyslexia). Altogether, these results point to two different mechanisms at play in the development of spoken and written language: a mechanism underpinning the representation of sounds and involved in spoken language development on the one hand, and a mechanism underpinning the retrieval and manipulation of sounds on the other hand, highly involved in the development of decoding skills. This distinction is represented in Figure 3-4.

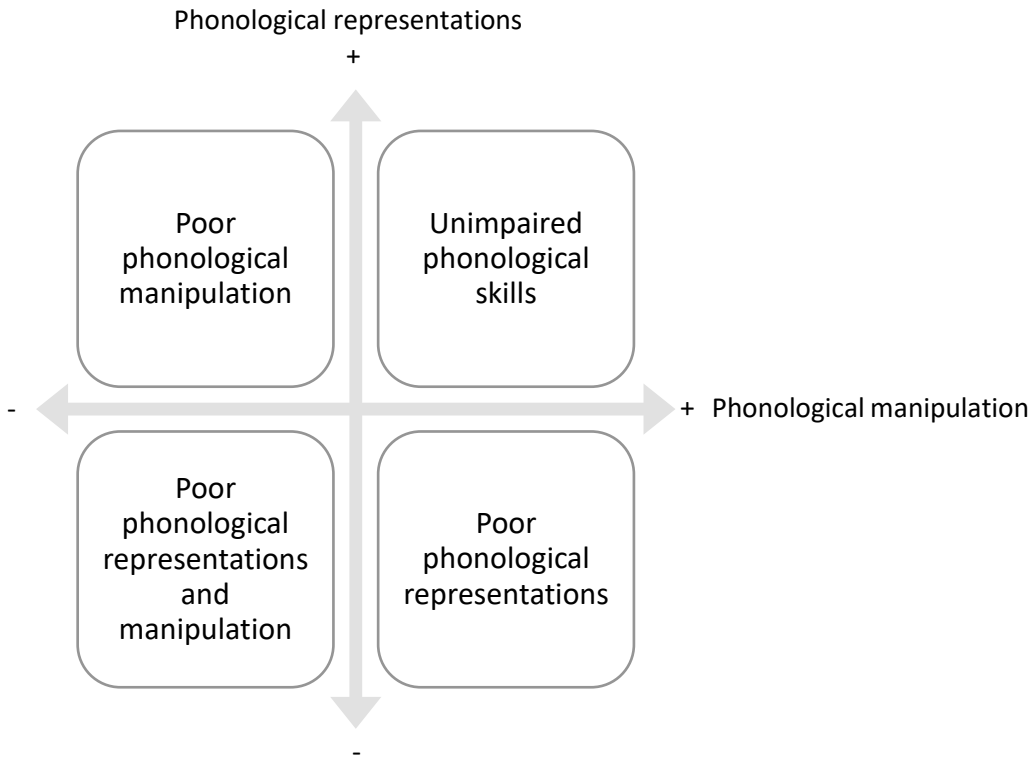

Figure 3-4: Conceptualisation of phonological skills in two dimensions, adapted from Ramus et al. (2013)

Although models implicating distinct mechanisms at play in DLD and reading disorders receive some supporting evidence, there is little mention of spelling in these models. Like reading, spelling involves phonological skills -arguably to a larger extent than reading (Bishop & Adams, 1990)- but also non-phonological language skills (at the sentence and discourse level). If phonological deficits (whatever their nature) and non-phonological deficits can be shared in DLD and reading disorders, it is still unclear how these deficits affect spelling in children with DLD. The following section will turn to specific aspects of the oral and written language productions of children with DLD, which have been the focus of previous research.

3.3.2. Presentation of DLD in English oral and written language

Studies on the oral and written productions of children with a Developmental Language Disorder vary in the range of methods used and specific objects of study. Typically, children with DLD have been compared to children of the same age, to acknowledge a difference in the way their language skills develop and assess potential domains of strengths and weaknesses. Children with DLD have also been compared to younger children with a typical

development (typically matched on Mean Length of Utterance -MLU-, considered a good indicator of language level in the early years), so as to highlight specific mechanisms affecting the development of their language (Leonard, 2014). Such comparisons with younger children are based on the idea that, if the development of the language of children with DLD is hindered by specific mechanisms, these mechanisms should appear when children with DLD are compared to typical children matched for language level. Specific components of their language have been under scrutiny.

Grammatical processing

One very commonly reported feature of DLD is the recurrence of errors with sentence structure. Typically, the syntactic development of children with DLD is delayed, with word combinations appearing later than expected, shorter sentences, and difficulties understanding long and complex sentences (Snowling & Hulme, 2009). More specifically, omissions of function words such as the article *the* and copula *is/are/has/have/did/do*, or verbal inflections for the past tense (*-ed*) and third person (*-s*), substitutions of subject/object pronouns (e.g. *Him have a pink body*) and difficulties with word order in non-canonical sentences such as questions (e.g. *why you need key for?*) are commonly reported in the spontaneous language of English children with DLD (Leonard, 2014). These difficulties are inconsistent, with correct sentence structures being produced alongside incorrect ones. Critically, differences in the rate of these grammatical errors are observed when children with DLD are compared to same-age children, but also when compared to children matched for MLU (Leonard, Caselli, Bortolini, Mcgregor, & Sabbadini, 1992; Oetting & Horohov, 1997). They are generally observed in preschool children with DLD, and become less apparent at school age (Bishop, 1994; Marchman, Wulfeck, & Weismer, 1999; Rice, Wexler, & Hershberger, 1998). At school-age, however, such difficulties become apparent in written language. One of the first studies to assess grammatical difficulties in the written language of children with DLD at school age was conducted by Windsor, Scott, and Street (2000). The

aim of their study was specifically to compare the accuracy of noun (plural –*s* and articles) and verb phrases (auxiliary *be*, third person -*s* and past tense -*ed*) on the one hand, and oral and written narrative samples on the other hand. Children with DLD (aged 7 to 12) were compared both to children matched on age and to younger children matched on language levels. Their results point to specific difficulties with verb endings and in particular past tense -ed, although relatively high error rates were also observed on noun plural -s. However, this was only evident in written language, with high levels of accuracy on all grammatical markers assessed in the oral narrative samples of all three groups. Windsor et al.'s results (2000) for written language on *spontaneous* samples of written language are corroborated by later English studies using *constrained* word spelling tasks (Larkin, Williams, & Blaggan, 2013; Silliman, Bahr, & Peters, 2006).

Evidence from languages other than English also points to grammatical difficulties. Like verb phrases in English, articles and clitics in Romance languages have emerged as grammatical markers of DLD. Again, these grammatical difficulties appear when children with DLD are compared to same-age but also younger typically-developing peers. In Italian, omission of object clitic pronouns has been widely reported in the literature (Leonard & Dispaldro, 2013). Clitic pronouns, such as *la* (*her*), *lo* (*him*), *le-li* (*them*) are widely used in Italian to replace nouns when verbs call for an object pronoun. They appear before the verb. An example of use of such pronouns is provided below (from Leonard & Dispaldro, 2013).

*Speaker 1: Non vedo **Gemma**, e siamo giá in ritardo. (I don't see **Gemma**, and we are already late.)*

*Speaker 2: **La** vedo adesso! (I see **her** now!)*

Spanish also widely uses object clitic pronouns (*el*/*la*/*los*/*las* – *him*/*her*/*them*), in the same way and position as Italian. Strikingly, children with DLD also experience difficulties producing this word category in Spanish, although substitution errors are produced rather than omissions (Bedore & Leonard, 2001). In French, object clitic pronouns also seem to be an

area of weakness in children with DLD. These pronouns have three forms in French (*le*/*la*/*les*, *him*/*her*/*them*) and are typically used between the subject and the verb. For example, the earlier example would translate as follows in French:

*Speaker 1: Je ne vois pas **Gemma**, et nous sommes déjà en retard. (I don't see **Gemma**, and we are already late.)*

*Speaker 2: Je **la** vois maintenant! (I see **her** now!)*

Unlike Italian and Spanish, French always requires a subject before the verb (e.g. *Je* in the example). Using the clitic pronoun thus disrupts the French canonical word order subject + verb + complement. French children with DLD produce an unusually high rate of object clitic errors in the early years (3-7, Hamann et al., 2003) and at school age (5-13, Jakubowicz, Nash, Rigaut, & Gérard, 1998) and continue experiencing difficulties processing sentences with clitic pronoun cues even in late primary school (7-12, Maillart & Schelstraete, 2003).

Difficulties with clitic pronouns are not the only markers of DLD in French. Consistent with English, difficulties have also been reported with verb morphology and in particular with the past tense (passé composé), which involves the auxiliary être (be) or avoir (have), often omitted (Jakubowicz, 2006). However, the data suggest that these difficulties may be restricted to early primary school (Thordardottir & Namazi, 2007). Jakubowicz and Nash (2001) have indeed found that within a group of French school-aged children with DLD, children aged six produced a mean of 12% correct past tense forms, at age 10 they produced about 65%, and at age 12, 96%. This was on a *constrained* task of sentence completion requiring the production of the target structure. Similarly, Hamann et al. (2003) showed that before the age of five, the *spontaneous* language samples of six children with DLD contained errors with verbal morphology in 15% of the clauses produced. Above age five on the contrary, verb constructions reached adult-like levels in the five children assessed. If we turn to the written language of French children with DLD, the evidence is very limited, but points to difficulties representing grammar accurately, but only in secondary school (age 12-18, Broc

et al. 2014), with a high rate of verbal ending errors. However, this study compared children with DLD to same-age peers only and used a *spontaneous* text sample.

It is important to consider the grammatical markers presented above with a developmental viewpoint. As discussed, in English, verb ending difficulties are firstly seen in oral language before becoming evident in written language at the end of primary school. In French, whilst difficulties with verb endings are evidenced in the early years, these are no longer prominent in primary school, while clitic pronoun errors remain instead. Another comment regards the type of tasks that have been used to assess target structures in the oral and written language of children with DLD. It is difficult to judge children's ability to produce a certain structure on the basis of spontaneous samples only, where they may not need to, or indeed avoid producing, the expected structure (Tuller, Henry, Sizaret, & Barthez, 2012). Unfortunately, no study could be found that assessed verb morphology in the written language of French students using a *constrained* word spelling task.

Lexical access

Lexical development is also often affected in children with DLD. Children with DLD typically produce their first words later than expected and their vocabulary grows at a slower rate than that of peers (Snowling & Hulme, 2009). Difficulties are also commonly reported with word retrieval (i.e. the ability to quickly produce words in their context) and word retrieval difficulties have been suggested as a clinical marker of DLD. Children with DLD often hesitate and use circumlocutions and generic words such as "stuff", "thing", "make" or "do", or semantic/phonological neighbours instead of a word target, such as *sheep/gate* for *goat.* They are also slower at naming pictures or objects, and their word definitions are often less elaborate than that of peers (Marshall, 2014).

The origins of such difficulties are debated, with both phonological and semantic accounts (Messer & Dockrell, 2013). Phonological accounts consider that lexical access difficulties stem

from difficulties at the point of programming word production, whilst semantic accounts rather consider problems to stem from underspecified semantic representations. A useful analogy to word retrieval is given by Leonard (2014, p. 58). He describes word retrieval as a process similar to a claw crane game in amusement parks. When words have a rich network of semantic and phonological specifications available, it is easier to quickly and accurately retrieve them (much like the claw crane catches toys with many points to latch onto). On the contrary, when words are underspecified, the chance is that a target word won't be immediately retrieved, but also that there won't be a rich network of other related words to latch onto. We also know that as children acquire more words, their retrieval processes become more efficient (Beck, Perfetti, & McKeown, 1982). Following the claw crane analogy, the more toys that are available in the game, the more likely a win. Difficulties with word retrieval may thus stem from storage problems: lack of words and word underspecifications (not enough toys with not enough appendages), but also from difficulties at the point of retrieval (the crane being broken). Figure 3-5 illustrates the claw crane game analogy described above, taken from Mirman and Britt (2014).

Figure 3-5: Illustration of the claw crane game analogy for word retrieval

From left to right, 1) typical retrieval, 2) difficulties with storage, and 3) difficulties with retrieval, from Mirman & Britt (2014).

Although the focus of the present study is not on theories of lexical access, different accounts may bring different predictions for spelling. On the one hand, underspecified word knowledge may involve poor orthographic representations as well as phonological and/or semantic ones. There is indeed evidence that orthographic, phonological and semantic representations are at least partially interdependent (Peleg, Edelist, Eviatar, & Bergerbest, 2016). On the other hand, difficulties with retrieval mechanisms may impair access to orthographic as well as phonological forms. Although there is a large body of evidence documenting the spelling difficulties of children DLD, to our knowledge, the spelling of children with DLD has not been assessed in terms of lexical access. However, one study examining word-finding difficulties in children aged 9 included a spelling task. Messer and Dockrell (2013) used cluster analysis to assess the phonological and semantic profiles of children with word-finding difficulties, as measured by a range of metalinguistic awareness, naming fluency and literacy tasks. The clusters revealed two profiles: one group of children performed relatively well on all language and literacy measures except for a measure of semantic fluency (poor comprehenders); the other group performed poorly on semantic fluency as well as spelling, word reading, phonological fluency, and reading and listening comprehension. In other words, whilst some children with lexical access difficulties had relatively preserved phonological and spelling skills, other remained impaired on both semantic and phonological dimensions. This study suggests that semantic access difficulties alone may not induce spelling difficulties. However, profiles involving poor semantic *as well as* phonological representations may impact spelling development.

3.4. Implications for the current study

This chapter raised terminological and identification issues. In line with the recent debates, the clinical sample for the current study was identified using professional and parental flagging (to acknowledge a functional impairment) as well as standardised language tasks (further described in chapter 6.2.1). Cognitive referencing was not used for identification.

Receptive language measures (receptive vocabulary and sentence comprehension) were used to ascertain language difficulties, alongside a receptive/expressive measure sensitive to language difficulties (sentence repetition). The sample is referred to as ‘‘children with DLD’’.

This chapter also described some of the main characteristics of children with DLD. One of the notable characteristics of this population is the risk of literacy difficulties at school age and the presence of phonological and/or grammatical and/or lexical difficulties within their language profiles. These difficulties are acknowledged in several languages, including French and English, and in both oral and written language. The present study stems from the literature reviewed on the markers of DLD in French and English oral and written language. It assesses difficulties with phonological, lexical and grammatical processes that may still be evident in the written language of these children at the end of primary school, as compared to both same-age and younger peers. The following chapter will turn to methods used to assess such processes.

Chapter 4. Assessing spelling processes in typical and atypical populations

The following chapter draws from studies assessing spelling in French and English typical and atypical children, with a focus on cross-language variations and methodological differences. The first section reviews studies using qualitative error analysis to identify potential markers of language difficulties in writing. The second section focuses on studies using reports of strategies to analyse underlying spelling processes. Because, to our knowledge, this has not been done in the DLD population, studies on typically developing and dyslexic students are also considered. The last section looks at studies which have used predictor analysis to highlight spelling process differences in children with DLD and typical children, across languages.

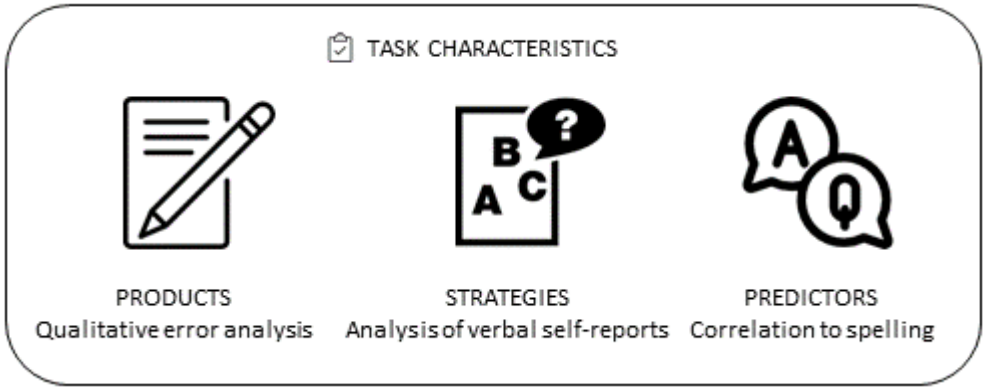

Figure 4-1: Tasks chosen to assess spelling processes in the present study and reviewed in Chapter 4.

4.1. Eliciting and analysing spelling products

Section 4.1. stems from a meta-analysis conducted as a prologue to the present thesis (Joye et al., 2018). This meta-analysis gathered studies comparing spelling performance in children with DLD and peers matched for age or language. Across all studies meta-analysed, children with DLD performed worse than age-matched peers (*g* = -1.42, (95%CI [-1.60, -1.24], $N_{studies}$ = 31), but not language-matched peers (*g* = -.20, 95% CI [-.54, .15], $N_{studies}$ = 4), suggesting a pattern of delay in spelling skills, in line with language development. However, the meta-analysis only assessed *quantitative* differences in scores between these groups. In the narrative section below, the *qualitative* differences in the spelling of children with DLD and their TD peers are further explored (both age- and language-/literacy-matched peers). It is argued that qualitative error analysis provides data complementary to spelling scores, and may provide a better "window into residual language deficits" (Bishop & Clarkson, 2003).

4.1.1. Early studies

In 2006, Silliman et al. were among the first to use spelling error analysis to identify potential markers of language difficulties in the spelling of eight children with DLD aged 9-11, as compared to eight age-matched (CA) and eight spelling-matched (SA) TD peers. To our knowledge, this was the first comparison of children with DLD to spelling-matched peers, as a way to identify specific mechanisms that may be hindered in DLD. They used a constrained spelling task with a selection of 30 words reflective of the spelling patterns of English and of the range of skills required to spell in this language. They analysed all three groups of children's productions according to three different acceptability scales: phonological (PA), orthographic (OA) and visual (VA, see paper for details on the scales). In all scales, the same pattern of differences was observed: age-matched controls produced more acceptable spellings than both the SA and DLD children, who did not differ. A fourth type of analysis was conducted in order to assess the relative weight of different error types on the spelling of

children with DLD and peers. In this last analysis, each error was considered as *either* phonological (PHON, to do with sound manipulations and representations in the words), *or* orthographic (ORTH, to do with spelling patterns and regularities), *or* morphological (MOR, to do with inflectional and derivational morphemes). This time, different patterns emerged between the DLD and SA groups. In the phonological and morphological categories, children with DLD produced more errors than both CA and SA. Specific errors were found in the phonological category with r-coloured vowels[4] and in the morphological category with omissions of inflections (particularly of the past tense -ed). This suggests that such coding scheme may provide an interesting tool for assessing different patterns of development and specific error types across groups and possibly across languages. One of the limitations of Silliman et al.'s (2006) study, like many studies in this population, is the small sample size, which limits generalisations. However, with the use of a detailed spelling error analysis scheme, on a set of words representative of the linguistic features of the orthography assessed, the authors provide an interesting tool for a detailed profiling of the spelling processes of children with DLD.

Only one study has assessed the quality of spelling errors produced by children with DLD in French. Broc et al. (2013, 2014) assessed 12 children with DLD (age 7-11) and 12 children with DLD (age 12-18) on two tasks: a word dictation task, comprising 10 regular words and 10 irregular words, and a written narrative task. In the written narrative, children were given 10-15 minutes to tell about a conflictual situation in their school context. The word dictation and written narrative were analysed for the phonological acceptability (PA, e.g. *parphum* for *parfum*) or unacceptability (PU, e.g. *parfu* for *parfum*) of the spelling errors made, measured in proportion per words produced. The spelling errors of the written text were further analysed for the morphological errors produced. Morphological errors were defined as

[4] R-coloured or rhotic vowels are typical to American English. They are vowels coloured with the following <r> letter, such as the /ɜː/ in first /ˈfɜːst/.

spelling errors on the grammatical part of words (verb/noun endings -e.g. *été-était*/*carte-cartes*-, as well as grammatical homophones – e.g. *s'est-ses*). Children with DLD produced a higher proportion of PU than PA at 7-11, but not at 12-18. This difference was only found in words from the dictation but not the written text. It was not found in the aged-matched TD samples at all. There was no direct comparison of the PU scores in children with DLD and TD children, although descriptive statistics suggest a group difference in dictation (M_{DLD} = .39, SD_{DLD} = .27; M_{TD} = .08, SD_{TD} = .09). Particular difficulties were identified in the young DLD sample with word segmentation. When the authors looked at morphological spelling errors, they found children with DLD produced a smaller proportion of morphological errors per words than TD at 7-11 but a higher one at 12-18. Morphological spelling errors were mostly to do with verbal inflections and grammatical homophones (in both the DLD and TD samples). The authors suggest that morphological errors may only become dominant in the written samples when children produce 15 words and above. There were indeed positive correlations (r = .75) between the number of words produced in the written sample by children with DLD aged 7-11 and their rate of morphological errors: the longer their texts, the higher the rate of morphological errors. In fact, although a direct comparison is not provided, the rate of morphological errors in the 7-11 DLD sample (M = .08, SD = .09) was very similar to that of the older 12-18 typical sample (M = .09, SD = .07), suggesting a pattern of delay in the spelling development of children with DLD. This study provides the only French account of spelling error analysis in children with DLD. Differences with results from American English (Silliman et al., 2006) are striking for two reasons: a) morphological error analysis does not point to specific difficulties with verbal inflections before age 12 in French; b) word segmentation errors are identified in the younger French DLD children which were not seen in the English sample. Comparison with spelling-matched peers is not provided, however, limiting the interpretation.

Swedish data from Nauclér (2004) provide further evidence of cross-linguistic differences in the spelling of children with DLD. In a longitudinal study, the author compared the spelling of 35 children with DLD and 9 age-matched TD peers (after attrition) at grade 1, 3, 4, and 12, using a word dictation task (unfortunately not described in the report). In a relatively more transparent language than English or French, children with DLD had caught up with peers in number of correct words produced by grade 3. However, the evolution of certain error types was different in the two groups. In Swedish spelling, vowel quantity is an area of particular difficulty, with complex orthographic constraints affecting choice of vowel spelling. When the rate of such errors was observed at grade 1 (age 6), children with DLD produced less errors (19%) than TD peers (36%). However, this rate increased sharply in both groups between grade 1 and 3 (from 19% to 48%, and from 36% to 55%), until they became similar in grade 4 (58% and 57%) and decreased in grade 12 (38% in both groups). In addition, the rate of phonologically-unacceptable errors was higher in the DLD sample than in their TD peers at all time points (including in grade 12). This data, along with the French data, suggests that the development of orthographic and morphological processes in spelling development may happen in children with DLD, although at a slower rate. It is less clear, however, how difficulties with phonological processes continue to affect children with DLD over time in different languages. Whilst the French sample seems to provide age-appropriate phonological spellings at age 12-18, it is still not the case in the Swedish sample aged 17. The transparency of the language considered could affect reliance on phonological processes. Similarly, morphological and/orthographic complexity can affect the rate of development of orthographic or morphological processes. In order to assess such processes, direct comparisons with spelling-match peers are needed. The section below outlines evidence from younger match comparisons.

4.1.2. Studies using a younger-match comparison

Five studies could be found (other than Silliman et al., 2006, already described above), which assessed the quality of the spelling errors produced by children with DLD and compared them to both age- and language-/spelling-/reading ability-matched (LA/SA/RA) typical peers[5], either for phonological acceptability (PA), orthographic acceptability (OA), morphological accuracy (MA), or a combination of these measures. Unfortunately, no such data could be found from languages other than English.

Of the studies identified, all assessed PA (as in Broc et al., 2013 and Silliman et al., 2006). Although all five studies point to a significantly lower rates of PA errors in the samples of children with DLD, as compared to age-matched peers, only two report lower rates of PA errors as compared to LA/SA/RA peers. These two studies were unique in that they found PA differences in either pseudowords (Larkin et al., 2013) or in derivational suffixes (Critten, Connelly, Dockrell, & Walter, 2014), but not in real/entire words. By contrast, all other studies (Dockrell et al., 2014; Mackie & Dockrell, 2004; Mackie et al., 2013) used real words from written texts. These results, along with those obtained from the single word dictation task of Silliman et al. (2006), indicate that qualitative differences in the proportion of PA word errors are consistent when children with DLD are compared to CA peers, but not when children with DLD are compared to younger peers matched on LA, SA or RA.

Similarly, orthographic acceptability (OA) was assessed in four studies (Dockrell & Connelly, 2015; Larkin et al., 2013; Mackie & Dockrell, 2004; Mackie et al., 2013). All but one (Mackie et al., 2013) report similar rates of OA errors in the DLD and LA/SA/RA groups, but higher ones than in the CA groups. The effect size was medium in the one study reporting such

[5] Please note that language-, spelling- and reading- matched peers are gathered together in the following discussion for two reasons: a) the small number of studies using younger matching for qualitative analysis and b) the fact that, in all studies where this was controlled, both spelling and language levels were commensurate in the group of children with DLD and spelling-/language-matched peers. Reading-matched control groups are only used in one study and qualitative results are in line with the language-match comparison.

differences (η^2 = .07). Again, qualitative differences in orthographic acceptability are consistently reported when children with DLD are compared to age-matched peers, but not when they are compared to peers matched on spelling or language.

Specific morphological patterns (such as -ed, -ing, 3rd person -s and plural -s) were further assessed in four studies (Critten et al., 2014; Larkin et al., 2013; Mackie & Dockrell, 2004; Mackie et al., 2013). Two studies used a set of controlled morphological words (Critten et al., 2014; Larkin et al., 2013), whilst two used a narrative task (Mackie & Dockrell, 2004; Mackie et al., 2013). Using a narrative task, Mackie and Dockrell (2004) showed children with DLD produce a higher rate of -ing and plural -s omissions than both their CA and LA peers. Mackie et al. (2013) also found higher rates of these omissions in the DLD as compared to the CA peers, but only the rate of -ed omissions differentiated children with DLD from younger peers matched on either language or reading. Results from the two studies using controlled morphological words also provide supportive evidence for specific difficulties with inflectional morphology. Using a spelling task comprising 12 -ed inflected verbs and 12 plural -s inflected nouns, Critten et al. (2014) showed that children with DLD omitted inflections -ed and plural -s (*M* = 1.6, *SD* = 2.3) more often than CA (*M* = .01, *SD* = .04) but not LA peers (*M* = .05, *SD* = .09). By contrast, Larkin et al. (2013) showed higher rates of errors and omissions on -ed, -ing, and 3rd person -s (*M* = 2.4, *SD* = 2.77) than both CA (*M* = .27, *SD* = .7) and SA peers (*M* = .2, *SD* = .41), using a dictation of 18 inflected words. Altogether, these four studies and those previously conducted by Silliman et al. (2006) and Windsor et al. (2000) suggest English-speaking children with DLD encounter specific difficulties spelling inflectional morphemes, as compared to CA- but also LA-, SA- or RA- matched peers. The regular past tense -ed may be a particularly good indicator of such morphological difficulties in English spelling.

Although the number of studies that have assessed patterns of spelling development in children with DLD using qualitative error analysis and a younger match group is limited (only eight, all mentioned above), there are a number of methodological variations which limit any attempt at directly comparing them: a) the use of multiple coding schemes for the analysis of spelling errors (constrained or unconstrained, scales or dichotomous measures, measured in proportion per words produced or in proportion per errors produced), b) the use of either constrained word lists (with various characteristics) or written narratives (also varying in length, topic and administration procedure), c) variations in the measure used for matching a younger control group (spelling, reading, expressive/receptive language at word/sentence/discourse level). Furthermore, all of these comparisons were conducted in English, limiting the generalisability of findings.

4.1.3. Implications for the current study

The characteristics of the studies reviewed above and in section 3.3.2 are summarised in Table 4-2. Methodological choices made on the basis of the existing literature are further discussed below.

In order to account for a range of spelling processes and difficulties at once, the choice was made in the present study to use a multi-component coding of spelling errors, similar to the one discussed in Silliman et al. (2006). This coding seemed promising for differentiating patterns of development. In this study, errors were classified as either phonological, morphological or orthographic. One further category was added in this coding scheme (following from Apel & Masterson, 2001): semantic errors, in order to account for the segmentation errors observed in French by Broc et al. (2014). The coding scheme adapted for the current study is described in section 6.5.3 of the methods chapter. Furthermore, children were assessed on both a controlled word dictation task and a written narrative. Previous studies showed that written narrative may not always provide sufficient

opportunities for all types of errors (Mackie & Dockrell, 2004; Windsor et al., 2000). By choosing specific words from a standardised French and English spelling task, chosen to assess a variety of orthographic, morphological and phonological patterns (as in Silliman et al., 2006), we aimed to provide similar opportunities to all children, whilst also giving them the chance to produce a more naturalistic sample of writing in a written narrative. Further detail on word choice for the qualitative analysis of spelling can be found in the methods chapter, section 6.5. Finally, we chose to compare children with DLD to children matched on spelling level, as qualitative analysis of patterns of spelling development requires a spelling-match comparison. In the present study, younger control children were matched on a standardised single word spelling task reflective of the orthography being assessed. The matching procedure is further described in the methods chapter, section 6.2.2.

Table 4-1: Summary of the methodological features of the studies reviewed above, for their qualitative analysis of spelling errors in children with DLD

Year	1st author	Lang	Age	Task				Controls				Qualitative analysis of errors						
				Text	Controlled dictation			Same-age	Younger			Coding scheme			Morphological marks			
															Verb			Noun
				TP	WD	NWD	MWD	CA	LA	SA	RA	PA	OA	Multi	ed	ing	3s	plur s
2000	Windsor	EN (UK)	7-12	+				+	+						+		+	+
2004	Mackie	EN (UK)	9-12	+				+	+			+	+		+	+	+	+
2004	Nauclér	SWE (SW)	6, 8, 9, 18		+			+				+	+	+				
2006	Silliman	EN (US)	9-11		+			+		+		+	+	+	+	+	+	+
2013	Larkin	EN (UK)	8-10			+	+	+		+		+	+		+	+	+	
2013	Mackie	EN (UK)	10-11	+				+	+		+	+	+		+	+	+	+
2013-2014	Broc	FR (FR)	7-11, 12-18	+	+	+		+				+			+ (verb endings overall)			+
2014	Critten	EN (UK)	9-10				+	+	+			+			+			+
2015	Dockrell	EN (UK)	10	+				+	+			+	+		+	+	+	+

A + indicates the feature was assessed, Lang: Language, EN(UK): British English, EN(US): American English, SWE(SW): Swedish, FR(FR): French (France), TP: Text production, WD: Word dictation, NWD: NonWord Dictation, MWD: Morphological Word Dictation, CA: Chronological Age control, LA: Language Ability control, SA: Spelling Ability control, RA: Reading Ability control, PA:Phonological Acceptability, OA: Orthographic Acceptability, Multi: multicomponent analysis, ed: past tense -ed inflection, ing: present progressive -ing inflection, 3s: 3rd person present -s inflection, plur s: plural -s inflection.

4.2. Eliciting and analysing verbal self-report of spelling strategies

There are a number of limitations to the use of error analysis as a way to explore children's spelling strategies. Firstly, difficulties with orthographic processes may not necessarily result in a spelling error. Secondly, error analyses lead to a high degree of assumptions on the part of the adult rater. Finally, multiple word errors involving a range of different strategies represent a challenge for error classification. One alternative to error analysis is to rely on children's commentaries on their spelling strategies, by asking them directly about their thought process during a spelling task. Thought processes are generally reported in up to seven broad categories: 1) The automatic retrieval of the word (e.g. "I just know it") is considered to be the most efficient and automatic process and consists in the mere retrieval of the word's orthographic form; 2) Phonological, phonetic or sounding out strategies (e.g. "I just sounded it out") rely on sound-to-letter matching; 3) Analogical strategies (e.g. " clip is lip with a -c- in front of it") rely on knowledge of other orthographic forms; 4) Orthographic rule strategies (e.g. "I learnt in class: <i> before <e> except after <c>" call on knowledge of orthographic rules as they are taught; 5) Visual checking (e.g. "It looks right") calls on visual sensitivity to orthographic regularities; 6) Semantic strategies (e.g. "there's two types of patience/patients, one is at the doctor and the other is when you have patience") relies on knowledge of homophones and semantic relationships; 7) morphological strategies (e.g. "because normally in teaching they say if you want to make a word the past tense, you add on an -ed") are based on knowledge of common inflections and derivations. Authors have used this experimental approach and these categories flexibly across studies depending on their research aims.

In this section I will review a selection of studies that have used such elicitation and classification of reported spelling strategies as a way to explore the processes involved in French and English spelling in children. Of the five studies identified, two assessed children learning to spell in French and three assessed children learning to spell in English. Most

studies assessed children with typical language development and spelling skills, providing important benchmarks on the development of spelling strategies throughout primary school. Two studies also assessed the spelling strategies reported by children with dyslexia, in English (Donovan & Marshall, 2015) and in French (Ruberto, Daigle, & Ammar, 2016). To our knowledge, no studies have used the analysis of spelling strategies in children with DLD.

4.2.1. Early studies

Verbal self-reports were used as a method of examining spelling in 1998 by Steffler, Varnhagen, Friesen and Treiman. The authors assessed the spelling strategies of 93 American children in grade 2 to 5 (aged 7-11) with average spelling ability. They combined the report of spelling strategy (defined as either automatic-retrieval, phonetic, rule-based, analogical or other) with a time measure of keystroke for typing CVCC, CVCe and CCVC words with regular letter-to-sound correspondences. Better performance on the spelling task was correlated with shorter typing times and higher reports of automatic retrieval. On the contrary, the use of other strategies, in particular phonetic strategies, was related with longer typing times and a lower spelling accuracy. Phonetic strategies were more frequent in grade 2 than in older children, suggesting children learned more automatic and efficient processes as they grew older, although children were able to use a range of strategies at all ages.

In 1999, Rittle-Johnson and Siegler further tested the methods on younger children. In their study, 30 American children (aged 6) were tested in November of first grade with a set of 15 words of increasing complexity. Words were chosen from the beginning, middle and end of the spelling book and moved from direct sound-to-spelling correspondences (e.g. <hat> /hat/) to words with less consistent sound-to-spelling correspondences (such as /ɜːr/ in <girl> /gɜːrl/). 23 of the children were then followed-up in November of second grade. Results showed a decrease in the use of sounding out strategies between first and second grade, towards more other back-up strategies and more retrieval reports. They also showed that as

early as grade 1, children can report a wide range of strategies (retrieval, sounding out, but also rule-based, analogical and visual checking strategies). Children could use those flexibly as the difficulty of words increased. Another important finding of their study was that the strategies reported by children matched the overt behaviours observed during the testing session, making it a reliable tool for assessing spelling strategies. This supports the idea that audio-recording children is an appropriate tool to assess children's spelling strategies. On this basis, in the present study, audio-recording was preferred to video-recording, for ethical (image property) and practical reasons (portability of the recording device).

4.2.2. Studies with dyslexic and/or French participants

More recently, Donovan and Marshall (2015) explored the spelling strategies of 22 children with dyslexia (mean age = 8:10). They introduced a decision task into the experimental design with three spelling choices for a set of 15 words of varying difficulty. Words were taken from a standardised spelling test widely used by specialist dyslexia teachers and alternative choices were taken from children' common incorrect productions on the task. Words were reflective of the English spelling system, as they were all inconsistent in the sound-to-spelling direction (e.g. <have>, <crack>, <spread>) and accurate spellings clearly relied on knowledge beyond phoneme-to-grapheme correspondences. The authors also compared the performance of children with dyslexia to that of younger spelling-matched TD peers, as well as to age-matched TD peers. The strategies reported by the group of children with dyslexia differed from those of the spelling- and age-matched TD group, although all groups could draw on all types of strategies. A majority of children with dyslexia reported using predominantly sounding out strategies, whilst a majority of the children matched on spelling reported using a retrieval or visual checking strategy, and age-matched peers had a variety of strategy profiles. Furthermore, students with dyslexia reported less strategies overall (compared to both TD groups), and they had a lower rate of retrieval reports. Arguably, choosing between different spelling options is a rather different process than spelling a word,

but performance on both tasks is highly related (Holmes & Davis, 2002). On the basis of a spelling choice task, (Donovan & Marshall, 2015) results (2016) support the hypothesis that more efficient spellers of English rely more heavily on automatic retrieval processes whereas poorer spellers tend to rely more on sounding out as a way to decide on a word's spelling, even for words where such a strategy will lead to incorrect spellings.

In French, only two studies could be found, which reported on the spelling strategies of French-speaking students. One focused on typically-developing students and used verbal reports to assess children's sensitivity to morphological constraints in word endings (Sénéchal et al., 2006), whilst the other used verbal reports to explore the spelling strategies of French students with dyslexia (Ruberto et al., 2016).

Sénéchal et al. (2006) assessed 39 children in Grade 4 (mean age 9; 9) on a spelling task involving so-called "phonological", "morphological" and "lexical" words. Phonological words were words which could be spelled by a simple sound-to-letter matching process (e.g. <castor> /kastɔʀ/ - beaver). Morphological words were words containing a silent final letter, which could be identified in a longer derived or inflected word (e.g. <bavar**d**> /bavaʀ/ - talkative, whose silent -d- can be heard in the feminine <bavar**de**> /bavaʀd/). Lexical words were words whose final silent letters could not be inferred from any related word (e.g. <foular**d**> /fulaʀ/ - scarf). The authors showed that children restricted their use of morphological strategies to morphological words, whilst the use of phonological strategies was more frequent in lexical than morphological words. Use of morphological strategies was related to a high success rate on those items and to a good score on a morphological awareness task. This study, as opposed to the English studies mentioned above, has a clear focus on a process (morphological silent letters) which is typical of the French written system. However other morphological processes are present in English and may allow for the disambiguation of a number of inconsistent English spellings (e.g. <heal>-<health>) (Apel &

Masterson, 2001). Because one of the aims of the present study was to explore such processes in both languages, morphological strategies were considered a separate type of strategy.

Finally, Ruberto et al. (2016) used verbal self-reports to compare the spelling strategies of a group of 32 children with dyslexia (aged 8-12) to a group of 25 aged-matched and 24 reading-matched TD peers. They assessed children using a word dictation task comprising 24 words of minimal, medium and maximum complexity. Words of minimal complexity had consistent sound-to-letter correspondences (e.g. <ami> /ami/ - friend). Medium complexity words contained one less frequent vowel or consonant spelling (e.g. less frequent diagraph -ain /ɛ̃/ for <main> /mɛ̃/ - hand or consonant doubling <pomme> /pɔm/ - apple). A maximum complexity item contained 2 spelling difficulties such as a less frequent spelling and/or a final silent letter (e.g. <oignon> /ɔɲɔ̃/ - onion). Words also varied in length (short words of one or two syllables and long words of three syllables or more). Using this material and an open-ended question to elicit children's strategies, the authors showed that dyslexic students as well as age- and reading-matched peers used primarily phonological strategies (compared to other type of strategies and automatic retrieval processes) to explain their spelling. They further showed that the group of students with dyslexia was the one reporting the most irrelevant, inaccurate and unknown strategies but also the most well-integrated automatic processes. It is important to note, however, that in this study, unlike in the studies mentioned above, strategy analysis was only made on strategies leading to correct spellings. It is likely that this methodological choice did not allow for the identification of less efficient strategy choices.

A number of methodological features are of importance in reviewing the literature outlined above and planning for the present study. These methodological features are discussed in the section below and summarized in Table 4-2.

4.2.3. Implications for the current study

The aim of the present study was to assess the spelling strategies of children with DLD compared to age- and spelling-matched peers. We also aimed to identify specific characteristics in the language considered.

Because the present study differed from all of the studies reviewed here in the population considered, one important methodological adjustment consisted in making the task accessible to children with DLD. Children with DLD may experience difficulties understanding open-ended questions (Leonard, 2014, p. 57). Closed questions prompts were included in the protocol. These closed questions prompts were adapted from the studies reviewed above (Rittle-Johnson & Siegler, 1999; Sénéchal et al., 2006). They targeted directly the strategy types previously reported in the literature. One further adaptation was to give three spelling options (Donovan & Marshall, 2015) rather than ask children to write words. It was expected that a spelling choice task would reduce the cognitive load involved in transcription (Graham & Harris, 2005), whilst still assessing children's orthographic representations (Holmes & Carruthers, 1998), and critically, whilst still allowing for the elicitation of spelling strategies (Donovan & Marshall, 2015). Furthermore, the focus of the task was on spelling strategies and not spelling products and children's knowledge of the specific set of words had already been tested during the group dictation task.

The choice was made of using words from the standardised spelling test used during the initial group session, in line with Donovan and Marshall (2015). Words were chosen from the French and English versions of this test so as to reflect the variety of orthographic features in the language. Furthermore, because spelling errors were classified according to a multilinguistic framework for spelling ability (as presented in section 6.5, in Chapter 6), we used the whole range of spelling strategies reviewed above for this study's classification, that-is-to-say morphological, semantic, phonological, analogical, visuo-orthographic, rule-

based and retrieval strategies. Table 4-2 below gives a summary of the methodological features considered and adjusted for the present study. The process and coding scheme for the analysis of verbal reports of spelling strategies is further described in 6.6 of the methods chapter.

Table 4-2: Summary of the methodological characteristics considered in studies using verbal self-reports of spelling strategies

Study	Steffler et al.	Rittle-Johnson et al.	Sénéchal et al.	Ruberto et al.	Donovan and Marshall
Year	1998	1999	2006	2016	2016
Language	EN (US)	EN (US)	FR (CA)	FR (CA)	EN (UK)
Aim	investigate spelling processes through on-line keystroke reaction times and verbal self-reports, relate them to spelling performance	assess the evolution of the strategy range and adaptivity between grade 1 and grade 2 and relate them to spelling performance	assess the role of morphological strategies to spell word with silent endings in French and relate strategy choice to word type, spelling performance and morphological awareness	assess the spelling ability as measured by a written text and a dictation task, and relate strategy choice to word types and spelling ability	explore the spelling strategies of dyslexic students as compared to age- and spelling-matched TD peers
Population	93 TD (year 2-5)	30 TD in first year (23 followed up in 2nd year)	46 TD in 4th year	32 DL aged 8-12 vs 24 reading-matched TD vs 25 age-matched TD	22 DL aged 6-9 vs 22 age-matched TD vs 22 spelling-matched TD
Task	Digitised dictation task, with sentence context	Dictation task	Dictation task	Dictation task	Constrained choice task
Material	36 monosyllabic four-letter words (12 CCVC, 12 CVCC, 12 CVCe) with consistent spelling-to-sound correspondences	15 mono and bi-syllabic words in year 1 and 24 in year 2, taken from the beginning, middle and end of the class spelling book	24 words: 6 Phonological words, 11 morphological words and 7 lexical words	24 words of increasing complexity and length	3 spelling options for 15 words representative of the spelling patterns of English
Initial prompt	"What was going on in your head when you spelled the word?"	"How did you figure out how to spell …?"	"What was going on in your head when you spelled the word?"	"Tell me what you did to write the word."	"Why did you choose this one and not the other 2?"
Further prompts	No further prompting	1) Did you just know how to spell it? 2) Sound it out? 3) Use another word to help you spell it? 4) Use a rule? 5) Do anything else?"	1) Did you know how to spell the word by heart? 2) Did you spell the word by sounding it out? 3) Did you use another word to help you spell the whole word? 4) And if so, what word did you use?	No closed prompting, only open encouragements: "How did you figure out the spelling of the word ____?", "Why did you write the word this way?"	No closed prompting: children asked to think of how they might teach/learn the correct spelling
Record	Audio-recording	Video-recording	Audio-recording	Audio-recording	Audio-recording
Data	Spelling products, keystroke latencies and verbal self-reports	Spelling products, overt behaviours during spelling and verbal self-reports	Spelling products and verbal self-reports	Spelling products in word dictation and written text production, spelling strategies reported to correctly-spelled words	Spelling products on a standardised spelling measures (HAST2), task word choice, and spelling strategies reported

Study	Steffler et al.	Rittle-Johnson et al.	Sénéchal et al.	Ruberto et al.	Donovan and Marshall
Strategies	Retrieval	Retrieval	*Retrieval	Automated procedures	Retrieval-automatic
				*Backup (mnemonics)	Retrieval-using strategy (mnemonics)
	Phonetic	Sounding out	*Phonological	*Phonological	Sounding out
	Analogy	Drawing analogies	Analogical	*Analogy	Analogy
		Visual Checking		*Visuo-orthographic	Visual Checking
		Relying on rules	Rule-based		Rules
					Semantic Knowledge
	Other		Another strategy	Irrelevant, inaccurate	
			*Morphological		
Methods +/-	Princeps study	Verbally-reported strategies match overt behaviour, methods appropriate even for young first graders. Uses a graded prompting approach with targeted closed questions to elicit strategies.	Justifies morphological strategies as a distinct category. Uses a graded prompting approach with targeted closed questions to elicit strategies.	Relates spelling products in written text production, word dictation to spelling strategies, but only considers strategies leading to a correct spelling	Justifies semantic strategies as a distinct category. Uses a spelling choice rather than a direct spelling task.

**Only these strategies were further analysed in the results of the study. DL = dyslexic; TD = typically-developing.*

4.3. Assessing and analysing predictors of spelling across languages

Another approach to studying spelling processes involves assessing and analysing predictors of spelling performance. There is a growing body of studies assessing predictors of spelling in different orthographies contrasted for their transparency. A number of studies have also assessed predictors of spelling performance in the DLD population. The following sections review these in turn, starting with studies assessing predictors of typical spelling development across languages, with a focus on the end of primary school, and on this study's two languages of interest, French and English.

4.3.1. Predictors of typical spelling development across languages

There is now a large body of evidence assessing predictors of literacy development in a range of orthographies contrasted for orthographic consistency. Across languages, this literature highlights the essential role of metalinguistic awareness, letter knowledge, and rapid naming in entering literacy. In their review chapter, Caravolas and Samara (2015) have described these three skills as the *Triple Foundation* of early literacy, as illustrated in Figure 4-2. According to the *Triple Foundation Model*, awareness of metalinguistic units (phonemes, syllables, rimes and morphemes) and symbol knowledge (letters, syllabographs, morphographs and word spellings) are involved in initial sound-to-symbol mappings, whilst rapid naming is considered an indicator of the ability to quickly and accurately retrieve these mappings for reading and spelling words. This model, however, focuses on the early stages of literacy development, relies more heavily on reading than spelling data, and considers exclusively single word reading and spelling.

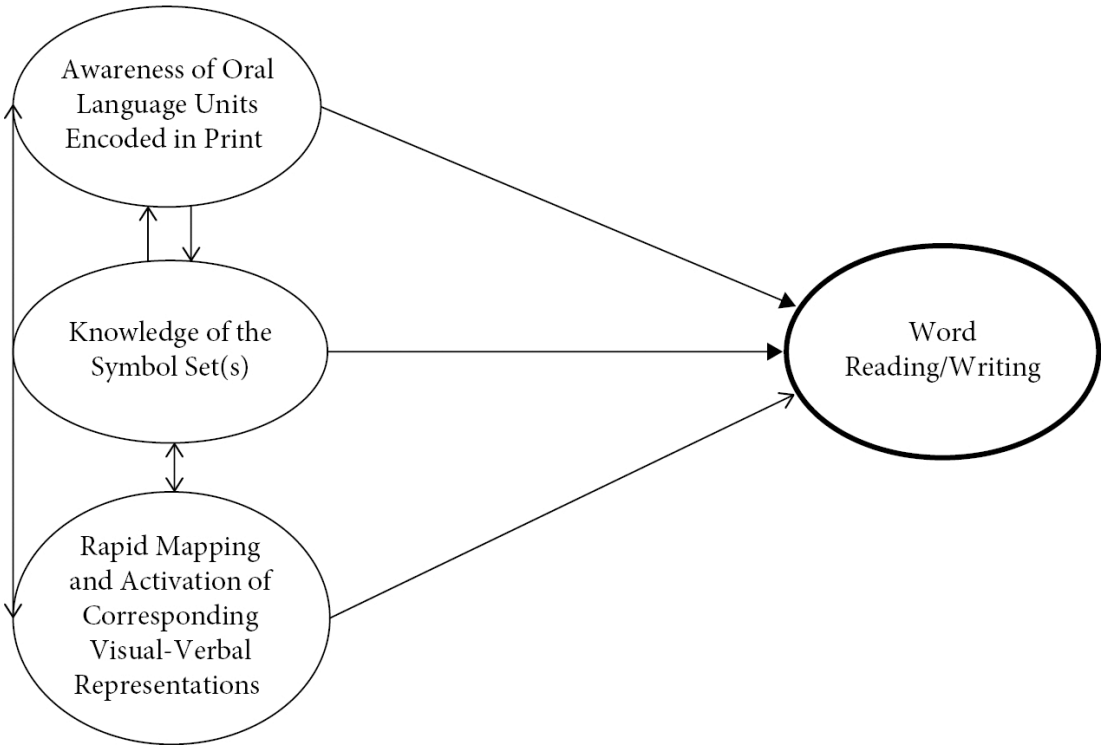

Figure 4-2: The Triple Foundation Model of early literacy proposed by Caravolas and Samara (2015).

To our knowledge, the only comprehensive assessment of spelling predictors in late primary school across languages is provided by the Neurodys European consortium (Moll et al., 2014). In as many as five languages, including English and French, Moll et al. (2014) assessed the Rapid Automatic Naming (RAN, digits and pictures), phoneme deletion skills (as an index of phonemic awareness), and digit span (as an index of phonological short-term memory) of 1062 typically-developing children, along with their word reading accuracy and speed, and word spelling accuracy. Children were between their third and seventh year of formal education at the time of testing. In English, RAN was significantly related to spelling (r = .43), as well as phonological awareness (r = .40) and phonological memory (r = .30). By contrast, in French RAN was not significantly related to word spelling, and only phonological memory (r = .30) and phonological awareness were (r = .21). In all other languages, phonological awareness was the most important correlate of spelling (r = [.37-.50]). Regressions confirmed the importance of RAN in English, with r^2 = 16.7% unique contribution to word spelling performance, whilst phonological memory stood out as the most important regressor in

French (r^2 = 6.6%). Results of the regression analyses were commensurate with those of the correlations. Altogether, RAN, phonological memory and phonological awareness accounted for a total of r^2 = 34.7% variance in spelling scores in English and r^2 = 8.9% in French. In all other languages, the model fit varied between r^2 = 9.3% and r^2 = 16.2%. However, when the impact of language on the regression models was assessed using multilevel modelling, no significant language effect appeared. These results raise two issues. One relates to the importance of RAN for spelling in English. Consistent with other studies (Stainthorp, Powell, & Stuart, 2013), RAN was a significant predictor of word spelling in English. This has been previously interpreted as a proxy of the depth of the English orthography, leading children to rely heavily on retrieval processes in specifying and accessing accurate orthographic representations (Savage, Pillay, & Melidona, 2008). The second comment relates to the relative importance of phonological memory in the French model, and the relatively poor fit of this model overall. The importance of phonological memory in French spelling suggests complex processes may be at play when French children attempt to spell words: processes putting a load on their phonological memory, and apparently not captured by a phoneme manipulation task.

One very recent study sheds further light on processes involved in spelling in these two languages. Desrochers, Manolitsis, Gaudreau, and Georgiou (2018) assessed Canadian French, Canadian English, and Greek students at the beginning of year 2 on RAN, phonological awareness and morphological awareness. Their spelling, reading accuracy, reading speed and reading comprehension was then assessed at the end of year 2. In English, phonological awareness (r = .61), morphological awareness (r = .51) and RAN (r = -.48) were significantly correlated to spelling scores. In French, a similar pattern was observed, with correlations of r = .53 with phonological awareness, r = .50 with morphological awareness, and r = -.19 with RAN. Structural equation modelling was further used to predict the weight of early year 2 measures with the literacy outcomes at the end of the school year. The model with three

predictors accounted for r^2 = 45% of variance in English, and r^2 = 32% of variance in French. Morphological awareness predicted a unique 1.4% of variance in English, and 6% in French, the most important contribution in all three languages. When models were compared across languages, however, no difference appeared in the relative weight of each predictor between the French and English sample. Consistent with previous studies conducted in French and English in children aged 8 and above (Casalis, Deacon, & Pacton, 2011; Deacon, Kirby, & Casselman-Bell, 2009), morphological awareness was an important predictor of spelling performance as early as the end of the second year of primary school. Importantly, both inflectional and derivational morphology were assessed in this study, and multiple tasks were also used to assess phonological awareness (phoneme elision in words and non-words) and RAN (colour and digit naming). The spelling task, from the WIAT-II, comprised regular and irregular words, as well as derived and inflected forms, capturing a variety of spelling processes. Figure 4-3 presents the results of the structural equation model conducted for English, French and Greek by Desrochers et al. (2018), and shows the relations of the RAN, phonological awareness and morphological awareness composites to literacy measures at the end of year 2. These recent findings provide a firm rationale for including morphological awareness, alongside phonological and RAN, as a predictor of spelling in late primary school in future models.

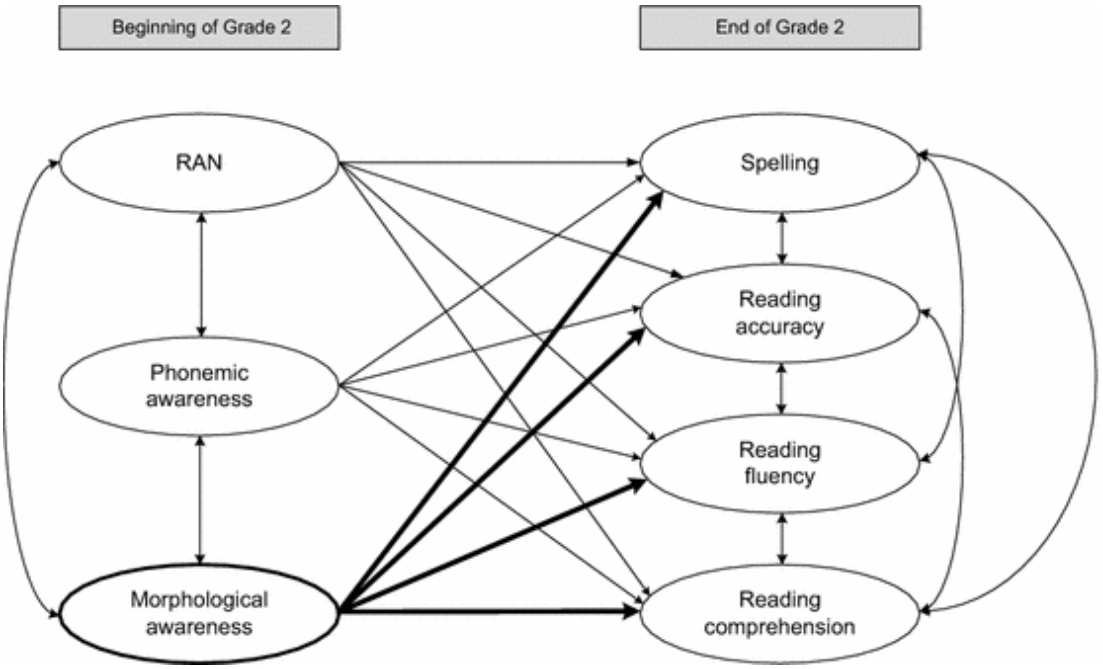

Figure 4-3: Model of relationships between RAN, phonological awareness, morphological awareness and literacy measures, as assessed by Desrochers et al. (2018) in English, French and Greek at the end of year 2.

4.3.2. Predictors of spelling in the DLD population in French and English

There has been a focus in the literature on the specific predictors of literacy outcomes in children with language difficulties. Phonological skills in particular have been under scrutiny. Tasks of nonword repetition, rapid naming, phoneme elision, phoneme blending, rhyming, and alliteration have been considered.

The literature assessing predictors at the beginning of literacy development in children with DLD is consistent with the Triple Foundation Model described above. Phonological skills in the early years are related to print awareness and letter knowledge (Boudreau & Hedberg, 1999), and both phonological, print awareness and rapid naming skills are related to early spelling skills (Cabell, Justice, Zucker, & McGinty, 2009; Cordewener, Bosman, & Verhoeven, 2012). In late primary school, evidence points to the lasting relation of phonological manipulation skills (r = [.57-.73]), nonword repetition (r = [.44-.70]) and RAN (r = .40) to word spelling (Dockrell et al., 2007; Larkin et al., 2013; Lewis, Freebairn, & Taylor, 2002; Vandewalle, Boets, Ghesquiere, & Zink, 2012). However, only one study could be found, which assessed later oral morphological skills of children with DLD, in relation to their spelling

skills. Using sentence completion tasks to assess children's awareness of derivation and inflection processes and a targeted morphological spelling task assessing a set of derivations and inflections, Critten et al. (2014) found no relation of oral inflectional and derivational morphology awareness to spelling derivations and inflections (r = [.03-.23]). This pattern of relation was also found in the language-matched control group (r = [.03-.14]), but not the same-age peers, whose derivational spelling was predicted by awareness of derivational morphology (r = .40), and to a lesser extent awareness of inflectional morphology (r = .21). It is unclear however, how awareness of morphological units may play a role in the general word spelling abilities of children with DLD, as well as in their spelling in the context of a text, where grammatical skills may be particularly solicited. Table 4-3 summarises the methodological features of the studies reviewed in the section above.

Table 4-3: Summary of the methodological features of the studies reviewed above, assessing predictors of spelling in children with DLD

Year	1st author	Lang	Age	Task				Predictors considered								
				TP	Controlled dictation											
				TP	WD	NWD	MWD	Print	Let	NW rep	Lang	Phon	Morph	Read	RAN	Others
1999	Boudreau	EN (US)	4-5					+	+			+				
2002	Lewis	EN (US)	4-6 then 9		+					+	+	+		+		
2007	Dockrell	EN (UK)	8 and 10		+					+	+	+		+	+	+
2009	Cabell	EN (US)	5		+			+	+			+				
2012	Cordewener	DU (ND)	5-6		+			+	+	+	+	+			+	+
2012	Vandewalle	DU (BE)	5 then 8		+					+		+			+	+
2013	Larkin	EN (UK)	9-10			+	+			+	+					
2014	Critten	EN (UK)	9-10				+				+	+	+	+		+

A + indicates the feature was assessed, Lang: Language, EN(US): American English, EN(UK): British English, DU(ND): Dutch, Netherlands, DU(BE): Dutch, Belgium, TP: Text production, WD: Word dictation, NWD: NonWord Dictation, MWD: Morphological Word Dictation, Print: Print awareness, Let: Letter knowledge, NW rep: NonWord repetition, Lang: Vocabulary/Grammar skills, Phon: Phonological awareness, Morph: Morphological awareness, Read: Reading, RAN: Rapid Automatic Naming

4.3.3. Implications for the current study

Recent evidence has shown the profiles of French children in years 3 and 5 of primary school could be differentiated according to their lexical and grammatical spelling proficiency (Morin, Alamargot, Diallo, & Fayol, 2018), showing partial independence between these two sets of skills in French. However, direct cross-language comparisons with languages with a less complex morphological system -such as English- are lacking. To our knowledge, no such studies have been conducted in the context of DLD, where grammatical and lexical representations may be affected.

The present study relies on current models of spelling development across languages at the end of primary school and integrates several measures of phonological awareness (at phoneme, rime and syllable level), morphological awareness (derivational and inflectional) and RAN (digits and numbers), in order to assess their predicting weight on the spelling of French and English students. Crucially, in the present study, spelling is measured at word level, using the WIAT-2, a task drawing on phonological, orthographic and morphological knowledge, but also at text level, using a short measure of free writing. It is hoped that a comprehensive assessment of spelling and predictive skills, including text-level spelling and morphological awareness, can shed light on the specific constraints of the French and English orthographies at the end of primary school, in the context of DLD.

Chapter 5. Summary, research questions and hypotheses

Chapter 2 reviewed the literature on the characteristics of French and English orthographic and linguistic systems and considered their impact on spelling. The inconsistency of both orthographic systems for spelling was highlighted, and specific complexities were noted: 1) in the syllabic structure of English and 2) in the morphological system of French. The complex syllabic and vowel system in English involves many vowel spelling errors. The complex morphological system of French involves long-lasting difficulties with verb and noun phrase agreement in spelling. On the other hand, as in other Romance languages, the relatively simple syllabic structure of French may involve word segmentation errors early on.

Chapter 3 reviewed the literature on the characteristics of the oral and written language of children with DLD. Current terminological and identification issues were addressed, which informed the present recruitment criteria. Linguistic processes affected in DLD were described: namely phonological, grammatical and lexical processes. The impact of linguistic difficulties on spelling is discussed in the languages of interest: French and English.

Chapter 4 reviewed three different types of methodologies for examining the spelling processes of typical and atypical children. Firstly, methods and data from studies using qualitative spelling error analysis in children with DLD are described. They show that specific error types (with verb morphology and phonology) can be revealed with comprehensive and well-tailored coding schemes. Secondly, studies eliciting and analysing verbal self-reports of

spelling errors are reviewed, and their adaptability for a population of children with DLD are discussed. Finally, important predictors of early and late spelling skills are identified across French and English, and in the population of children with DLD.

Much of the literature on the links between language and literacy has focused on reading, and on the early stages of literacy development. It has also been largely dominated by English data. However, spelling, and in particular spelling of morphologically-complex words and text, may be a good marker of difficulties with underlying linguistic processes later on in development. Markers can only be identified with reference to typical development. If typical spelling development varies across languages, markers should also vary across languages. Furthermore, markers should be identified with regards to age, but also literacy level, and younger match should be included to identify breakdowns in developmental trajectories. The present thesis proposes to build on the literature reviewed above by offering the first direct cross-language evaluation of errors, strategies and predictors of spelling in French and English children with DLD. The objective is twofold:

1. To identify the linguistic constraints that may affect typical spelling in French and English at the end of primary school

2. To identify the specific linguistic difficulties that may still be apparent in the spelling of children with DLD in both these languages at the end of primary school.

A set of research questions and hypotheses was defined to meet the objective:

a) Is there a difference in spelling productivity, accuracy, and error types between two representative French and English samples, and between children with and without DLD? (Chapter 7)

On the basis of the literature reviewed, it was expected that although rate of spelling errors would be equivalent, error types would vary across languages, with French children

producing more word-ending morphological errors and English children producing more within-word orthographic errors. It was also expected that children with DLD would produce more errors than same-age peers, and that markers of oral language difficulties would be apparent in their writing, with more errors with inflectional morphology in the DLD sample.

b) Is there a difference in strategy breadth and rates between two representative French and English samples, and between children with and without DLD? (Chapter 8)

On the basis of the literature reviewed, French children were expected to rely on morphological strategies more than their English peers, as this strategy type has only been identified in French studies as yet. We expected both French and English older typical children to use a breadth of different strategies, whilst younger children would be less flexible in their strategy use, and rely more readily on phonological strategies. Predictions regarding the DLD sample were tentative given the lack of this type of data on this group of children: we hypothesised that children with DLD would report fewer strategies, and use them less flexibly than typical children of the same age.

c) Is there a difference in linguistic predictors of spelling between two representative French and English samples? (Chapter 9)

We expected French and English spelling performance to be predicted by phonological memory, RAN and metalinguistic awareness, as shown in previous studies. The current literature shows the different predictors weigh relatively similarly on spelling performance across French and English. However, this literature either does not include measures of morphological awareness (Moll et al., 2014) or assesses it at the beginning of primary school (year 2, Desrochers et al., 2018). The present study explored the role of a range of metalinguistic awareness tasks (including awareness of derivational and inflectional

morphology) across French and English at the end of primary school, when they may be differentiated.

Part II. Experimental studies

Chapter 6. Methods

6.1. Design

To address the first two research questions, an independent factorial design was used. Six groups of 17 children (102 children in total) were recruited to account for the effect of language (French vs English) and DLD (DLD vs chronological-age matched peers or spelling-ability matched peers) on two aspects of spelling: a) spelling errors and b) spelling strategies. The last research question examining predictors of spelling performance was assessed using a correlational design with a pooled group of 149 children (82 English, 67 French), within and across languages.

6.2. Participants

6.2.1. Identification of the group of children with DLD

One hundred and two participants were recruited from five schools in the South-East of England and seven schools in the South-East of France and the greater Paris area. The same recruitment process was used in both countries. Mainstream schools with a language unit were approached, as well as mainstream schools with a known caseload of children with DLD (see Appendix D and E for the letter of information sent out to target schools). Language units ("ULIS-école" in France) are specialist units within mainstream schools, where children with Language Disorders (associated or not with a known genetic, neurological or physical condition and occurring or not alongside other attentional, social communication or learning difficulties) receive specialist care and instruction for some of the curriculum and are

included in the mainstream classroom for the rest of their learning. Teachers, speech and language therapists and Special Education Needs Coordinators (SENCOs, in the UK) were consulted verbally, and parents were consulted using a brief questionnaire (within the consent form, see Appendix F and G), in order to identify children thought to experience language and literacy difficulties within the language units and mainstream Year 3, 4, 5 and 6 classes (age 8 to 11).

Children were further tested to ascertain their language difficulties using standardised measures. In order to account for both receptive and expressive skills, three measures were taken: sentence repetition, word comprehension and sentence comprehension. Children's DLD diagnosis was confirmed and they were included in the DLD sample if they scored -1.28 SD or below in at least two of these measures, or on a composite of all three measures. Children reaching scores -2SD or below on Non-Verbal Performance (NVP) and qualifying for a diagnosis of Intellectual Disability according to DSM-5™ (Diagnostic and Statistical Manual of Mental Disorders Fifth Edition, American Psychiatric Association, 2013) were excluded. NVP was measured by the Raven's Coloured Progressive Matrices (Raven, Raven, & Court, 1998a). Appendix A and B present a flowchart of the recruitment process and sample characteristics in both countries.

Following this procedure, 17 children with language difficulties were identified within the French sample and 17 in the English sample. Table 6-1 provides a summary of the tasks and thresholds used for the identification of children with DLD.

Table 6-1: Summary of the tasks used for the identification of children with DLD in both countries.

	Ability tested	French	English	Inclusion threshold
Language measures	Sentence repetition	L2MA2-Répétition de phrase (Chevrie-Muller, Maillart, Simon, & Fournier, 2010)	CELF-4 Recalling sentences (Semel, Wiig, & Secord, 2006)	-1.28 SD and below in at least two of these three measures or on a composite of all three measures
	Sentence comprehension	E.CO.S.SE (Epreuve de COmpréhension Syntaxico-SEmantique, Lecocq, 1996, Short version and standardisation from the Batterie Analytique du Langage Ecrit, BALE (Jacquier-Roux, Lequette, Pouget, Valdois, & Zorman, 2010))	TROG-2 (Test for Reception Of Grammar – 2nd edition, Bishop, 2003)	
	Word comprehension	TVAP (Test de Vocabulaire Actif et Passif, Deltour & Hupkens, 1980, short version and standardisation from the BALE, (Jacquier-Roux et al., 2010)	BPVS-3 (British Picture Vocabulary Scale – 3rd edition, Dunn, Dunn, Sewel, & Styles, Ben, 2009)	
Control measures	Non-verbal ability	Raven's Coloured Progressive Matrices (CPM, Raven, Raven, & Court, 1998)	Raven's Coloured Progressive Matrices (CPM, Raven, Raven, & Court, 1998)	Above -2 SD (Standard score 70)
	Functional impairment and other diagnoses and languages	Professional flagging and parental questionnaire: diagnosis (Language impairment, Attention or Hyperactivity Disorder, Autistic Spectrum Disorder, dyslexia, hearing impairment, or others) and other languages spoken at home	Professional flagging and parental questionnaire: diagnosis (Language impairment, Attention or Hyperactivity Disorder, Autistic Spectrum Disorder, dyslexia, hearing impairment, or others) and other languages spoken at home	Language concerns or diagnosis of language disorder and/or dyslexia, (in the absence of ASD, hearing impairment or other known conditions)

6.2.2. Identification of the control groups

A further 17 typically-developing children matched on chronological age (CA), and 17 younger children (SA) matched on the raw spelling scores of the Wechsler Individual Achievement Test (WIAT), were identified in both countries. These children had NVP, language and spelling scores within the norm of their age range, as reported by parents and teachers and measured on standardised tasks. Table 6-2 provides a summary of the groups' characteristics. As per the defined matching criteria, the group of children with DLD had the same *raw* spelling scores as their younger SA peers, and the same age as their CA peers. However, the *standard* scores of children with DLD in spelling, reading, NVP and language were lower than those of both groups of TD children, as expected given their language difficulties. The French sample was a few months older than the English sample, although the English sample had been in formal education for about a year longer. Indeed, English children enter primary school aged 5, whilst French children do so aged 6. In both countries, children leave primary education aged 11. The French and the English TD samples were representative of the general population, as evidenced by their spelling, reading, NVP and language composite standard scores.

Table 6-2: Characteristics of the sampling population.

	M(SD)						***F* (Robust 2x3)**	***p***	**ξ [95% CI]**	**Post-hoc (Robust)**
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**				
N	17	17	17	17	17	17				
Age in years	10.16 (0.75)	9.81 (0.70)	10.13 (0.85)	9.82 (1.01)	7.76 (1.05)	6.76 (0.84)	language: 7.80 subgroup: 158.25 interaction: 1.24	.008 ** .001*** .548 n.s.	.21 [0-.49] .01 [0-.37]	EN<FR SA<DLD=CA EN-DLD<FR-DLD, EN-CA<FR-CA, EN-SA<FR-SA
Spelling Raw score	30.13 (4.15)	36.60 (6.25)	19.20 (5.14)	21.93 (3.18)	19.20 (5.06)	21.00 (2.98)	language: 16.10 subgroup: 131.14 interaction: 3.11	.001*** .001*** .234 n.s.	.17 [0-.44] .81 [.77-.99]	EN>FR SA=DLD<CA EN-DLD>FR-DLD, EN-CA>FR-CA, EN-SA>FR-SA
Spelling Standard score	98.93 (9.86)	110.00 (10.98)	71.93 (11.24)	78.53 (7.16)	104.53 (11.20)	104.40 (18.33)	language: 5.72 subgroup: 124.54 interaction: 6.77	.021* .001*** .049*	.13 [0-.39] .95 [.82-.99] .13 [0-.39]	EN>FR DLD<SA=CA EN-DLD>FR-DLD, EN-CA>FR-CA, EN-SA<FR-SA
Reading Standard score	105.30 (6.12)	110.64 (13.48)	58.18 (22.92)	80.73 (13.60)	90.96 (13.90)	109.00 (16.07)	language: 23.51 subgroup: 103.30 interaction: 8.41	.001*** .001*** .027*	.36 [.05-.64] .95 [.80-.99] .36 [.08-.63]	EN>FR DLD<SA=CA EN-DLD>FR-DLD, EN-CA>FR-CA, EN-SA>FR-SA
Raven Standard score	106.33 (11.11)	108.67 (10.60)	97.00 (13.35)	92.00 (15.11)	102.33 (15.82)	103.67 (14.60)	language: .01 subgroup: 10.70 interaction: 1.11	.895 n.s. .010** .585 n.s.	.61 [.28-.80]	EN=FR DLD<SA=CA EN-DLD=FR-DLD, EN-CA=FR-CA, EN-SA=FR-SA

	M(SD)						***F* (Robust 2x3)**	***p***	**ξ [95% CI]**	**Post-hoc (Robust)**
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**				
Language Standard score	98.43 (8.46)	98.01 (10.99)	58.00 (16.20)	71.12 (9.55)	101.82 (9.77)	98.68 (7.40)	language: .34 subgroup: 90.87 interaction: .82	.563 n.s. .001*** .674 n.s.	.95 [.86-.99]	EN=FR DLD<SA=CA EN-DLD=FR-DLD, EN-CA=FR-CA, EN-SA=FR-SA

M(SD). *Mean and Standard deviation were computed using a 20% trimming,* ***EN.*** *English,* ***FR.*** *French,* ***DLD.*** *Developmental Language Disorder,* ***CA.*** *Typically-Developing children matched on age,* ***SA.*** *Typically-developing children matched on raw spelling score,* ***N****. Number of participants in subgroup,* ***F(Robust 2x3).*** *Robust ANOVAs were computed with the two factors language (French vs English) and subgroup (DLD, CA or SA), using the t2way function in R (WR2S package, (Mair, Schoenbrodt, & Wilcox, 2016)) and a trimmed mean of 20%.;* ***p.*** *p-value:* ***n.s.*** *non-significant, *p < .05, **p<.01, *** p<.001.* ***ξ [95%CI]****. Robust explanatory measure (with 95% confidence interval) for the size of the effect computed using the yuen.effect.ci function in R (WR2S package, Mair et al., 2016), values of* ***ξ*** *= .10, .30, and .50 correspond to small, medium, and large effect sizes (Wilcox & Tian, 2011),* ***Post-hoc (Robust).*** *Post-hoc comparisons were computed using the mpc2atm function in R (WR2S package, Mair et al., 2016) and a trimmed mean of 20%.*

Note: *Trimmed means, results of the robust ANOVAs and post-hoc tests did not differ from those of traditional means, ANOVAs, and post-hoc Tukey tests, but robust results are reported for consistency throughout the thesis.*

6.2.3. Collapsing of groups for the predictor analysis

In order to assess predictors of spelling performance at the end of primary school within and across languages, all children who had participated to testing were selected if: a) they had been administered the individual language and meta-language tasks, as described in section 6.3 below, and b) they were in their third year of formal literacy instruction and above – thereby excluding children in years 1 and 2 (CP-CE1 in French). Sampling resulted in a group of 149 children (82 English, 67 French, see Appendix C), who were in the last four years of primary education (in the last three years in France). All 68 children from the EN-DLD, FR-DLD, EN-CA and FR-CA were included in this resampling, as well as six EN-SA (all in year 3) and six FR-SA (four in year 3, two in year 4) and 69 other children not included in studies 1 and 2. Table 6-3 presents a summary of the sample characteristics. The sample included both children with typical development (n = 101) and DLD (n = 41 according to our criteria, with or without other educational needs), as well as children without DLD but flagged up as having other educational needs (n = 7, e.g. "pure" dyslexia or attention difficulties), resulting in a high representation of children with atypical development (around 30%). Most children in the sample (90%) were monolingual. All scores were converted to Z-scores, on the basis of the class standardisation of the test conducted.

Table 6-3: Sampling characteristics for the predictor analysis

		EN (n = 82)	FR (n = 67)	ALL (n = 149)
%	**Monolingual**	91.5	89.6	90.6
	Male	46.3	53.7	49.7
	TD	63.4	73.1	67.8
M (SD)	**Age in years**	9.44 (1.08)	9.95 (0.81)	9.67 (1)
	Raven Z-score	-0.03 (1.08)	0.29 (0.98)	0.12 (1.05)
	Language composite Z-score	-0.65 (0.94)	-0.7 (1.21)	-0.67 (1.07)
	WIAT spelling Z-score	-0.5 (1.09)	-0.59 (1.02)	-0.54 (1.05)
	Word Reading Z-score	-0.21 (1.28)	-0.73 (1.64)	-0.45 (1.48)

EN: English sample; FR: French sample; ALL: all children

6.3. Measures

6.3.1. Standard measures

All standard measures were administered and scored following the test manual's instructions. Table 6-4 provides a summary the standard measures used, with their reliability and validity. The measures are further described below.

Table 6-4: Description, reliability and validity of standard measures

Ability	English test	Task	Rel	Val	French test	Task	Rel	Val
Language								
Sentence repetition	CELF-4 – Recalling sentences	Child to repeat 32 sentences of increasing length	.91	.84**	L2MA2 - Répétition de phrase	Child to repeat 15 sentences of increasing complexity	N/A	.85**
Sentence comprehension	TROG-2	Child to choose 1 out of 4 pictures that goes with the sentence given. Up to 20 blocks of 4 items. Discontinued after 5 blocks failed.	.87	.54*[a]	E.CO.S.SE (from BALE)	Child to choose 1 out of 4 pictures that goes with the sentence given. 20 items. No discontinuation rule.	N/A	N/A
Word Comprehension	BPVS-3	Child to choose 1 out of 4 pictures that goes with the word given. Up to 14 blocks of 12 items. Discontinued after 8 or more errors within a block	N/A	N/A	TVAP (from BALE)	Child to choose 1 out of 6 pictures that goes with the word given. 15 items. No discontinuation rule.	N/A	N/A
NVP								
Matrices	Raven's Coloured Progressive Matrices	Child to choose 1 out 6 figures to fill in a pattern. 3 sets of 12 patterns to complete. No discontinuation rule.	.80	.91*[b]	Raven's Coloured Progressive Matrices	Child to choose 1 out of 6 figures to fill in a pattern. 3 sets of 12 patterns to complete. No discontinuation rule.	.80	.91*[b]
Reading								
Timed word reading	BAS-3 – Word reading list A	Child to read up to 90 words of increasing complexity (discontinued after 8 failures within a block of 10)	.98	.89*[c]	BALE – Lecture de mots réguliers et irrégulier peu fréquents	Child to read 20 regular words and 20 irregular words. No discontinuation rule.	N/A	N/A

Ability	English test	Task	Rel	Val	French test	Task	Rel	Val
Spelling								
Word spelling	WIAT-UK-II – Spelling	Child to spell up to 53 words of increasing complexity (discontinued after 6 misspellings)	.94	.78* [d]	WIAT-CDN-FR - orthographe	Child to spell up to 53 words of increasing complexity (discontinued after 6 misspellings)	.91	N/A

Rel. *Reliability;* ***Val.*** *Validity; *concurrent validity; **construct validity; [a] with 'concepts and following directions' from the CELF-3 [b] with WISC-R, [c] with list B of the same test, [d] with WRAT3, N/A = not available*

Language

Language was assessed using three measures reflective of grammar and vocabulary levels, and sensitive to language difficulties: sentence repetition, sentence comprehension and word comprehension.

Sentence repetition. The sentence repetition task assesses the ability to attend to and repeat sentences of increasing length and complexity.

In English, the CELF-4-UK recalling sentences subtest was used. The reliability of the task is reported at .91 across age groups. A construct validity of .83 is reported with the CELF-4-UK 'Core Language Index', .84 with 'Expressive Language Index' and .67 with 'Receptive Language Index'. The task comprises 32 sentences. It is discontinued when the child provides no response to five sentences in a row. The CELF-4-UK sentence repetition task provides a raw score (max. 96), which can be transformed to a scaled score based on UK norms (M = 10, SD = 3). This was further converted to a Z-score.

In French, the L2MA2 – "répétition de phrases" was used. At -1.28 SD, the cut-off point chosen in the present study, Leclercq, Quémart, Magis, and Maillart (2014) report a sensitivity of .97, and a specificity of .88 on this task. Its construct validity ranged from .38 to .59 when compared to other test measures of syntactic content, number of words, verb morphology, functional words, lexical words and semantic content. The task comprises 13 to 15 sentences, with no discontinuation rule. The raw score of the child (max. 13 or 15) can be transformed to a Z-score based on the French standardisation.

Sentence comprehension. Sentence comprehension requires the child to a) listen to spoken sentences involving various structures, and b) to point to the corresponding picture amongst four, without being distracted by the surrounding pictures, which involve the same characters, but different structures.

In English, the computerised version of the TROG-2 was used. The split-half reliability of the TROG-2 is reported at .87. Its concurrent validity, against the 'Concepts and following directions' subtest of the CELF-3 reached .54. The test has 20 blocks of 4 items of increasing difficulty. A block is failed when it contains at least one error and passed otherwise. The total number of blocks passed is summed up to give a raw score (max. 20), which is automatically converted to a standard score (*M* = 100, *SD* = 15) against the UK standardisation. This was further converted to a Z-score.

In French, the short BALE version and standardisation of the E.CO.S.SE. were used. No reliability or validity indices are given for this measure, but the task was constructed on the basis of the TROG. The short BALE version provides the widest and most recent standardisation of this measure (586 children tested in 1999-2000). It contains 20 items with 20 different sentence structures. The raw score (max. 20) is converted to a Z-score using the French norms.

Word comprehension. The word comprehension test provides a measure of vocabulary breadth. Children are exposed to a set of pictures and are given a word orally. They are to point to the corresponding picture, without being distracted by the other (semantically or phonologically related) pictures.

In English, the BPVS-3 was used. A measurement error of 5-13 standard score points and a standardisation error of 1-2 standard score points were reported for the test. The test is comprised of 168 items, organised in blocks of 12. The child is assessed on the blocks corresponding to his/her age group. For example, children aged 8 start at block 6. Once a baseline has been established (no more than one error in a block of 12 items), the tester moves on to the following block. The test is discontinued when the testee reaches ceiling (eight or more errors in a block). The number of correct responses between baseline and

ceiling gives a raw score. This score is converted to a standard score (*M* = 100, *SD* = 15) against the UK norms. This was further converted to a Z-score.

In French, the BALE short version and standardisation of the TVAP was used. No reliability or validity indices are given for this measure, but the short BALE version provides the widest and most recent standardisation of a receptive vocabulary breadth measure (586 children tested in 1999-2000). It contains 15 items scored either 0 (unrelated response), 1 (semantically-related response), or 2 (target picture). The raw score (max. 30) is converted to a Z-score against the French norms.

Non-verbal Performance

Non-verbal performance was assessed using Raven's coloured progressive matrices in both French and English. The group paper-and-pencil version of the test was used. Children's performance was checked against the most recent French (1998) and UK (2008) norms. Split-half reliability estimates ranged from .82 to .97, across different languages and cultures. Crucially for this study, the test has strong cross-cultural validity. Children are presented with an incomplete pattern, which they have to fill choosing one in six figures. The task involves spatial and perceptual reasoning. It has been designed to be understood with minimal verbal input and can be completed with no verbal output. There are three sets of 12 patterns to complete. Raw score (max. 36) is converted to a percentile score according to the country's norms.

Reading

Word reading tasks were chosen to be reflective of the written vocabulary encountered by children at the end of primary school. It was timed, to assess reading speed. There were both regular and irregular words.

In English, the BAS-3 Word reading list A was used. The split-half reliability of the BAS-3 word reading list A is reported at .97-.99 for the age range 5-11. Concurrent validity of the test with

the alternative list B reached .89. BAS word reading varies in length depending on the child's age and reading ability. For example, children aged 8-11, start at item 21 and go on to read until they reach 8 failures within a block of 10. There are 90 items in the test in total. Stress patterns are considered. A score of 1 is awarded per word correctly read. The raw score is converted to an ability score following the manual, which can then be converted to a standard score (*M* = 100, *SD* = 15) according to the UK norms. This was further transformed to a Z-score.

In French, the BALE "lecture de mots réguliers et irréguliers peu fréquents" (low frequency regular and irregular words) was used. The high frequency word lists are tailored for children below grade 3 and were not used. No reliability or validity indices are given, but the BALE provides the widest and most recent standardisation of a reading accuracy measure (586 children tested in 1999-2000). In total, 20 regular and 20 irregular words were read by each participant. A score of 1 is awarded for each correct attempt. Raw scores are converted to Z-score following the French norms.

Spelling

A standardised measure of spelling accuracy was taken. The parallel English and French versions of the WIAT test (WIAT-2-UK – spelling and WIAT-CDN-FR – "orthographe") were chosen as the only parallel spelling test available. The items were reflective of a range of words from the target language and of a range of possible spelling processes (orthographic, phonological, morphological). Words were given in a sentence context, calling on grammatical and semantic knowledge. In both languages, there are 41 words to spell (from <*we*> to <*conscientious*> in English, from <*te*> to <*accommoder*> in French). The manual indicates the task should be discontinued after six consecutive misspellings. As we administered the task as a group, all children spelled at least 28 items. Those who had not reached ceiling were then administered the rest individually. The raw scores were converted

to standard scores and Z-scores using the norms. The raw scores of the group of children with DLD was also used to match them to younger peers. Misspellings were further analysed qualitatively as detailed in section 6.5 below.

In English, a reliability coefficient of .94 is reported across all age groups for this subtest. Concurrent validity with the WRAT3 (Wide Range Achievement Test- 3rd Edition, Wilkinson, 1993) reached .78.

In French, a Canadian standardisation by age group was used, the only available one for the French language. Reliability of the measure was reported at .91 across age groups on this subtest.

6.3.2. Bespoke measures

All experimental tasks were piloted and adapted as appropriate. The measures described below were appropriate for the age group and target skills assessed.

Written narrative

A naturalistic sample of writing was obtained from children using a narrative task. The narrative Curriculum-Based Measure for Writing (CBM-W) from (Dockrell, Connelly, Walter, & Critten, 2015) was used in both languages. These authors have shown that the proportion of words spelled correctly in the CBM-W has good construct validity (.87) as an accuracy measure and good consistency with the WOLD-writing expression score (.30). The task was administered in small groups. Children were asked to write following the prompt: "One day, I had the best/worst day ever...". Children were given a sheet with the prompt, and told they were to write the best story possible within five minutes. They were given 30 seconds to think about their story before they started writing. At the end of the five minutes, children finished their last sentence and put their pens down. The texts were analysed for the number and proportion of misspelled words produced. Misspellings were further analysed qualitatively as detailed in section 6.5 below.

Orthographic awareness

The orthographic awareness task aims to assess children's ability to perceive frequent patterns in their orthographic system. Given two nonwords (one with a frequent doublet and one with an infrequent doublet), they are asked to choose which is more word-like. This was administered as a pencil-and-paper group task, where children had to circle their choice. One point was given per frequent doublet chosen, giving a raw score (max. 12).

A set of two frequent doublets (<ll> and <ss>) and three infrequent doublets (<cc>, <mm> and <vv> in English and <cc>, <dd> and <vv> in French) were identified in each language, on the bases of the study of Cassar and Treiman (1997) in English and Pacton, Perruchet, Fayol, and Cleeremans (2001) in French. The frequency of each doublet was verified using the Manulex-infra database in French (Peereman et al., 2007) and the Children's Printed Words Database in English (Masterson, Stuart, Dixon, & Lovejoy, 2010). Table 6-5 provides a summary of the doublets chosen in both languages with their frequency.

Table 6-5: Frequency of the doublets chosen in each language

		Frequency in French*	**Frequency in English****
Frequent doublets	ss	12911	5906
	ll	19468	28772
Infrequent doublets	cc	1026	223
	mm	N/A	1377
	dd	21	N/A
	vv	0	8

**Sum of the frequency of initial, middle and final occurrence of the doublet by token, as given by Manulex-infra (Peereman et al., 2007). **Sum of the frequencies of each word in which the doublet occurs, as given in the Children's Printed Words Database (Masterson et al., 2010). N/A = not applicable for this task*

Pairs of nonwords were constructed. In each pair, one nonword had a frequent doublet and the other an infrequent doublet. All doublets were in legal position in the language, i.e. in middle position. In each language, half of the nonwords were 6 letters long and half were 4 letters long. In total, 12 pairs were constructed in each language. Table 6-6 presents the French and English pairs, with target doublets and letter counts.

Table 6-6: Nonwords pairs constructed in both languages

English pairs		fqt	infqt	Nb	French pairs		fqt	infqt	Nb
wassud	waccud	ss	cc	6	essura	eccura	ss	cc	6
wossum	wommud	ss	mm	6	issote	iddote	ss	dd	6
hissom	hivvom	ss	vv	6	assyla	avvyla	ss	vv	6
pellib	peccib	ll	cc	6	illetu	iccetu	ll	cc	6
sallip	sammip	ll	mm	6	elloba	eddola	ll	dd	6
fillod	fivvod	ll	vv	6	illaro	ivvaro	ll	vv	6
ossa	occa	ss	cc	4	usse	ucce	ss	cc	4
ussa	umma	ss	mm	4	essa	edda	ss	dd	4
isso	ivvo	ss	vv	4	usso	uvvo	ss	vv	4
ullo	ucco	ll	cc	4	alli	acci	ll	cc	4
illu	immu	ll	mm	4	olle	odde	ll	dd	4
illa	ivva	ll	vv	4	olli	ovvi	ll	vv	4

fq. frequent doublet; infqt. infrequent doublet ; Nb. Number of letters.

Morphological awareness (derivations-inflections)

Derivational morphology. The task chosen assesses ability to produce orally "a related multimorphemic word when given a base word, in the context of a sentence" (Apel, Diehm, & Apel, 2013). The task was adapted from the French-English comparison study of Duncan, Casalis and Colé (2009): children were given a sentence frame, which they had to complete using a derived word. One point was awarded per correct response, giving a raw score (max. 10). Two items were changed in the word lists, as they were outliers in Duncan et al. (2009), baggage/postage, replaced by magician/musician in English, magicien/musicien in French. Two practice items were also introduced in both languages. Table 6-7 provides the items, with their sentence frame and frequency.

Table 6-7: Items, sentence frames and frequency counts for assessing children's awareness of derivational morphology

	French				**English**			
	Sentence frame	**Target**	**fq**		**Sentence frame**	**Target**	**fq**	
			rt	**deriv**			**rt**	**deriv**
#	**Quand on peint on fait de la ...**	***peinture***			**Someone who cleans is a ...**	***cleaner***		
#	**Celui qui plonge est un**	***plongeur***			**When you move you make a ...**	***movement***		
1	Une petite fille est une ...	*fillette*	472	60	A little pig is a ...	*piglet*	151	8
2	Une petite jupe est une ...	*jupette*	29	N/A	A little book is a ...	*booklet*	541	5
3	Celui qui travaille est un ...	*travailleur*	57	2	Someone who works is a ...	*worker*	68	3
4	Celui qui ment est un ...	*menteur*	6	9	Someone who runs is a ...	*runner*	22	N/A
5	Celui qui fait la guerre est un ...	*guerrier*	77	3	A baker works in a ...	*bakery*	59	5
6	Celui qui s'occupe de la ferme, c'est le ...	*fermier*	155	40	A robber carries out a ...	*robbery*	133	8
7	On rase avec un ...	*rasoir*	2	8	When the party fails, it is a ...	*failure*	N/A	3
8	On arrose avec un ...	*arrosoir*	8	9	When you mix things, you make a ...	*mixture*	78	38
9	Quelqu'un qui fait de la magie est un…	*magicien*	25	29	Someone who can do magic tricks is a …	*magician*	30	22
10	Quelqu'un qui joue de la musique est un…	*musicien*	179	20	Someone who can play music is a…	*musician*	122	N/A
	Mean		**101**	**20**			**133.7**	**11.5**
	Standard Deviation		**137**	**19.6**			**159.1**	**12.3**

fq: frequency; rt: root frequency; deriv: derived word frequency; N/A: not applicable

Inflectional morphology. A measure of children's ability to inflect words orally was taken. Following from Critten, Connelly, Dockrell and Walter (2014), items were taken and adapted from the CELF-4 UK in English and the ELO in French. A range of regular and irregular inflection processes were chosen in French and English, as shown in Table 6-8. Children were shown a picture prompt and given a sentence frame, which they had to complete. Responses were recorded on the scoring sheet. One point was awarded per correct response, giving a raw score (max. 8). French and English plate examples are given in Figure 6-1 and Figure 6-2. Items with sentence frames are given in Table 6-8. It is to be noted that for regular noun plurals in French, the determiner and noun both had to be correct for the point to be awarded (as the plural is only heard in the liaison between the determiner and noun).

Ici, la poule a pondu un œuf. Là, la poule a pondu ... (trois oeufs)

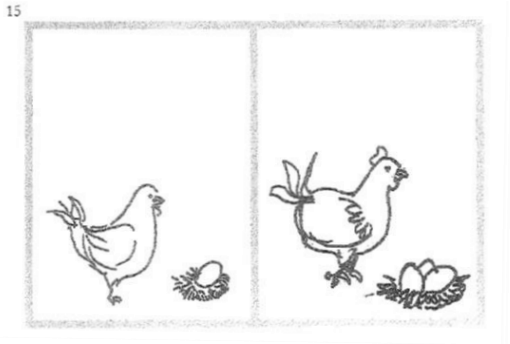

Figure 6-1: French plate example for the task of inflectional morphology

Here is one child. Here are three ... (children)

Figure 6-2 : English plate example for the task of inflectional morphology

Table 6-8: Items and sentence frame for the task assessing awareness of inflectional morphology

	French	English
Regular noun plurals	Ici, il y a un avion, là il y a ... *deux avions*	Here is one book. Here are two … *books*
	Ici la poule a pondu un œuf. Là la poule a pondu … *des œufs (trois œufs)*	Here is one horse. Here are two … *horses*
Irregular noun plurals	Ici le dragon n'a qu'un œil, là, le dragon a ... *deux yeux*	Here is one mouse. Here are two … *mice*
	Ici, le garçon regarde le journal. Là, le garçon regarde les … *journaux*	Here is one child. Here are three… *children*
Verb inflections (present)	Ici la fille a des fleurs. Là, les filles … *ont des fleurs*	The boy likes to read. Every day he … *reads*
	Ici l'ours dort. Là, les ours … *dorment*	Here the bird eats. Here, the bird … *flies*
Verb inflections (past)	Ici, maintenant je m'habille. Là, avant je ... *dormais*	The man is climbing the ladder. This is the ladder that the man … *climbed*
Verb inflections (future)	Ici, je joue maintenant. Là, plus tard, ... *je mangerai/je vais manger*	She is sliding now. Soon, he … *will slide/ will be sliding*

Phonological awareness (syllable-phoneme-rime)

Children's ability to extract a common sound unit in two words was tested. A parallel phonological awareness task was adapted from Duncan, Colé, Seymour and Magnan (2006). It was originally designed for the comparison of French and English speakers aged 4 to 6. Children were asked to extract the common unit in a pair of disyllabic words presented orally (e.g. panic – paddle). There were one demonstration and three practice items for each unit. The common unit was either a syllable (e.g. **pa**nic-**pa**ddle), a rime (e.g. bamb**oo**-can**oe**), or a phoneme (e.g. **k**ettle-**c**urry). The lists included units in CV and CVC syllables. In the original study, the task was sensitive to the unit considered, the language and the age of participants. In the current study, the task was used to assess phonological awareness in older children. Adaptations were made following piloting. Rimes were shifted to the end of words (rather than end of syllables), and four practice items were added for each series of pairs. One point was awarded per correct response, providing a raw score (max. 8) for each unit (syllable,

rimes and initial phoneme). Table 6-9 presents the items selected for the task, in French and English.

Table 6-9: Items selected for the phonological awareness task

	French CV	French CVC	English CV	English CVC
Syllable	gâteau-galette	corbeau-cordon	canal-cassette	confuse-control
	cadeau-cahier	carton-carnet	reward-release	dislike-dismay
	balai-baguette	marteau-mardi	command-correct	surprise-survey
	midi-minuit	dispute-discours	delight-demand	complain-compare
Rime	marché-purée	silence-défense	bamboo-canoe	baboon-cartoon
	lutin-jardin	piqûre-futur	marquee-settee	delight-invite
	bijou-partout	virgule-calcul	although-below	forget-upset
	sortie-bougie	décor-support	today-delay	machine-canteen
Initial phoneme	lapin-leçon	berceau-balcon	machine-myself	fulfil-foresee
	sapin-secret	parcours-pistache	Peru-police	sardine-submit
	rocher-requin	biscuit-berger	hello-hooray	harpoon-himself
	matin-maison	palmier-portable	balloon-beside	success-segment

Rapid Automatic Naming (RAN, Numbers and Objects)

Children's ability to name rapidly a series of objects or digits was tested. Items and procedures were taken from the Comprehensive Test of Phonological Processing (CTOPP, (Rashotte, Torgesen, & Wagner, 1999) in English. A parallel version was constructed for French, by matching items for frequency and syllabic structure (using oral frequency from the CELEX and Lexique databases, see Table 6-10). After checking the participant's knowledge of the six words used, the child was presented a 9x4 pictures plate. The participant named these pictures as quickly as possible, from left to right, line by line, until the end of the page. A second plate with the same number of the same pictures was administered. The same procedure was followed for digits. The naming speed per plate was recorded for each subset (objects and digits), giving a raw score. The raw score for each task (digits and objects) was converted to a Z-score using the US standardisation in English and the present study's sample in French, stratified per year group. Table 6-10 presents the frequency and structure of the objects and digits selected for the rapid naming task.

Table 6-10: Frequency and structure of the objects and digits selected for Rapid Automatic Naming

	CTOPP items	Frequency	Structure	French match	Frequency	Structure
Objects	Boat	79	CVC	robe	84	CVC
	Star	111	CCVC	fleur	1000	CCVC
	Pen	29	CVC	poule	37	CVC
	Chair	149	CVC	balle	122	CVC
	Fish	205	CVC	coeur	240	CVC
	Key	91	CV	chat	93	CV
Digits	Eight		VC	huit		VC
	Five		CVC	cinq		CVC
	Four		CVC	sept		CVC
	Seven		CVCVC	quatre		CVCC
	Three		CCV	trois		CCV
	Two		CV	deux		CV

Oral frequency counts and syllabic structures were taken from the CELEX database in English (Baayen, Piepenbrock, & Gulikers, 1995) and the Lexique database in French (New, Pallier, & Matos, 2001). Frequency is not considered for the digits, as all digits are considered high frequency words.

Non-word repetition

Children's capacity for attending to and repeating nonwords was assessed. A set of nonwords was created in both languages. The following principles for constructing these two sets of nonwords were borrowed from previous tests in French (Chevrie-Muller et al., 2010; Poncelet & Van Der Linden, 2003) and in English (Archibald, Gathercole, & Joanisse, 2009; Dollaghan & Campbell, 1998; Gathercole, Willis, Baddeley, & Emslie, 1994):

- The nonwords increased in length in both languages: 2, 3, 4, 5 and 6 syllables, giving 15 stimuli per language in total. The test could be discontinued when the child could not produce 2 out of the 3 nonwords attempted in a subset.
- None of the syllables used for constructing the nonwords were words in the language considered (e.g. /kat/-"cat" in English or /pje/-"pied" in French).
- The syllables were constructed according to the two most common syllable structures in both French and English (Delattre & Olsen, 1969): CV and CVC
- In order to avoid any articulation difficulty, the last consonants acquired in each language were not used: "the late eight" in English (Shriberg & Kiatkowski, 1994, cited by Dollaghan & Campbell, 1998), ʧ, ʃ, θ, ð, s, z, l, r, and the last five consonants to be acquired in initial (w, ɥ, ʁ, l, v) and in final (v, ʒ, d, g, ɲ) in French (MacLeod, Sutton, Trudeau, & Thordardottir, 2011). The order of the initial consonants in the syllable set was also balanced for place and mode of articulation, so that, for example, a bilabial was not followed by another bilabial (/bapa/), or a fricative by another fricative (/fatha/).
- Following from Burke and Coady (2015) and Dollaghan, Biber, and Campbell, (1995), only tense vowels were kept in English, in order to avoid unstressed syllable

reduction in English, and thus match the English stimuli to French, where syllables are roughly equally-stressed (Maillart & Parisse, 2006).

- In each language, the stress patterns were followed. In French, the last syllable of the nonword was consistently stressed, whereas in English, the second (for 2- and 3-syllable stimuli), and penultimate syllable (for stimuli of 4 syllables and above) were stressed.
- Phonotactic regularities were also balanced across languages. In both countries, children heard sets of nonwords with legal but low-frequency syllables.

The experimenter said the nonword to the child, who repeated it. The participant's response was scored online and audio-recorded for a second check. The task is scored in number of words (max. 15) and syllables (max. 60) correct. Table 6-11 presents the items constructed and used for the nonword repetition task.

Table 6-11: Parallel French and English items for the French and English nonword repetition task.

Number of syllables	Syllable structure	French items	Syllable structure	English items
PRACTICE ITEMS		tjœ-mib		koʊ-muːk
		byʁ-nja-lɛk		næs-teɪ-kiːv
2	CV.CVC	bja-fik	CV.CVC	moʊ-fæk
2	CVC.CV	dub-zje	CVC.CV	diːt-vaʊ
2	CV.CVC	pja-sab	CV.CVC	hoʊ-piːf
3	CVC.CV.CVC	byk-fja-tym	CVC.CV.CVC	mɜːdʒ-faʊ-tɔːm
3	CV.CVC.CV	dɥɪ-zɛb-kjo	CV.CVC.CV	daʊ-viːb-kɔɪ
3	CVC-CV-CVC	pok-sɛj-moz	CVC-CV-CVC	hæs-pɔːt-suːk
4	CV.CVC.CV.CVC	bɛj-fob-tjœ-gym	CV.CVC.CV.CVC	mjuː-fiːk-teɪ-guːb
4	CVC.CV.CVC.CV	dik-zwa-kyn-lij	CVC.CV.CVC.CV	duːt-veɪ-kiːb-wɔɪ
4	CV.CVC.CV.CVC	pjo-sub-mɥɪ-gɛm	CV.CVC.CV.CVC	hɔɪ-pæf-saʊ-biːb
5	CVC.CV.CVC.CV.CVC	byn-fɛj-tob-gɥi-mɛz	CVC.CV.CVC.CV.CVC	miːb-faʊ-tiːb-gɔɪ-buːp
5	CV.CVC.CV.CVC.CV	dja-zim-kɛj-lym-njo	CV.CVC.CV.CVC.CV	dɔɪ-vɔːp-kaɪ-wæv-neɪ
5	CVC.CV.CVC.CV.CVC	pɛk-sjo-mɛl-gwa-tam	CVC.CV.CVC.CV.CVC	huːs-pɔɪ-siːd-bjuː-gɔːp
6	CV.CVC.CV.CVC.CV.CVC	bœj-fim-tja-gɛl-mɥɪ-sym	CV.CVC.CV.CVC.CV.CVC	mɔɪ-fuːk-taʊ-gætʃ-bjuː-siːs
6	CVC.CV.CVC.CV.CVC.CV	dab-zɛj-kym-lwo-nɛp-fje	CVC.CV.CVC.CV.CVC.CV	dɔːt-vaɪ-kiːv-wɔɪ-næl-foʊ
6	CV.CVC.CV.CVC.CV.CVC	pœj-saʁ-mje-gab-tja-zik	CV.CVC.CV.CVC.CV.CVC	hoʊ-piːb-saʊ-buːd-gaʊ

Elicitation of spelling strategies

Children were asked about their spelling strategies, using the protocol developed by Donovan and Marshall (2016). They were given a word, followed by its sentence context, and the word again. They were then shown a card with three spelling options for the word and were asked to point to the spelling they thought to be the right one. They then explained why they had chosen this spelling over the other two, and the card was turned to reveal the correct spelling. Given the correct spelling, children were then given time to think of ways to remember this spelling or teach it to a friend. If the child could not answer, the response was prompted using a sequence of closed questions: ‘‘Could you sound it out to spell it right? Could you chunk it out to spell it right? Could you think of a word that looks a bit like this one? Is there a same-family word to help you spell this? Do you know a spelling rule to help you spell this? Is there any other trick to remember this word?’’ Children were given a chance to expand on their response. The sequence was audio-recorded and transcribed.

Twelve items were chosen for the elicitation of spelling strategies. They were selected from the words commonly misspelled by children in both languages following the group administration of the WIAT. The common misspellings produced by children were used as alternatives in the choice task, as well as some invented spellings that clearly violated phonological, orthographic, morphological or semantic conventions. Words were chosen to give children opportunities to demonstrate a range of strategy use. Words were also matched across language on number of letters, phonemes, graphemes, and syllables and as much as possible on frequency counts. Accuracy scores on the 12 words were highly correlated to raw scores on the full WIAT scale, both in French (r = .94) and in English (r = .96). Cronbach’s Alpha was .85 on the French scale, and .89 on the English scale, indicating good reliability. Table 6-12 presents the stimuli and their alternative choices.

Table 6-12: Stimuli used for the elicitation of spelling strategies

English target	English choice 1	English choice 2	French target	French choice 1	French choice 2
big	bigg	beg	gros	gross	gres
hand	han	hund	main	man	mai
guess	gess	gues	suis	suie	sui
climbed	climbd	climed	plafond	plafon	plafomd
riding	rideing	ridin	grimpa	grinpa	grimpat
strength	strengh	strenght	sautait	sauteait	sautit
careless	carless	careles	plomb	plon	plonb
knew	new	know	dois	doigt	douas
patients	patience	pashents	mer	mère	mar
right	rite	rigt	excitation	ecxitation	excitacion
ceiling	celing	cieling	soupçon	soupcon	soupson
couldn't	could'nt	couldent	aujourd'hui	aujour'dhui	aujourdui

Table 6-13 and Table 6-14 present the characteristics of the words considered, with the main type of strategy/error expected in both languages.

The strategies reported by children were further coded as detailed in section 6.6 below.

Table 6-13: Characteristics of the English word targets.

Strategies targeted	ENTarget	PhonTrans	Freq	NbPhon Neigh	NbPhon	NbLet	SyllStruc	NbSyll	GraphSeg	NbGraph
PHON	big	bɪg	2666	14	3	3	[CVC]	1	b.i.g.	3
PHON	hand	hand	295	8	4	4	[CVCC]	1	h.a.n.d.	4
MOR-DER	careless	ˈkɛːlɪs	3	0	5	8	[CVV][CVC]	2	c.are.l.e.ss.	5
MOR-DER	strength	strɛŋ(k)θ	22	0	6	8	[CCCVCC]	1	s.t.r.e.n.g.th.	7
MOR-INF + ORTH-RUL	riding	ˈrʌɪdɪŋ	143	4	5	6	[CVV][CVC]	2	r.i.d.i.ng.	5
MOR-INF + ORTH-IRR	climbed	klaɪmd	373	3	5	7	[CCVVCC]	1	c.l.i.m.b.ed.	6
ORTH-IRR	guess	gɛs	127	10	3	5	[CVC]	1	g.u.e.ss.	4
ORTH-REG	right	rʌɪt	852	24	3	5	[CVVC]	1	r.igh.t.	3
SEM-HOM	knew	njuː	270	8	3	4	[CCVV]	1	k.n.ew.	3
SEM-HOM	patients	ˈpeɪʃnts	38	0	6	8	[CVV][CCCC]	2	p.a.t.ie.n.t.s.	7
ORTH-RULE	ceiling	ˈsiːlɪŋ	35	5	5	7	[CVV][CVC]	2	c.ei.l.i.ng.	5
MOR-CON	couldn't	ˈkʊdnt	NA	2	5	8	CVC-CC	2	c.ou.l.d.n.'.t.	7
r (with full WIAT scale)	.96		438.55	6.5	4.42	6.08		1.42		4.92
Cronbach's α	.89		(778.25)	(7.05)	(1.16)	(1.83)		(.51)		(1.56)

ENTarget. Strategies targeted: PHON. *Phonological strategies,* ***MOR-DER.*** *Use of a derivational process,* ***MOR-INF.*** *Use of an inflectional process,* ***ORTH-RUL.*** *Use of a taught spelling rule,* ***ORTH-REG.*** *Use of an orthographic regularity,* ***ORTH-IRR.*** *Reliance on mere memorisation of an irregular pattern,* ***SEM-HOM.*** *Reliance of semantic contrasts,* ***MOR-CON.*** *Use of contraction patterns;* ***ENTarget.*** *English word target,* ***PhonTrans****. Phonological Transcription,* ***Freq****. Frequency per million (*$Frequency\ per\ million = \frac{number\ of\ occurrences\ of\ target\ word}{number\ of\ all\ word\ occurrences\ in\ database} \times 1000\ 000$*),* ***NbPhonNeigh****. Number of Phonological Neighbours,* ***NbLet****. Number of Letters,* ***SyllStruc****. Syllabic structure,* ***NbSyll****. Nb of syllables,* ***GraphSeg****. Grapheme segmentation,* ***NbGraph****. Number of graphemes. The indices given above were all taken from the Children's word printed database (Masterson, Stuart, Dixon, & Lovejoy, 2010),* ***r (with full WIAT scale)****. Accuracy scores' Pearson's correlation coefficient with full WIAT scale,* ***Cronbach's α.*** *Average of split-half reliability index for all the items of the scale.*

Table 6-14: Characteristics of the French word targets.

Strategies targeted	FRTarget	PhonTrans	Freq	NbPhGr Neigh	NbPhon	NbLet	SyllStruc	NbSyll	GraphSeg	NbGraph
PHON	main	mɛ̃	684	8	2	4	[CV]	1	m.ain.	2
PHON + MOR-DER	gros	gʀo	757	3	3	4	[CCV]	1	g.r.o.s.	4
MOR-DER	plomb	plɔ̃	19	0	3	5	[CCV]	1	p.l.om.b.	4
MOR-INF	sautait	sote	7	4	4	7	[CV][CV]	2	s.au.t.ai.t.	5
MOR-INF + ORTH-RUL	grimpa	gʀɛ̃pa	1	1	5	6	[CCV][CV]	2	g.r.im.p.a.	5
ORTH-IRR	plafond	plafɔ̃	29	0	5	7	[CCV][CV]	2	p.l.a.f.on.d.	6
ORTH-IRR	suis	sɥi	855	8	3	4	[CVVC]	1	s.ui.s.	3
ORTH-REG	excitation	ɛksitasjɔ̃	3	0	9	10	[VC][CV][CV][CVV]	4	e.x.c.i.t.a.t.ion.	8
SEM-HOM	mer	mɛʀ	521	8	3	3	[CVC]	1	m.e.r.	3
SEM-HOM	dois	dwa	117	8	3	4	[CVV]	1	d.oi.s.	3
ORTH-RULE	soupçon	supsɔ̃	3	0	5	7	[CVC][CV]	2	s.ou.p.ç.on.	5
MOR-CON	aujourd'hui	oʒuʀdɥi	249	NA	7	11	[V][CVC][CVV]	3	au.j.ou.r.d.'.h.ui.	8
r (with full WIAT scale)	.94		271.54	3.64	4.33	6		1.75		4.67
Cronbach's α	.85		(335.15)	(3.7)	(2.02)	(2.52)		(.97)		(1.92)

FRTarget.Strategies targeted: PHON. *Phonological strategies,* ***MOR-DER.*** *Use of a derivational process,* ***MOR-INF.*** *Use of an inflectional process,* ***ORTH-RUL.*** *Use of a taught spelling rule,* ***ORTH-REG.*** *Use of an orthographic regularity,* ***ORTH-IRR.*** *Reliance on mere memorisation of an irregular pattern,* ***SEM-HOM.*** *Reliance of semantic contrasts,* ***MOR-CON.*** *Use of contraction patterns;* ***FRTarget.*** *French word target,* ***PhonTrans****. Phonological Transcription,* ***Freq****. Estimated frequency of* ***U****sage per million (*$U = \frac{number\ of\ occurrences\ of\ target\ word}{number\ of\ all\ word\ occurrences\ in\ database} \times dispersion\ of\ the\ frequencies\ across\ readers \times 1000\ 000$*),* ***NbPhGrNeigh****. Number of Phonographic (phonological and orthographic) Neighbours,* ***NbLet****. Number of Letters,* ***SyllStruc****. Syllabic structure,* ***NbSyll****. Nb of syllables,* ***GraphSeg****. Grapheme segmentation,* ***NbGraph****. Number of graphemes. The indices given above were all taken from the Manulex database (Lété, Peereman, & Fayol, 2008),* ***r (with full WIAT scale)****. Accuracy scores' Pearson's correlation coefficient with full WIAT scale,* ***Cronbach's α.*** *Average of split-half reliability index for all the items of the scale.*

6.4. Procedure for data collection

Data were collected between October 2016 and January 2017 in England, and between February and June 2017 in France. Children were tested in a quiet room within the school, in two separate sessions, less than a month apart: one group session (45-50 minutes) and one individual session (60-75 minutes). Because of time constraints, not all children seen in a group could be seen individually. Choices were made on the basis of performance on the group tasks and with regards to the identification criteria. Figure 6-3 details the tasks conducted at each session.

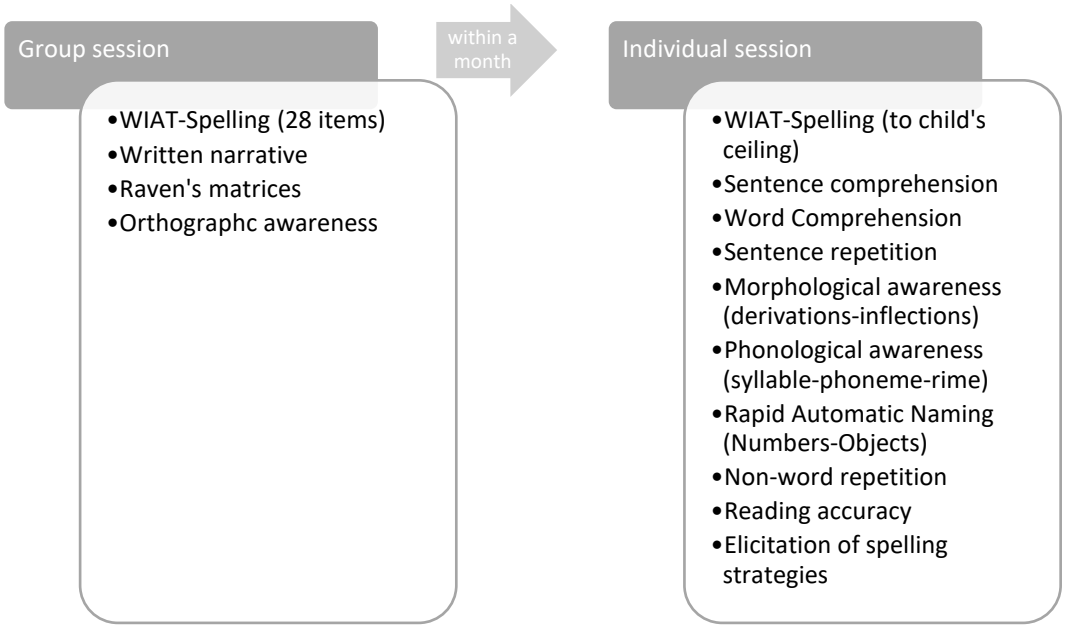

Figure 6-3: Administration procedure for the group and individual tasks

6.5. Qualitative analysis of spelling errors

The section below details the procedure for the analysis of the spelling errors from a set of chosen dictated words and from the written texts.

6.5.1. Transcription

Dictated words

The twelve target words chosen for the elicitation of spelling strategies were also analysed qualitatively for the spelling errors produced during the group spelling task. The twelve words produced by each child were gathered onto one spreadsheet, one word per row.

Written samples

Each child's text was transcribed into a text document exactly as it was written on paper. The spelling check of the word processor software was turned off and the transcription accounted for word segmentation, punctuation and capitalisation as well as spelling. Words that were crossed out were initially transcribed but not included in further analysis. When the handwriting for part of a word was unclear, reference was made to previous representations of the unclear letter(s) in the sample. For example, if it was unclear whether the child wrote *<canp> or <camp>, previous representations of the letters <n> and <m> were firstly checked. If this did not help decision-making, the correct spelling was favoured over the incorrect one. The same principle applied to spacing. Whole words whose handwriting was too unclear to decipher were excluded from analysis as illegible words.

Once transcribed, the texts were transferred onto a spreadsheet in order to allow for a detailed analysis of errors. There was one row per word in the spreadsheet so the attempted words could be automatically counted. All proper nouns (Thailand, Lucy, Domino's pizza, O2, London, etc.) and acronyms (Mr, Mrs, P.E., I.C.T., PS4, KS2, etc.) were removed from further analysis. Numbers, illegible words and words from the prompt were also excluded. Remaining spellings were checked.

6.5.2. Productivity and accuracy counts

From the spreadsheets, the number of correct and attempted words could be calculated for each child. An additional measure of accuracy and productivity was calculated from the number of correct and attempted graphemes.

Word error count

The number of rows was counted for each child and gave the total number of words attempted per child. Incorrectly-spelt words were defined as incorrect representations of the word in its sentence context. This included grammatical as well as lexical and segmentation spelling errors, that-is-to-say problems with the inflectional word ending, with the word root, and with the word boundary. Capitalisation and punctuation errors were not considered, in order to make the free writing and word dictation tasks comparable. When there was an incorrectly-spelt word, the correct spelling was written in the following cell of the row and a word error was counted. Spellings were checked against the Oxford English Dictionary online (2017) in English, and the online dictionary "Le Robert" (2017) in French. The number of words incorrectly-spelt was deducted from the total number of words attempted and a proportion of words correctly-spelt was calculated using the following formula:

$$\frac{\text{number of words attempted} - \text{number of words incorrectly spelt}}{\text{number of words attempted}}$$

Grapheme error count

In order to account for word length, a grapheme error count was conducted as well as the word error count (Daigle, Costerg, Plisson, Ruberto, & Varin, 2016). Three types of graphemes were considered: a) phonographs: graphemes that represent a sound (e.g. <ss> in <class> represents the /s/ sound); b) morphographs: graphemes that represent a morpheme (e.g. <s> in <hours>, which marks the plural); c) visuographs: graphemes with no phonological or morphological function (silent letters, e.g. <h> in <hour>).

Most graphemes represented one phoneme (e.g. <but> for /bʌt/), although sometimes phoneme and grapheme counts did not match perfectly (e.g. in the case of silent letters, the letter <x>-/ks/ or /gz/, or multigraphs such as <ur>, <er>, <ir> -/ə/ in English or <in>-/ɛ̃/, <oin>-/wɛ̃/ in French).

When there was any doubt about grapheme segmentation, the Oxford English Dictionary was used for a phonetic transcription of the word analysed, and the corresponding graphemes were checked against the list provided by Brooks (2015). Both those references account for the Received Pronunciation (RP) of English. In French, the French Dictionary "Le Robert" was similarly used to obtain a phonetic transcription. It was also decided that an incorrect spacing or hyphen would be counted as one grapheme error (whether it was missing or in excess). Similarly, an error with the use of an apostrophe (e.g. <Im> for <I'm>) was counted as one grapheme error. The proportion of correctly-spelt graphemes was calculated using the following formula (Daigle et al., 2016):

$$\frac{\text{number of graphemes attempted} - \text{number of incorrect graphemes}}{\text{number of graphemes attempted}}$$

6.5.3. Qualitative analysis of spelling errors

The spelling errors obtained in both tasks were further analysed qualitatively. The coding scheme for analysing spelling errors was adapted from the multilinguistic framework of analysis developed by Apel and Masterson (2001) and used by McCarthy, Hogan, and Catts (2012). Adaptations were made to this scheme following a first round of double-coding, with the support of two independent coders, native speakers of the language coded. Both coders had extensive experience of coding spelling errors in atypical populations. Initially, samples were independently coded by myself and the two independent coders. The samples represented 10% of all texts. A Cohen's Kappa of .17 (30% agreement) was obtained in English and .59 (69% agreement) in French. Where recurrent overlaps were found, categories were collapsed. The terminology used and definition of the different categories was also

clarified at this stage, this round of coding serving both as a training and piloting of the coding scheme.

The adapted coding comprised four categories, depending on whether the child produced:

- A phonological error, i.e. an error to do with the representation of the sounds in the words
- An orthographic error, i.e. an error to do with the orthographic rules, regularities and word-specific knowledge of the orthographic system
- A morphological error, i.e. an error to do with misrepresentations of the morphemes within the word
- Semantic errors, i.e. errors to do with the segmentation and meaning representation (homophones).

It is important to stress that these four categories were exclusive: for example, for an error to be classified as morphological, it could not affect the phonology of the word (e.g. *il a manger* for *il a mangé* in French would be classified as a morphological error, given that the change of inflection cannot be heard, but *he say* for *he says* in English would not be classified as morphological as the inflection is heard). For those errors at the overlap between more than one error type, a fifth category was created. This mixed category comprised errors which included more than one of the above representations (phonological and orthographic, morphological and phonological, orthographic and morphological, semantic and phonological, morphological and semantic). Additionally, because morphological errors are largely audible in English and mostly silent in French, errors at the overlap between morphology and phonology are reported in turn in the morphological and in the mixed category in the results section. Table 6-15 details the categories considered with examples from both French and English.

Following adaptations, a second round of coding was conducted jointly by myself and each of the two coders to ensure familiarity with the adapted scheme. Finally, each coder independently coded a further 10% of the samples. Cohen's Kappa reached .82 (88%

agreement) in English and .76 (81% agreement) in French following this third round of blind coding.

Table 6-15: Multilinguistic framework for coding spelling errors (adapted from Apel & Masterson, 2001 and McCarthy, Hogan, & Catts, 2012).

Overall category	Fine-grained coding	Definition	Example (EN)	Target (EN)	Example (FR)	Target (FR)
PHON - Errors where the child did not represent the phonological skeleton of the word	PHON-OM-vow	Omission of a stressed vowel	*destintion	destination	*frpé	frappé
	PHON-OM-cons	Omission of an obligatory consonant	*chool	school	*tabeau	tableau
	PHON-SUB-vow	Substitution of a stressed vowel	*dack	duck	*lou	les
	PHON-SUB-cons	Substitution of a consonant	*den	then	*pardi	parti
	PHON-ADD	Addition of a phoneme	*minunts	minutes	*lavai	avait
ORTH - Errors where the child did not call on relevant orthographic knowledge in his/her production	ORTH-IRR-silent	Omission of an unpredictable silent letter	*climed	climbed	*plafon	plafond
	ORTH-IRR-cons	Substitution of an ambiguous consonant spelling	*squeesing	squeezing	*cand	quand
	ORTH-IRR-vow	Substitution of an inconsistent long vowel grapheme	*laiter *hed	later head	*ancre *copin	encre copain
	ORTH-IRR-vow	Substitution or omission of an unstressed vowel grapheme	*apon *favrite	upon favourite	N/A	N/A
	ORTH-IRR-accent	Error on an accent	N/A	N/A	*embêter	embéter
	ORTH-IRR-MGR	Error of letter inversion	*beacuse	because	*avce	avec
	ORTH-REG	Error on a regular spelling pattern	*sista	sister	*journé	journée
	ORTH-RUL	Error on a taught spelling rule or an illegal letter sequence	*recieve *annd	receive and	*grinpa	grimpa
MOR - Errors where the child did not call on relevant morphological knowledge in his/her production	MOR-INF-gender	Error on gender inflection	N/A	N/A	rempli	remplie
	MOR-INF-tense	Error on tense inflection	*happend	happened	demander	demandé
	MOR-INF- Person	Error on person marking	*comse	comes	avais	avait
	MOR-INF-Number	Error on number marking	way's	ways	copain	copains
	MOR-INF-Poss	Error on possessive marking	teachers	teacher's	N/A	N/A
	MOR-DER-base	Error on the base of a complex word	ment	meant	gran	grand
	MOR-DER-Pre	Error on the prefix of a complex word	*extrordinary	extraordinary		
	MOR-DER-Suff	Error on the suffix of a complex word	assemble	assembly	*maîtrèsse	maîtresse
	MOR-CON	Errors on word contractions	*I'am	I'm	*quon	qu'on

Overall category	Fine-grained coding	Definition	Example (EN)	Target (EN)	Example (FR)	Target (FR)
SEM - Errors on the meaning of the word attempted	SEM-SEG	Segmentation errors (related or not related to a "liaison")	*some thing	something	*les cole *on n'a	l'école on a (liaison)
	SEM-HOMO	Homophone errors (within the same grammatical category)	peace	piece	poing	point
MIX - Errors affecting more than one aspect of spelling	PHON-ORTH	Error with orthographically-constrained graphemes affecting phonology	*tims *techer	times teacher	*amourese *gour	amoureuse jour
	PHON-MOR	Error with a morphological marker affecting phonology	head (verb) goal	headed goals	grand le	grande les
	PHON-SEM	Wrong word choice: use of another word, affecting semantics and phonology	were	wear	j'ai	j'aime
	MOR-ORTH	Error with rule-constrained inflections and derivations	*realy *blammed	really blamed	*obligait	obligeait
	MOR-SEM	Use of a grammatical homophone	their your	there you're	et à	est a

Categories of spelling errors. *PHON. Phonological; ORTH. Orthographic; MOR. Morphological; SEM. Semantic; MIX. Mixed.* ***Languages.*** *EN. English; FR. French; N/A = not applicable*

6.6. Coding of the strategies reported in the elicitation task

Once transcribed, the strategies reported by children on the elicitation task were coded in one of four categories. The same categories as in the analysis of spelling errors were used: phonological, morphological, orthographic, or semantic.

A phonological strategy was coded if a child clearly relied on sound-to-spelling correspondence in his explanation, e.g. "Use your phonics, and then go /s/, /t/, /r/, /ɛ/, /n/, /ɡ /, /t/, /h/." or "Listen the sounds.". When the child clearly relied on the phonemic, syllabic or rime unit, this was also coded.

A morphological strategy was coded when the child relied on knowledge of morphological parsing in his explanation, e.g. "Caring and careless are kind of the same, but just remember that careless is when no one cares, so just put care and then a less." or "Just remember climb and add -e-d-." A distinction was made between derivational and inflectional morphology.

An orthographic strategy was coded when children relied on orthographic knowledge in their explanation, either because they knew the word (retrieval, e.g. "Because I already knew."), because they called on memorisation (e.g. "There is a way, you just have to remember it." or "It is -i-g-h- as in "I Gallop Horses", and you can remember it like that"), because they knew a similar word or word chunk (analogy/regularity, e.g. "I would say guest. You take the -t- away and then you just add an -s-.", "Hum, /raɪt/, it's light with an -r- on it, with an -r- instead of an -l-."), or because they knew a spelling rule (e.g. "Because when you are adding -ing you've got to take the -e- off." or "-i- before e except after -c-").

Semantic strategies were coded when the child relied on semantic distinction, e.g. "And this one is new, like I brought a brand-new pair of trainers, it also has a different meaning".

Finally, a category was added for responses that were considered task-specific. Because children were given spelling options, many of them used an elimination strategy on

explaining their spelling choice. Initially responses were differentiated in terms of whether children relied on the sound (phonological), orthographic form (visuo-orthographic) or meaning (semantic) of the other options to explain their choice, but this was not further analysed as the focus was on explaining the spelling of the target word rather than the other spelling options given.

Irrelevant reports and instances where children did not know any strategy were further coded as "other".

Specific examples for both languages and each strategy type are given in Table 6-16. When a child did not respond spontaneously, children's responses to the prompting questions were also coded. If a child relied on more than one strategy in his explanation, each strategy was coded separately.

A second coder was trained. She was French-English bilingual and had experience designing and using a similar strategy coding scheme. She independently recoded 10% of the strategy samples (10 participants, 406 strategies). Cohen's Kappa reached .71 (80%). Following reliability checks, both coders pursued coding independently, checking any problematic decisions together.

Table 6-16: Strategy types and examples in both languages

Overall category	Fine-grained coding	Example (EN)	Example (FR)
PHON – Reliance on sound-spelling correspondences	PHON-general	"Maybe just sound it out."	« Et le reste ça s'écrit comme t'entends. »
	PHON-phoneme	"It's gonna be /b/i/g/"	« Tu récites en une fois, tu fais /mɛr/, tu fais /m/ɛ/r/. »
	PHON-syllable	"You go /si:/ and /lɪŋ/."	« Déjà on peut le séparer, on fait /gʁɛ̃/ et /pa/. »
	PHON-rime/onset	"Put /ength/ and then put /str/"	« On coupe en deux : /pl/ et /ɔ̃/ »
ORTH – Reliance on orthographic form of the word	ORTH-retrieval	"I can remember it from Read write inc." "Because I've spelt it before."	« Parce que j'ai déjà vu ce mot, je l'ai appris. » « je sais qu'il s'écrit avec un -d-. »
	ORTH-memorisation	"Then /ai/ as in "I Galop Horses", and you can remember it like that." "You go /knu:/." (to remember knew) "I could practice writing it down a couple of times, and then I could give it to somebody and read it out, and then check." "Look, cover, write, check."	« Parce qu'à la fin on met un -d-, on dit /plafɔ̃d/ pour s'en souvenir. » « Sinon on fait une affiche, on travaille ce mot plusieurs fois. On le lit, on lit on lit, et on dit à ses parents comment l'écrire et normalement on le sait. »
	ORTH-analogy/regularity	"Hum, /raɪt/, it's light with an -r- on it. With an -r- instead of an -l-."	« le /sjɔ̃/ à la fin, ça fait pas avec un -c-. C'est comme récréation, c'est -t-i-o-n-. »
	ORTH-rule	"I've remembered a pattern that the teacher said: I before e expect after c. So I remember that so that's how you spell ceiling." "usually - whenever you put -ing, or something with ride, you take the -e- off."	« Mer tu l'écris comme "meur", tu mets pas d'accent vu que c'est entre deux consonnes, du coup tu mets pas d'accent. » « c'est la règle du -m-b-p-, fin faut toujours mettre un -m- devant un -m- un -b- ou un -p-. »
MOR – Reliance on morphological units	MOR-inflection	"Because the one below it doesn't have the -e-d- at the end, so it wouldn't be in the past tense"	« et après le -a-i-t-, c'est la terminaison de l'imparfait, donc après ça faut connaître aussi. »
	MOR-derivation	"Caring and careless are kind of the same, but just remember that careless is when no one cares, so just put care and then a less."	« On prend plombier et à partir du -b- on coupe tout ce qu'il y a derrière. » (pour plomb)

Overall category	Fine-grained coding	Example (EN)	Example (FR)
SEM – Reliance on semantic distinctions	SEM-homophones	"Cause without the -k- is new as in "brand new", as in "just got it". Knew is what you guessed would happen, or knew would happen."	« Parce que le mot mère avec l'accent grave -r-e-, c'est la mère, celle qui fait partie de notre famille. Et la mar, c'est là où sont les canards, et la mer, c'est comme un océan.»
ELIM – Reliance on other spelling options (elimination strategy)	ELIM-phonological	"That one just says han."	« Parce que sinon là ça fait /ɡʀo/ et là ça fait /ɡʀɛ/.»
	ELIM-visual	"It's right but it's in the wrong order." "This one it doesn't look right."	« Parce que j'ai jamais vu ça -o-u-a-. » « Là ça paraîtrait bizarre »
	ELIM-semantic	"That's not a real word that one"	« Parce que on peut pas dire ça, ça n'existe pas. Et celui-là, c'est pas un mot. »
OTHER– No/irrelevant response	Asking-dictionary	"Look in the dictionary!"	« Et sinon on cherche dans le dictionnaire. Ou on demande à un adulte. »
	No response-irrelevant	"I don't know" "You could do an action like you turn to your right, and then you spell out the word." "I just guessed."	« Je sais pas trop. » « Je suis sûre, parce que j'avais un chat. » « J'ai fait au hasard. »

Categories of spelling errors. *PHON. Phonological; ORTH. Orthographic; MOR. Morphological; SEM. Semantic.* ***Languages.*** *EN. English; FR. French.*

Chapter 7. Spelling errors across language and groups

Chapter 7 assesses the effect of language and DLD on spelling products, as outlined in Figure 7-1. Spelling products came from the texts and dictated words described in 6.5.

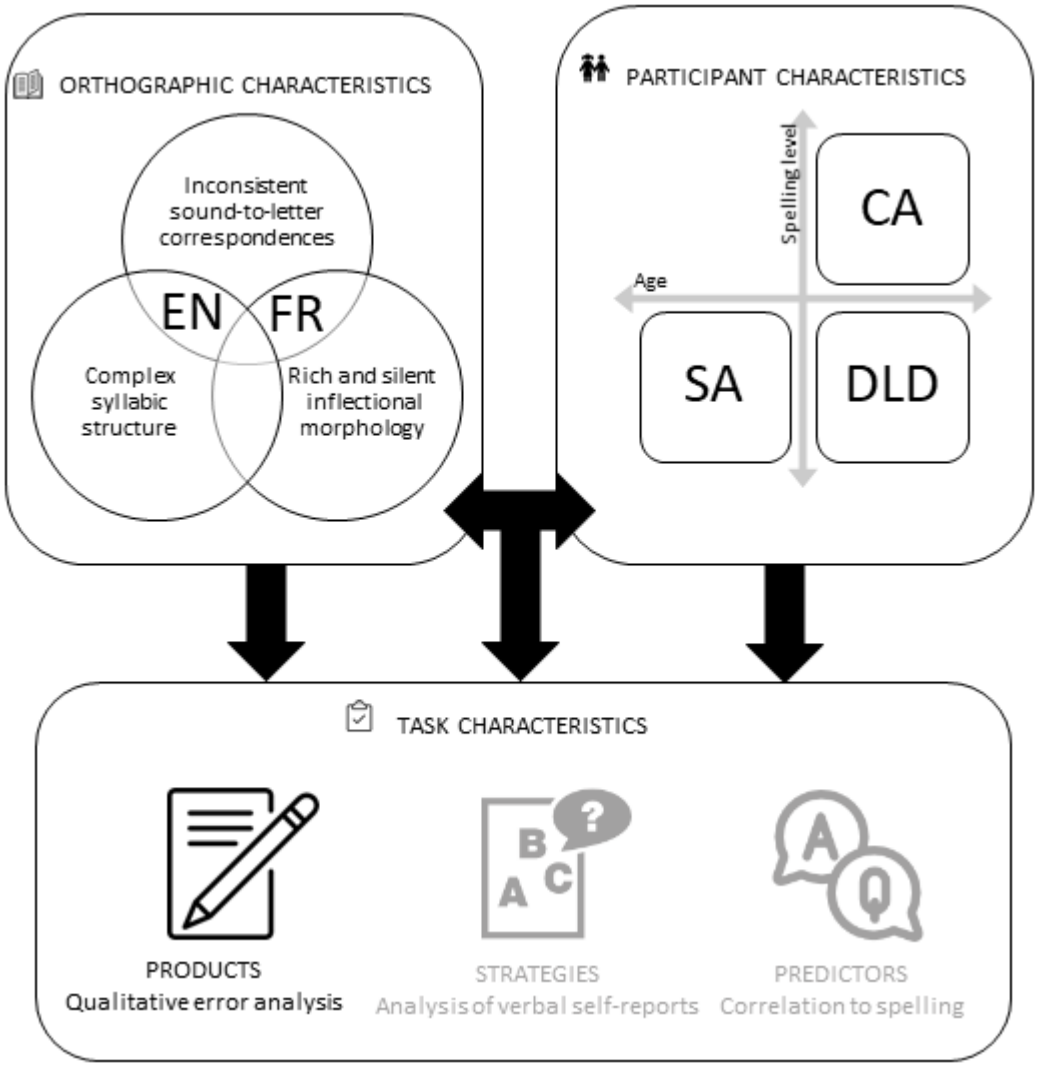

Figure 7-1: Outline of the thesis with a focus on spelling products

7.1. Productivity and accuracy

Spellings were produced by French and English children during a written narrative and a word dictation task. Twelve of the dictated words were chosen for analysis in this chapter, along with the texts (see methods section 6.5). Detail of the analysis procedure is given in the methods chapter, 6.5. Results are presented for the measures of productivity and accuracy in the first instance:

- Number of words attempted
- Proportion of words correct
- Number of graphemes attempted
- Proportion of graphemes correct

Given the presence of outliers and the heterogeneity of variance in some of the data, the comparisons were conducted using robust ANOVAs based on a 20% trimmed mean. Robust ANOVAs allow for the comparison of data which break the assumption of normality and homogeneity of variance to a degree. They are based on an estimation of the mean which is trimmed, with the aim of limiting the impact of outliers and skewness on the comparisons (Field & Wilcox, 2017). Robust ANOVAs and post-hoc tests were conducted using the t2way and mcp2atm functions of the WRS2 package (Mair & Wilcox, 2018) for R (R Core Team, 2018). They were 2x3 ANOVAs, with language (French vs English) and subgroup (DLD vs CA vs CA) as factors. A robust measure of effect size (ξ) was also computed where relevant, using the function yuen.effect.ci of the same package. ξ-values of 10, .30, and .50 correspond to small, medium, and large effect sizes (Wilcox & Tian, 2011). Table 7-1 shows the results of these comparisons.

Table 7-1: Productivity and accuracy measures for the written texts and the twelve dictated words

		M(SD)						*F* (Robust)	*p*	*ξ* [95% CI]	Post-hoc (Robust)
		FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**				
	N	17	17	17	17	17	17				
Written texts	**Words attempted**	34.91 (4.57)	51.00 (4.45)	14.73 (3.15)	24.55 (6.14)	20.45 (2.91)	21.09 (4.62)	language: 6.70 subgroup: 39.00 interaction: 3.93	.013* .001*** .161 n.s.	.32 [.07-.52] .71 [.46-.86]	EN>FR SA=DLD<CA
	Graphemes attempted	124.36 (17.17)	167.91 (10.30)	53.18 (12.95)	79.27 (18.59)	70.73 (9.33)	69.73 (15.61)	language: 4.25 subgroup: 44.88 interaction: 3.12	.045* .001*** .231 n.s.	.28 [0-.55] .71 [49-.89]	EN>FR SA=DLD<CA
	Proportion of words correct	.75 (.03)	.95 (.02)	.45 (.07)	.81 (.02)	.44 (.09)	.74 (.03)	language: 50.15 subgroup: 53.21 interaction: 5.00	.001*** .001*** .110 n.s.	.79 [.54-.91] .65 [.39-.89]	EN>FR SA=DLD<CA
	Proportion of graphemes correct	.91 (.01)	.98 (.01)	.71 (.06)	.91 (.02)	.71 (.06)	.87 (.02)	language: 26.36 subgroup: 44.73 interaction: 7.04	.001*** .001*** .052 n.s.	.62 [41-.82] .82 [.50-.95]	EN>FR SA=DLD<CA
12 dictated words	**Words attempted**	12 (0)	12 (0)	12(0)	12(0)	12 (0)	12 (0)	NA			
	Graphemes attempted	56 (0)	59 (0)	56 (0)	59 (0)	56 (0)	59 (0)	NA			
	Proportion of words correct	.62 (.05)	.85 (.03)	.22 (.07)	.30 (.04)	.24 (.07)	.29 (.02)	language: 10.03 subgroup: 169.92 interaction: 5.37	.003** .001*** .090 n.s.	.08 [0-.39] .99 [.76-.99]	EN>FR SA=DLD<CA
	Proportion of graphemes correct	.89 (.02)	.95 (.01)	.66 (.05)	.70 (.04)	.70 (.04)	.72 (.03)	language: 2.59 subgroup: 111.09 interaction: .70	.115 n.s. .001*** .711 n.s.	.08 [0-.37] .78 [.77-.99]	EN=FR SA=DLD<CA

M(SD). *Trimmed means and standard deviations were computed using a 20% trimming of the sample,* ***EN.*** *English,* ***FR.*** *French,* ***DLD.*** *Developmental Language Disorder,* ***CA.*** *Typically-Developing children matched on age,* ***SA.*** *Typically-developing children matched on raw spelling score,* ***N****. Number of participants in subgroup,* ***Stand.*** *Standard score,* ***Comp.*** *Composite score,* ***F(Robust).*** *Robust ANOVAs were computed using the t2way function in R (WR2S package, Mair & Wilcox, 2015) with a trimmed mean of 20%,* ***p.*** *p-value:* ***n.s.*** *non-significant, *p < .05, **p<.01, *** p<.001.* ***ξ [95%CI]****. Robust explanatory measure (with 95% confidence interval) for the size of the effect computed using the yuen.effect.ci function in R (WR2S package, Mair & Wilcox, 2015), values of ξ = .10, .30, and .50 correspond to small, medium, and large effect sizes (Wilcox & Tian, 2011).*

7.1.1. Written texts: Productivity and accuracy

As shown in Table 7-1, there was a significant effect of language and subgroup on all productivity and accuracy measures in the written texts, but no interaction.

Effect of language

Productivity. The English children produced more words (*M* = 32.90, *SD* = 3.78) and graphemes (*M* = 108.00, *SD* = 12.18) than the French children (M_{words} = 22.65, SD_{words} = 2.36 and M_{graph} = 78.74, SD_{graph} = 8.74). On average, English texts were 10 words - or 30 graphemes - longer than the French texts.

Accuracy. English children also produced a higher rate of correct words (*M* = .84, *SD* = .02) and correct graphemes (*M* = .93, *SD* = .01) than French children (M_{words} = .57, SD_{words} = .04 and M_{graph} = .80, SD_{graph} = .03). On average, English children produced a misspelling every six words -every 14 graphemes-, whilst the French children produced a misspelling every other word -every 5 graphemes. This difference was significant in all subgroups.

Effect of subgroup

Productivity. Children with DLD produced fewer words (*M* = 18.86, *SD* = 3.07) and graphemes (*M* = 65.09, *SD* = 11.16) than their CA (M_{words} = 43.54, SD_{words} = 3.18 and M_{graph} = 148.45, SD_{graph} = 10.62) but not SA peers (M_{words} = 20.45, SD_{words} = 2.83 and M_{graph} = 69.18, SD_{graph} = 8.81). On average, the texts of children with DLD and SA peers were half the length of those written by CA peers.

Accuracy. Children with DLD also produced a lower rate of correct words (*M* = .62, *SD* = .06) and correct graphemes (*M* = .83, *SD* = .03) than their CA (M_{words} = .87, SD_{words} = .03 and M_{graph} = .95, SD_{graph} = .01) but not their SA peers (M_{words} = .63, SD_{words} = .05 and M_{graph} = .81, SD_{graph} = .03). On average, children with DLD and SA peers produced a misspelling every two/three words -every five/six graphemes-, whilst CA peers produced a misspelling every seven/eight

words -every 20 graphemes. This pattern of differences was significant in both French and English.

7.1.2. 12 dictated words: Accuracy

As shown in Table 7-1, all children attempted the same number of words and graphemes in the dictation. Productivity was thus not considered here. There was a significant effect of language and subgroup on the proportion of words but not graphemes correct. There was a significant effect of subgroup on both accuracy measures, and no interaction.

Effect of language

Word correctness was higher in English (p = .003, ξ = .08, M = .42, SD = .05) than in French (M = .38, SD = .04). However, only in the CA subgroup was this difference significant (p = .04, M_{EN} = .85, SD_{EN} = .02; M_{FR} = .62, SD_{FR} = .05). The language effect was not significant in grapheme correctness (p = .115, M_{EN} = .78, SD_{EN} = .02; M_{FR} = .76, SD_{FR} = .02). On average, there was a misspelling every word –every four/five graphemes- in both the English and the French words analysed.

Effect of subgroup

Children with DLD produced a lower rate of correct words (M = .28, SD = .04) and correct graphemes (M = .68, SD = .03) than their CA (M_{words} = .73, SD_{words} = .05; M_{graph} = .91, SD_{graph} = .01), but not their SA peers (M_{words} = .28, SD_{words} = .03; M_{graph} = .71, SD_{graph} = .02). On average, there was a misspelling every word to every two words -every three to four graphemes- in the words selected from the DLD and SA samples, and one misspelling every three to four -every 11 graphemes- in the words taken from the CA samples. This pattern was significant in both French and English.

7.1.3. Summary: Productivity and accuracy in the written texts and 12 dictated words

In the written texts, French children produced fewer words and graphemes than their English peers overall, with a higher rate of spelling errors. However, on a constrained dictation task involving 12 words matched for complexity in both languages, and using grapheme as the unit of measure, French and English children produced spelling errors at a similar rate.

Children with DLD produced fewer words and graphemes in their texts, and a higher rate of spelling errors, than their CA peers. However, their performance on these measures was in line with that of SA peers. This pattern of difference was also found in the dictated words.

7.2. Qualitative analysis of spelling errors

Results are presented for the qualitative analysis of spelling errors, as described in Section 6.5.3 of the methods (see Table 6-15, p. 137). Each spelling error was considered as either phonological, orthographic, morphological (derivational or inflectional), semantic or mixed in the first instance. They were then broken down into finer-grained specific error types. Additionally, because of the recurrent overlap between the morphological and phonological categories in English (as opposed to French), PHON-MOR errors are reported in the fine-grained coding of both morphological and mixed errors. All results are reported in proportion for each error type on the number of words attempted ($proportion\ for\ each\ error\ type = \frac{\text{Number of errors in each category}}{\text{Number of words attempted}}$).

Given the non-normal nature of the data, Wilcoxon rank-sum tests were conducted for all comparisons of interest, that-is for the French vs English comparison (overall and within subgroups) and for the DLD vs CA, DLD vs SA, and CA vs SA comparisons (within languages). A Bonferroni adjustment for multiple comparisons was applied to this set of comparisons, setting the significance level at $p < .005$ for all tests (Chen, Feng, & Yi, 2017). Table 7-2

presents the results of these comparisons for the written texts and Table 7-8 for the 12 dictated words.

7.2.1. Written texts: qualitative analysis of spelling errors

Figure 7-2 presents bean plots for the proportion of errors per words attempted, by error type, country and subgroup, in the written texts. Bean plots represent the median, data points and a density curve (verticalized). As shown in Figure 7-2, there were outliers in almost all subgroups and the data were highly skewed towards the lower end of the distribution (i.e. towards a low error rate for each error type).

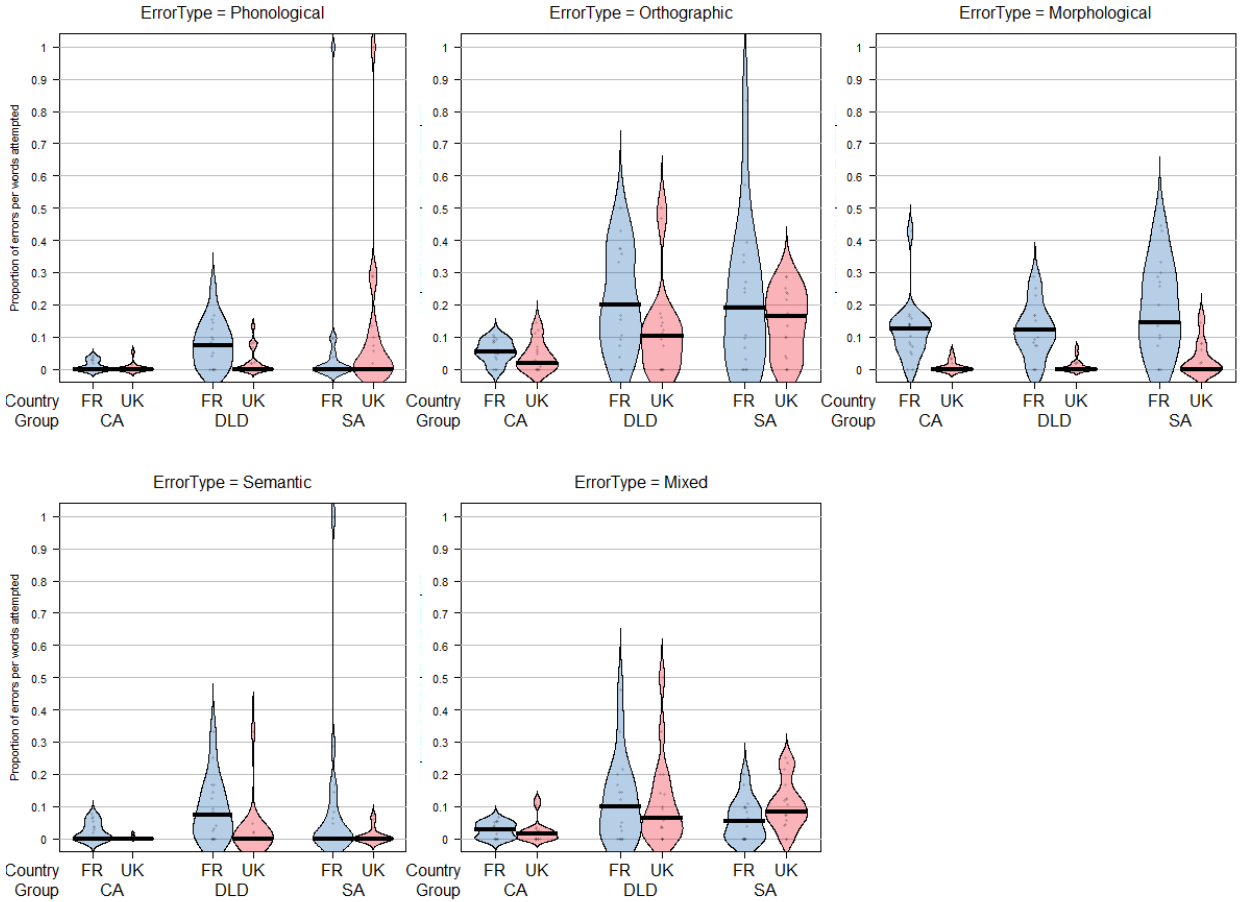

Figure 7-2: Bean plots for the proportion of errors per words attempted in the written texts, by error type, subgroup and country. The bean plots represent the median, data points and a bean-shape smoothed density curve (verticalized). In these plots, the morphological category excludes PHON-MOR errors, which are included in the mixed category.

Table 7-2: Language and subgroups comparisons for phonological, orthographic, morphological, semantic and mixed errors in the written texts

	Proportion per words attempted: Median [range]						***Language comparisons***			***Subgroup comparisons***		
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**	***W***	***p***	***r***	***W***	***p***	***r***
PHON	.00 [0-.04]	.00 [0-.05]	.07 [0-.25]	.00 [0-.13]	.00 [0-1]	.00 [0-1]	FRvsEN: 1463.5	.22 n.s.	-.41	FR: DLDvsCA: 57.5	.002*	-.54
										FR: DLDvsSA: 80.5	.02 n.s.	-.40
							DLD: FRvsEN: 78.5	.02 n.s.	-.40	FR: SAvsCA: 149	.87 n.s.	-.03
							CA: FRvsEN: 110.5	.12 n.s.	-.26			
							SA: FRvsEN: 174.5	.25 n.s.	-.20	EN: DLDvsCA: 98	.04 n.s.	-.35
										EN: DLDvsSA: 166.5	.42 n.s.	-.14
										EN: SAvsCA: 202.5	.01 n.s.	-.42
ORTH	.05 [0-.11]	.02 [0-.14]	.20 [0-.50]	.10 [0-.50]	.19 [0-.83]	.16 [0-.29]	FRvsEN: 1535.5	.11 n.s.	-.16	FR: DLDvsCA: 53.5	.002*	-.54
										FR: DLDvsSA: 133.5	.72 n.s	-.06
							DLD: FRvsEN: 90	.06 n.s.	-.32	FR: SAvsCA: 205.5	.04 n.s.	-.36
							CA: FRvsEN: 110	.24 n.s.	-.20			
							SA: FRvsEN: 123.5	.48 n.s.	-.12	EN: DLDvsCA: 102	.14 n.s.	-.25
										EN: DLDvsSA: 181.5	.20 n.s.	-.22
										EN: SAvsCA: 224.5	.005*	-.47
MOR	.13 [0-.43]	.00 [0-.05]	.12 [0-.29]	.00 [0-.07]	.14 [0-.44]	.00 [0-.17]	FRvsEN: 2260	<.001*	-.66	FR: DLDvsCA: 139.5	.88 n.s.	-.02
										FR: DLDvsSA: 187	.15 n.s.	-.25
							DLD: FRvsEN: 33	<.001*	-.69	FR: SAvsCA: 188	.14 n.s.	-.25
							CA: FRvsEN: 22.5	<.001*	-.75			
							SA: FRvsEN: 49	<.001*	-.58	EN: DLDvsCA: 138	.79 n.s.	-.05
										EN: DLDvsSA: 172	.28 n.s.	-.02
										EN: SAvsCA: 178	.17 n.s.	-.23

	Proportion per words attempted: Median [range]						*Language comparisons*			*Subgroup comparisons*		
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**	***W***	***p***	***r***	***W***	***p***	***r***
SEM	.00 [0-.08]	.00 [0-.02]	.07 [0-.33]	.00 [0-.33]	.00 [0-1]	.00 [0-.01]	FRvsEN: 1819.5	<.001*	-.40	FR: DLDvsCA: 80.5	.02 n.s.	-.39
										FR: DLDvsSA: 110	.22 n.s.	-.21
							DLD: FRvsEN: 67	.004*	-.49	FR: SAvsCA: 158	.62 n.s.	-.08
							CA: FRvsEN: 86.5	.014 n.s.	-.42			
							SA: FRvsEN: 103	.079 n.s.	-.30	EN: DLDvsCA: 123.5	.29 n.s.	-.18
										EN: DLDvsSA: 138	.77 n.s.	-.05
										EN: SAvsCA: 156	.54 n.s.	-.11
MIX	.06 [0-.50]	.01 [0-.12]	.08 [0-.25]	.10 [0-.46]	.03 [0-.07]	.05 [0-.20]	FRvsEN: 1170.5	.379 n.s.	-.08	FR: DLDvsCA: 92	.07 n.s.	-.31
										FR: DLDvsSA: 107.5	.20 n.s.	-.22
							DLD: FRvsEN: 141	.92 n.s.	-.02	FR: SAvsCA: 180.5	.21 n.s.	-.22
							CA: FRvsEN: 115.5	.31 n.s.	-.17			
							SA: FRvsEN: 198	.065 n.s.	-.32	EN: DLDvsCA: 70	.009 n.s.	-.44
										EN: DLDvsSA: 164	.51 n.s.	-.11
										EN: SAvsCA: 244.5	<.001*	-.59

Error types. ***PHON***. *Phonological errors;* ***ORTH***. *Orthographic errors;* ***MOR***. *Morphological errors;* ***SEM.*** *Semantic errors;* ***MIX***. *Mixed errors.* ***Languages***. ***EN***. *English;* ***FR***. *French;* ***Subgroups***. ***DLD***. *Developmental Language Disorder;* ***CA***. *Age-matched controls;* ***SA***. *Spelling-matched controls;* ***Non-parametric test results***. ***W***. *Wilcoxon sum-rank test value.* ***p***. *p-value:* ***n.s.*** *non-significant, *significant Bonferroni-adjusted p < .005;* ***r***. *effect size for the Wilcoxon rank-sum tests, computed using the rFromWilcox function in R (Field, Miles, Fields, 2012, p.664): values of r = .10, .30, and .50 correspond to small, medium, and large effect sizes.*

Phonological errors

As shown in Table 7-2, phonological errors were very rare across groups, except French children with DLD.

Language comparisons. There was no language difference in the proportion of phonological errors (*W* = 1463.5, *p* = .22). Overall, English children produced a similar rate of phonological errors (*Mdn* = 0, range 0-1) to French children (*Mdn* = 0, range 0-1). This was the case in the CA subgroups (*W* = 110.5, *p* = .12) SA subgroups (*W* = 174.5, *p* = .25) and the DLD subgroups (*W* = 78.5, *p* = .02, *r* = .40).

Subgroup comparisons. Subgroup differences were significant in French but not English. In French, children with DLD (*Mdn* = .07, range 0-.25) produced a significantly higher rate of phonological errors than the CA (*Mdn* = 0, range 0-.04, *W* = 57.5, *p* = .002, *r* = .54) but not SA peers (*Mdn* = 0, range 0-1, *W* =80.5, *p* = .02, *r* = .40). In English, both children with DLD (*Mdn* = 0, range 0-.13, *W* = 98, *p* = .04, *r* = .35) and SA peers (*Mdn* = 0, range 0-1, *W* = 202.5, *p* = .01, *r* = .42) performed worse than CA (*Mdn* = 0, range 0-.05) but none of these differences were significant after applying Bonferroni correction.

Specific error types. Table 7-3 presents a summary of the specific phonological errors produced, per subgroup. Within the phonological category, errors were most frequent with consonant omissions and substitutions (in consonant clusters in particular). Children in the DLD and SA samples also produced some additions and vowel omissions.

Table 7-3: Error types within the phonological category, per language and subgroup, in the written texts

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
OM-vow	0 [0-.04] *0*	0 [0-.05] *0*	0 [0-.17] *.03*	0 [0-.02] *0*	0 [0-.06] *0*	0 [0-.14] *.01*
OM-cons	0 [0-.03] *0*	0 [0-.02] *0*	0 [0-.08] *.01*	0 [0-.07] *.01*	0 [0-1] *.01*	0 [0-.14] *.01*
SUB-vow	0 [0-.03] *0*	0 [0-0] *0*	0 [0-.15] *.01*	0 [0-.02] *0*	0 [0-0] *0*	0 [0-.08] *0*
SUB-cons	0 [0-.04] *0*	0 [0-0] *0*	0 [0-.08] *.01*	0 [0-.08] *.01*	0 [0-.04] *0*	0 [0-.04] *.01*

Mdn [range] *trimM*	FR-CA	EN-CA	FR-DLD	EN-DLD	FR-SA	EN-SA
ADD	0 [0-0] *0*	0 [0-0] *0*	0 [0-.02] *.01*	0 [0-0] *0*	0 [0-0] *0*	0 [0-1] *.01*

Mdn: Median, trimM: trimmed mean, OM-vow: vowel omission, OM-cons: consonant omission, SUB-vow: vowel substitution, SUB-cons: consonant substitution, ADD: Addition

Orthographic errors

As shown in Table 7-2, orthographic errors were the most frequent spelling errors across all groups and languages, except the French CA controls. The rate of orthographic errors differentiated groups of children within language, but there were no cross-language differences.

Language comparisons. There was no language difference in the proportion of orthographic errors (W = 1535.5, p = .11). English children produced a similar rate of orthographic errors (*Mdn* = .07, range 0-.50) to French children (*Mdn* = .09, range 0-.83). This was the case in all subgroups (DLD: W = 90, p = .06; CA: W = 110, p = .24; SA: W = 123.5, p = .48).

Subgroup comparisons. Patterns of difference varied in French and English. In French, children with DLD (*Mdn* = .20, range 0-.50, W = 53.5, p = .002, r = .54) performed worse than CA (*Mdn* = .05, range 0-.11) but not SA peers (W = 133.5, p = .72, r = - .06). The two typical groups' performance did not significantly differ (W = 205.5, p = .04, r = - .36). In English, only children with SA (*Mdn* = .16, range 0-.29) produced a higher rate of errors than CA (W = 224.5, p = .005, r = .47, *Mdn* = .02, range 0-.14).

Specific error types. Table 7-4 presents a summary of the specific orthographic errors produced, per subgroup. Within the orthographic category, errors were most frequent with inconsistent vowels (especially in English, with unstressed and long vowels). There were also difficulties applying the regular patterns of the orthographic system in both languages. Errors with spelling rules, the application of accent, and unpredictable silent letters were particularly present in French.

Table 7-4: Error types within the orthographic category, per language and subgroup, in the written texts

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
IRR-silent	0 [0-.05] *.01*	0 [0-.03] *0*	0 [0-.17] *.03*	0 [0-.02] *0*	0 [0-.19] *.05*	0 [0-.14] *0*
IRR-cons	0 [0-.05] *0*	0 [0-0] *0*	0 [0-.15] *.01*	0 [0-.06] *0*	0 [0-.25] *.03*	0 [0-.14] *.01*
IRR-vow	0 [0-.03] *.01*	0 [0-.09] *.01*	.02 [0-.14] *.04*	.03 [0-.33] *.03*	0 [0-.25] *.03*	.03 [0-.25] *.06*
IRR-accent	0 [0-.05] *.01*	-	0 [0-.17] *.02*	-	0 [0-.14] *.02*	-
ORTH-MGR	0 [0-0] *0*	0 [0-.02] *0*	0 [0-.17] *.01*	0 [0-.06] *0*	0 [0-.05] *0*	0 [0-.05] *0*
ORTH-REG	0 [0-.08] *.01*	0 [0-.1] *.02*	0 [0-.33] *.02*	.02 [0-.5] *.04*	0 [0-.11] *.03*	0 [0-.21] *.03*
ORTH-RUL	0 [0-.03] *0*	0 [0-0] *0*	0 [0-.10] *.01*	0 [0-.04] *0*	0 [0-.29] *.01*	0 [0-.02] *0*

Mdn: Median, trimM: trimmed mean, IRR-silent: Omission of an unpredictable silent letter, IRR-cons: Substitution of an ambiguous consonant spelling, IRR-vow: Substitution/omission of an inconsistent vowel grapheme, IRR-accent: Error on an accent, ORTH-MGR: Error of letter inversion, ORTH-REG: Error on a regular spelling pattern, ORTH-RUL: Error on a taught spelling rule or an illegal letter sequence

Morphological errors

As shown in Table 7-2, morphological errors were relatively rare in English but frequent in French. It was the most frequent error type in the French CA group. Cross-language differences were evident. However, patterns of frequency were similar across groups in each language.

Language comparisons. There was a large and significant language difference in the proportion of morphological errors produced (W = 2260, p < .001, r = .66). French children produced a higher proportion of morphological errors (*Mdn* = .12, range 0-.44) than their English peers (*Mdn* = 0, range 0-.17). This difference was significant and large in all subgroups (DLD: W = 33, p < .001, r = .69; CA: W = 22.5, p < .001, r = .75; SA: W = 49, p < .001, r = .58). When PHON-MOR errors were included in the morphological category, the same pattern was observed: French children still produced more morphological errors (*Mdn* = .17, range 0-.71) than their English peers (*Mdn* = 0, range 0-.17, W = 2344.5, p < .001, r = .70).

Subgroup comparisons. In both French (*Mdn* = .12, range 0-.29) and English (*Mdn* = .00, range 0-.07), children with DLD produced a similar rate of morphological errors to CA (Mdn_{FR} = .13,

range 0-.43, W = 139.5, p = .88, Mdn_{EN} = .00, range 0-.03, W = 138, p = .79) and SA (Mdn_{FR} = .14, range 0-.44, W = 187, p = .15, Mdn_{EN} = .00, range 0-.17, W = 172, p = .28). There was also no difference between the CA and SA subgroups (W = 681.5, p = .19). This pattern was observed across languages, and regardless of whether PHON-MOR were included in the analysis or not.

Specific error types. Table 7-5 presents a summary of the morphological errors, per specific error type and subgroup. Within the morphological category, errors were most frequent with inflectional morphology (mostly in French, with tense and number marking). There were also errors of contractions in all French subgroups, and in the EN-SA subgroup. Most morphological errors regarded inflectional morphology. Comparatively few were produced in derivational morphology.

Table 7-5: Error types within the morphological category, per language and subgroup, in the written texts

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
MOR-INF-gender	0 [0-.07] *.01*	-	0 [0-.05] *0*	-	0 [0-.17] *.01*	-
MOR-INF-tense	.03 [0-.16] *.03*	0 [0-.02] *0*	.02 [0-.14] *.04*	0 [0-.05] *0*	.05 [0-.28] *.08*	0 [0-.08] 0*.01*
MOR-INF-Person	0 [0-.29] *.01*	0 [0-0] *0*	0 [0-.05] *0*	0 [0-.02] *0*	0 [0-.1] *.01*	0 [0-0] *0*
MOR-INF-Number	0 [0-.09] *.01*	0 [0-.02] *0*	0 [0-.17] *.03*	0 [0-0] *0*	0 [0-.14] *.02*	0 [0-0] *0*
MOR-INF-Possessive	-	0 [0-.02] *0*	-	0 [0-0] *0*	-	0 [0-0] *0*
MOR-INF-Comp Sup	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*
MOR-DER-base	0 [0-.04] *0*	0 [0-.02] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-.03] *0*	0 [0-.02] *0*
MOR-DER-Pre	0 [0-0] *0*	0 [0-.05] *0*	0 [0-0] *0*	0 [0-.07] *0*	0 [0-0] *0*	0 [0-0] *0*
MOR-DER-Suff	0 [0-0] *0*	0 [0-0] *0*	0 [0-.02] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-.14] *0*
MOR-CON	.02 [0-.14] *.02*	0 [0-.02] *0*	0 [0-.08] *.02*	0 [0-0] *0*	.05 [0-.14] *.05*	0 [0-.17] *.01*
PHON-MOR	0 [0-0] *0*	0 [0-.06] *0*	0 [0-.1] *.01*	0 [0-.09] *.01*	0 [0-.05] *0*	0 [0-.08] *.01*

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
MOR total (excl. PHON-MOR)	**.13 [0-.43]** ***.11***	**0 [0-.05]** ***.01***	**.12 [0-.29]** ***.12***	**0 [0-.07]** ***.01***	**.14 [0-.44]** ***.18***	**0 [0-.17]** ***.03***
MOR total (incl. PHON-MOR)	**.13 [.02-.29]** ***.14***	**0 [0-.06]** ***.01***	**.18 [0-.38]** ***.19***	**0 [0-.09]** ***.02***	**.20 [0-.71]** ***.23***	**.02 [0-.17]** ***.04***

Mdn: Median, trimM: trimmed mean, MOR-INF-gender: Error on gender inflection, MOR-INF-tense: Error on tense inflection, MOR-INF-Person: Error on person marking, MOR-INF-Number: Error on number marking, MOR-INF-Possessive: Error on possessive marking, MOR-DER-base: Error on a word base, MOR-DER-Pre: Error on a derivational prefix, MOR-DER-Suff: Error on a derivational suffix, MOR-CON: Error on word contractions, PHON-MOR: Errors on morphology affecting phonology, MOR total (excl. PHON-MOR): total rate of morphological errors excluding PHON-MOR, MOR total (incl. PHON-MOR): total rate of morphological errors including PHON-MOR.

Semantic errors

As shown in Table 7-2, semantic errors were very rare across groups, except French children with DLD. Cross-language differences were identified.

Language comparisons. There was a large and significant language difference in the proportion of semantic errors produced (W = 1819.5, p <.001, r = .40). French children produced a higher proportion of semantic errors (*Mdn* = .02, range 0-1) than English children (*Mdn* = 0, range 0-.33). This difference was significant only in the DLD subgroup (W = 67, p = .004, r = .49) but not in CA (W = 86.5, p = .014, r = .42) or SA (W = 103, p = .07, r = .30).

Subgroup comparisons. There were no subgroup differences in either French or English. The frequency of semantic errors was similarly marginal across groups within language.

Specific error types. Table 7-6 presents a summary of the semantic errors, per specific error type and subgroup. Within the semantic category, errors were most frequent with segmentation (with or without the presence of a "liaison"). The rate of these segmentation errors was high in French compared to English.

Table 7-6: Error types within the semantic category, per language and subgroup, in the written texts

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
SEM-HOMO	0 [0-.03] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-.06] *0*	0 [0-0] *0*

Mdn [range] *trimM*	FR-CA	EN-CA	FR-DLD	EN-DLD	FR-SA	EN-SA
SEM-SEG-liaison	0 [0-.05] *.01*	0 [0-0] *0*	0 [0-.17] *.02*	0 [0-0] *0*	0 [0-.14] *.01*	0 [0-0] *0*
SEM-SEG no liaison	0 [0-.07] *.01*	0 [0-.02] *0*	.03 [0-.33] *.05*	0 [0-.33] *.01*	0 [0-1] *.03*	0 [0-.07] *.01*

Mdn: Median, trimM: trimmed mean, SEM-HOMO: Homophone errors (within the same grammatical category), SEM-SEG- liaison: Segmentation errors (related to a ''liaison''), SEM-SEG no liaison: Segmentation errors (not related to a ''liaison'')

Mixed errors

Mixed errors were a combination of errors at the overlap between different error types. This error type appeared with some degree of frequency in all groups and both languages. There were no language differences, but group variations were observed in the English sample.

Language comparisons. There was no language difference in the proportion of mixed errors produced (W = 1170.5, p = .79). French (*Mdn* = .04, range 0-.46) and English children (*Mdn* = .04, range 0-.50) produced a similar rate of mixed errors. This was true in all subgroups (DLD: W = 141, p = .92; CA: W = 115.5, p = .31, SA: W = 198, p = .065).

Subgroup comparisons. In English, children with DLD produced similar rates of mixed errors than CA (W = 70, p = .009, r = .44) and SA (W = 164, p = .512). However, the SA group produced a higher rate of orthographic errors than the CA group (W = 244.5, p < .001, r = .59). In French, no group differences appeared (DLDvsCA: W = 92, p = .068; SAvsCA: W = 180.5, p = .21; DLDvsSA: W = 107.5, p = .198).

Specific error types. Table 7-7 presents a summary of the mixed errors and non-codable errors, per specific error type and subgroup. Although non-codable errors were not considered as mixed errors in the analysis, they are also reported here for transparency. Within the mixed category, errors were particularly present:

- in the EN-DLD and EN-SA groups, with orthographically-constrained graphemes, affecting phonology (PHON-ORTH)
- in the EN-SA and EN-CA with rule-constrained inflections and derivations (MOR-ORTH)
- in the EN-DLD group with word choice (near-homophone or use of another word affecting both phonology and semantics – PHON-SEM)

- in the EN-DLD and EN-SA groups with morphological markers affecting phonology (PHON-MOR)
- in French, with grammatical homophones (MOR-SEM)

In the DLD and SA samples, there were more occurrences of non-codable errors (unreadable or too remote from target) than in the CA groups.

Table 7-7: Error types within the mixed and non-codable errors, per language and subgroup, in the written texts

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
PHON -ORTH	0 [0-.05] *0*	0 [0-.05] *0*	0 [0-.15] *.01*	.02 [0-.5] *.04*	0 [0-.05] *0*	.04 [0-.18] *.05*
PHON-MOR	0 [0-0] *0*	0 [0-.06] *0*	0 [0-.1] *.01*	0 [0-.09] *.01*	0 [0-.05] *0*	0 [0-.08] *.01*
PHON-SEM	0 [0-.04] *0*	0 [0-.02] *0*	0 [0-.15] *0*	0 [0-.2] *.01*	0 [0-.08] *0*	0 [0-.03] *0*
MOR-ORTH	0 [0-0] *0*	0 [0-.05] *.01*	0 [0-0] *0*	0 [0-.07] *0*	0 [0-.05] *0*	0 [0-.25] *.02*
MOR-SEM	0 [0-.07] *.02*	0 [0-.02] *0*	.04 [0-.25] *.06*	0 [0-.07] *.01*	0 [0-.2] *.03*	0 [0-.05] *0*
Non-codable	0 [0-0] *0*	0 [0-0] *0*	0 [0-.25] *.01*	0 [0-.07] *0*	0 [0-.05] *0*	0 [0-.03] *0*

Mdn: Median, trimM: trimmed mean, PHON -ORTH: Error with orthographically-constrained graphemes affecting phonology, PHON-MOR: Error with a morphological marker affecting phonology, PHON-SEM: Wrong word choice: use of another word, affecting semantics and phonology, MOR-ORTH: Error with rule-constrained inflections and derivations, MOR-SEM: Use of a grammatical homophone

7.2.2. 12 dictated words: qualitative analysis of spelling errors

Figure 7-3 presents bean plots for the proportion of errors per words attempted, by error type, country and subgroup, in the 12 dictated words. As shown in Figure 7-3, there were outliers in almost all subgroups and the data was highly skewed to the bottom end of the distribution (i.e. towards a low error rate for each error type). Table 7-8 presents a summary of the analyses conducted to investigate language and subgroup differences in the quality of errors produced in the 12 dictated words.

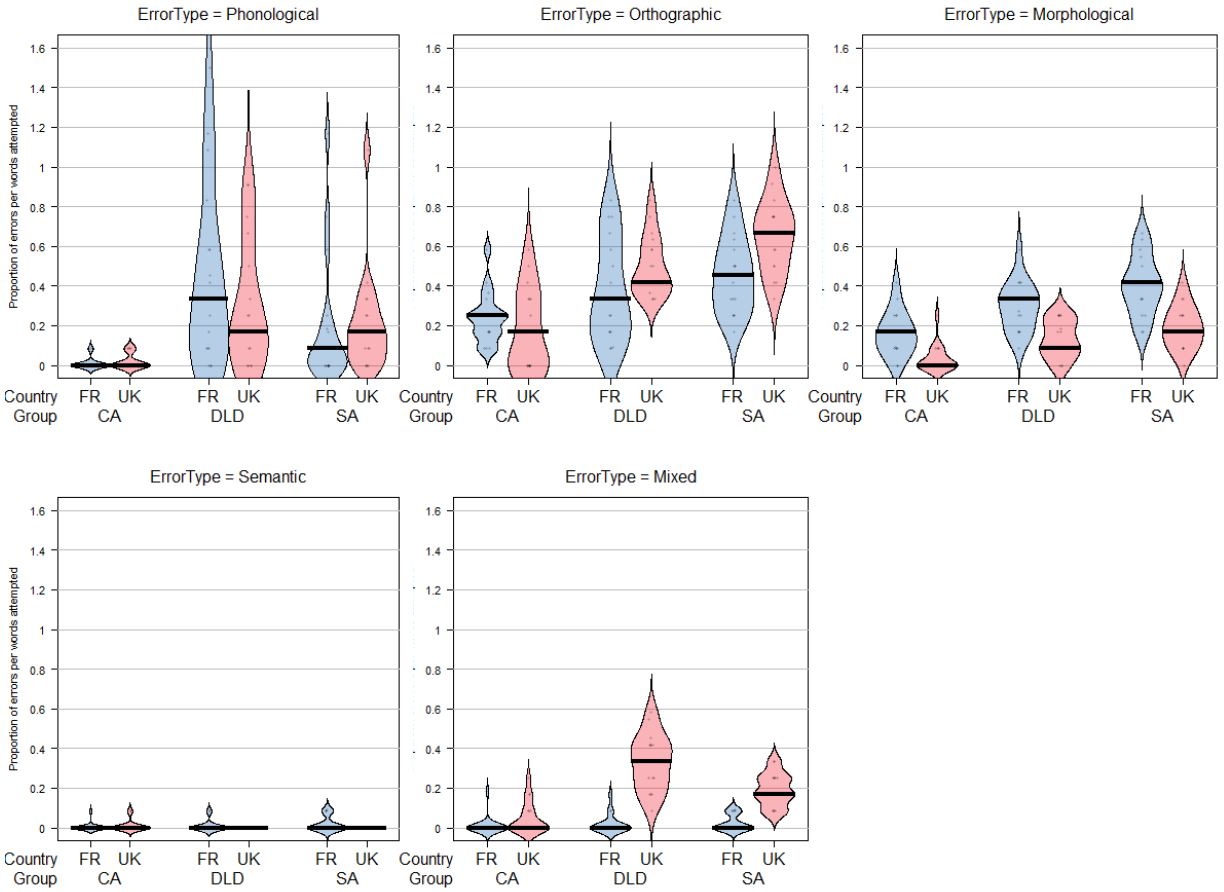

Figure 7-3: Bean plots for the proportion of errors per words attempted in the 12 dictated words, by error type, subgroup and country.

The bean plots represent the median, data points and a bean-shape smoothed density curve (verticalized).

Table 7-8: Language and subgroups comparisons for phonological, orthographic, morphological, semantic and mixed errors in the 12 dictated words

	Proportion per words attempted: Median [range]						***Language comparisons***			***Subgroup comparisons***		
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**	***W***	***p***	***r***	***W***	***p***	***r***
PHON	0 [0-.08]	0 [0-.08]	.33 [0-1.5]	.17 [0-.91]	0 [0-1.17]	.17 [0-1.08]	FRvsEN: 1183.5	.41 n.s.	-.08	FR: DLDvsCA: 31.5	<.001*	-.72
										FR: DLDvsSA: 72.5	.012 n.s.	-.43
							DLD: FRvsEN: 123	.46 n.s.	-.12	FR: SAvsCA: 206	.011 n.s.	-.43
							CA: FRvsEN: 161.5	.39 n.s.	-.15			
							SA: FRvsEN: 195.5	.07 n.s.	-.31	EN: DLDvsCA: 46	<.001*	-.62
										EN: DLDvsSA: 125	.51 n.s.	-.11
										EN: SAvsCA: 241	<.001*	-.61
ORTH	.25 [.08-.58]	.17 [0-.58]	.33 [.08-.83]	.42 [.33-.83]	.33 [0-.75]	.67 [.33-1]	FRvsEN: 924	.011 n.s.	-.25	FR: DLDvsCA: 105	.17 n.s.	-.23
										FR: DLDvsSA: 139.5	.88 n.s.	-.03
							DLD: FRvsEN: 195.5	.08 n.s.	-.30	FR: SAvsCA: 190.5	.11 n.s.	-.27
							CA: FRvsEN: 108.5	.21 n.s.	-.21			
							SA: FRvsEN: 245	<.001*	-.59	EN: DLDvsCA: 33	<.001*	-.66
										EN: DLDvsSA: 214.5	.016 n.s.	-.41
										EN: SAvsCA: 275.5	<.001*	-.78
MOR	.17 [0-.42]	0 [0-.25]	.33 [.08-.58]	.08 [0-.25]	.33 [0-.64]	.17 [0-.42]	FRvsEN: 1976	<.001*	-.45	FR: DLDvsCA: 61	.004*	-.50
										FR: DLDvsSA: 158.5	.64 n.s.	-.08
							DLD: FRvsEN: 44	<.001*	-.60	FR: SAvsCA: 216	.014 n.s.	-.42
							CA: FRvsEN: 41.5	<.001*	-.63			
							SA: FRvsEN: 84.5	.038 n.s.	-.36	EN: DLDvsCA: 56.5	.001*	-.55
										EN: DLDvsSA: 184.5	.162 n.s.	-.24
										EN: SAvsCA: 259	.001*	-.70

	Proportion per words attempted: Median [range]						***Language comparisons***			***Subgroup comparisons***		
	FR-CA	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**	***W***	***p***	***r***	***W***	***p***	***r***
SEM	0 [0-.08]	0 [0-.08]	0 [0-.08]	0 [0-0]	0 [0-.09]	0 [0-0]	FRvsEN: 1429	.081 n.s.	-.17	FR: DLDvsCA: 136	.575 n.s.	-.10
										FR: DLDvsSA: 162.5	.363 n.s.	-.16
							DLD: FRvsEN: 127.5	.163 n.s.	-.24	FR: SAvsCA: 170.5	.153 n.s.	-.24
							CA: FRvsEN: 153	.575 n.s.	-.09			
							SA: FRvsEN: 110.5	.039 n.s.	-.35	EN: DLDvsCA: 161.5	.163 n.s.	-.24
										EN: DLDvsSA: 144.5	N/A	N/A
										EN: SAvsCA: 127.5	.163 n.s.	-.24
MIX	0 [0-.18]	0 [0-.25]	0 [0-.17]	.33 [.08-.58]	0 [0-.09]	.17 [.08-.33]	FRvsEN: 386.5	<.001*	-.65	FR: DLDvsCA: 129	.356 n.s.	-.16
										FR: DLDvsSA: 158	.547 n.s.	-.10
							DLD: FRvsEN: 285.5	<.001*	-.86	FR: SAvsCA: 176	.108 n.s.	-.28
							CA: FRvsEN: 185	.051 n.s.	-.33			
							SA: FRvsEN: 281	<.001*	-.83	EN: DLDvsCA: 12	<.001*	-.80
										EN: DLDvsSA: 61.5	.004*	-.50
										EN: SAvsCA: 256.5	<.001*	-.68

Error types. ***PHON***. *Phonological errors;* ***ORTH***. *Orthographic errors;* ***MOR***. *Morphological errors;* ***SEM.*** *Semantic errors;* ***MIX***. *Mixed errors.* ***Languages***. ***EN***. *English;* ***FR***. *French;* ***Subgroups***. ***DLD***. *Developmental Language Disorder;* ***CA***. *Age-matched controls;* ***SA***. *Spelling-matched controls;* ***Non-parametric test results***. ***W***. *Wilcoxon sum-rank test value.* ***p***. *p-value:* ***n.s.*** *non-significant, *significant Bonferroni-adjusted p < .005;* ***r***. *effect size for the Wilcoxon rank-sum tests, computed using the rFromWilcox function in R (Field, Miles, Fields, 2012, p.664): values of r = .10, .30, and .50 correspond to small, medium, and large effect sizes; N/A = not applicable*

Phonological errors

As shown in Table 7-8, phonological errors were rare in the dictated words, except for the DLD and English SA samples. Differences were evident across groups.

Language comparisons. There was no language difference in the proportion of phonological errors (*W* =1183.5, *p* = .41). Overall, English children produced a similar rate of phonological errors (*Mdn* = .08, range 0-1.08) to French children (*Mdn* = 0, range 0-1.5). This was the case in the DLD (*W* = 123, *p* = .47), CA (*W* = 161.5, *p* = .39) and SA subgroups (*W* = 195.5, *p* = .07).

Subgroup comparisons. In French, children with DLD produced a higher rate of phonological errors (*Mdn* = .33, range 0-1.5) than the CA (*Mdn* = 0, range 0-.08, *W* = 31.5, *p* < .001, *r* = -.72) but not SA peers (*Mdn* = 0, range 0-1.17, *W* = 72.5, *p* = .012, *r* = -.43). SA controls also produced a similar rate of phonological errors to CA controls (*W* = 206, *p* = .011, *r* = -.43). In English the pattern was different (DLD=SA>CA): both children with DLD (*Mdn* = .17, range 0-.91, *W* = 46, *p* = <.001*, *r* = -.62) and SA (*Mdn* = .17, range 0-1.08, W = 241*, p* = <.001*, *r* = -.61) produced a higher rate of phonological errors than CA peers (*Mdn* = 0, range 0-.08).

Specific error types. Table 7-9 presents a summary of the error types within the phonological category, per language and subgroup. Within the phonological category, errors were most frequent with consonant omissions (particularly in consonant clusters). French children with DLD also produced a high proportion of vowel substitutions (with similar sounds *grapa/grimpa, *aujordui/aujourd'hui).

Table 7-9: Error types within the phonological category, per language and subgroup, in the 12 dictated words

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
OM-Vow	0 [0-0] *0*	0 [0-0] *0*	0 [0-.33] *.06*	0 [0-.33] *.04*	0 [0-0] *0*	0 [0-.25] *0*
OM-Cons	0 [0-0] *0*	0 [0-.08] *.01*	.08 [0-.75] *.11*	.17 [0-.50] *.14*	0 [0-.17] *.01*	.08 [0-58] *.08*
SUB-Vow	0 [0-0] *0*	0 [0-0] *0*	.09 [0-.50] *.14*	0 [0-.18] *.03*	0 [0-.58] *.02*	0 [0-.17] *.04*
SUB-Cons	0 [0-.08] *0*	0 [0-0] *0*	.08 [0-.33] *.06*	0 [0-.09] *.02*	0 [0-.33] *.02*	0 [0-.17] *.02*

Mdn [range] *trimM*	FR-CA	EN-CA	FR-DLD	EN-DLD	FR-SA	EN-SA
ADD	0 [0-.08] *0*	0 [0-.08] *0*	0 [0-.18] *0*	0 [0-.17] *.03*	0 [0-.17] *.02*	0 [0-.08] *.01*

Mdn: Median, trimM: trimmed mean, OM-vow: vowel omission, OM-cons: consonant omission, SUB-vow: vowel substitution, SUB-cons: consonant substitution, ADD: Addition

Orthographic errors

As shown in Table 7-8, orthographic errors were the most frequent error type across groups. Cross-language differences were evident, as well as cross-group differences in English.

Language comparisons. There was a language difference in the proportion of orthographic errors produced in the dictated words (W = 924, p = .011, r = -.25). However, this effect was only significant in the SA group (W = 245, p < .001, r = -.59), where English SA children produced a higher rate of orthographic errors (*Mdn* = .67, range .33-1) than French SA peers (*Mdn* = .33, range 0-.75) . In the DLD and CA groups, French and English children produced a similar rate of orthographic errors (DLD: W = 195.5, p = .08; CA: W = 108.5, p = .21).

Subgroup comparisons. Patterns varied widely across languages. In English, both DLD (*Mdn* = .42, range .33-.83, W = 33, p <.001, r = -.66) and SA children (*Mdn* = .67, range .33-1, W = 275.5, p < .001, r = .78) produced a higher rate of errors than CA peers (*Mdn* = .17, range 0-.58). In French, no subgroup difference was significant (DLDvsCA: W = 105, p = .17; SAvsCA: W = 190.5, p = .11; DLDvsSA: W = 139.5, p = .88). In English, children in the SA group produced the highest rate of errors (*Mdn* = .67, range .33-1), followed by children with DLD (*Mdn* = .42, range .33-.83) and CA peers (*Mdn* = .17, range 0-.58). In French, about a third of children's words contained an orthographic error in all groups.

Specific error types. Table 7-10 presents a summary of the frequency of errors made within the orthographic category, by language and subgroup. Errors within the orthographic category were most frequent with unpredictable silent letters in both languages (e.g. **coudn't/couldn't, *plafon/plafond*) particularly in the SA and DLD subgroups, with irregular consonants in both languages (e.g. **seiling/ceiling, *soupson/soupçon*) and irregular vowels

in English (e.g. *cairless/careless, *mair/mer). There were also difficulties applying the regular patterns of the orthographic system in both languages. Errors with spelling rules were particularly present in French and errors of letter inversions and incomplete orthographic representations were particularly present in English.

Table 7-10: Error types within the orthographic category, per language and subgroup, in the 12 dictated words

Mdn [range] *trimM*	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
IRR-Silent	.08 [0-.18] *.07*	0 [0-.17] *.03*	.17 [0-.42] *.16*	.09 [0-.27] *.14*	.17 [0-.25] *.11*	.17 [0-.33] *.20*
IRR-Cons	.08 [0-.17] *.12*	0 [0-.17] *.03*	.08 [0-.17] *.08*	.17 [.08-.18] *.14*	.08 [0-.17] *.10*	.17 [.08-.25] *.16*
IRR-Vow	0 [0-.08] 0	.08 [0-.25] *.08*	0 [0-.33] *.06*	.17 [.08-.25] *.16*	0 [0-.27] *.03*	.25 [.08-.42] *.22*
IRR-acc	0 [0-0] *0*	-	0 [0-.08] *.01*	-	0 [0-.08] *.01*	-
ORTH-MGR	0 [0-0] *0*	0 [0-0] *0*	0 [0-.08] *0*	0 [0-.09] *.02*	0 [0-0] *0*	0 [0-.17] *.01*
ORTH-REG	0 [0-.09] *.02*	0 [0-.08] *.01*	0 [0-.08] *.02*	0 [0-.33] *.02*	0 [0-.25] *.03*	.08 [0-.08] *.05*
ORTH-RUL	0 [0-.17] *.03*	0 [0-0] *0*	0 [0-.08] *.02*	0 [0-0] *0*	.08[0-.09] *.04*	0 [0-0] *0*

Mdn: Median, trimM: trimmed mean, IRR-silent: Omission of an unpredictable silent letter, IRR-cons: Substitution of an ambiguous consonant spelling, IRR-vow: Substitution/omission of an inconsistent vowel grapheme, IRR-accent: Error on an accent, ORTH-MGR: Error of letter inversion, ORTH-REG: Error on a regular spelling pattern, ORTH-RUL: Error on a taught spelling rule or an illegal letter sequence

Morphological errors

As shown in Table 7-8, morphological errors were common in all groups. Cross-language and cross-group differences were evident.

Language comparisons. There was a significant language difference. Overall, French children produced a higher rate of morphological errors (*Mdn* = .25, range 0-.64) than English peers (*Mdn* = .08, range 0-.42, *W* = 1976, *p* < .001, *r* = .45). This language difference was observed across all subgroups (DLD: *W* = 44, *p* < .001, *r* = .60; CA: *W* = 41.5, *p* < .001, *r* = .63) but SA (*W* = 84.5, *p* = .038, *r* = .36). It was also observed when PHON-MOR errors were included in the analysis, with French children still producing more morphological errors (*Mdn* = .25, range 0-.67) than their English peers (*Mdn* = .17, range 0-.42, *W* = 1865, *p* < .001, *r* = .38).

Subgroups comparisons. Children with DLD produced a higher rate of morphological errors than CA, but not SA peers, in both French (DLDvsCA: W = 61, p = .004, r = .50; DLDvsSA: W = 158.5, p = .638; CAvsSA: W = 216, p = 014, r = .42) and English (DLDvsCA: W = 56.5, p = .001, r = .55; DLDvsSA: W = 184.5, p = .162). English SA children also produced more morphological errors than CA peers (CAvsSA: W = 259, p < .001, r = .70). When PHON-MOR errors were included in the analysis, the exact same pattern was observed, but French SA children also produced more morphological errors than their CA peers when this error type was taken into account (W = 28, p < .001, r = .69).

Specific error types. Table 7-11 presents a summary of the morphological errors, per specific error type and subgroup. Within the morphological category, errors were most frequent with derivational morphology (mostly in French, with base errors) and inflectional morphology (especially in French, with person and tense agreement, although EN-SA and EN-DLD also produced errors with tense inflections). There were also errors of contractions in all subgroups and in both languages.

Table 7-11: Error types within the morphological category, per language and subgroup, in the 12 dictated words

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
MOR-INF-gender	0 [0-0] *0*	-	0 [0-0] *0*	-	0 [0-0] *0*	-
MOR-INF-tense	0 [0-.08] *.03*	0 [0-0] *0*	.08 [0-.09] *.07*	0 [0-.17] *.02*	.08 [0-.09] *.05*	.08 [0-.17] *.06*
MOR-INF-Person	.08 [0-.17] *.05*	0 [0-0] *0*	.08 [0-.17] *.06*	0 [0-0] *0*	.08 [0-.25] *.09*	0 [0-0] *0*
MOR-INF-Number	0 [0-.17] *0*	0 [0-.08] *0*	0 [0-.08] *0*	0 [0-0] *0*	0 [0-.17] *0*	0 [0-.08] *0*
MOR-INF-Poss	-	0 [0-0] *0*	-	0 [0-0] *0*	-	0 [0-0] *0*
MOR-INF-Comp Sup	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*
MOR-DER-base	.08 [0-.09] *.06*	0 [0-.08] *0*	0.17 [0-.25] *.13*	0 [0-.08] *0*	.08 [0-.27] *.11*	0 [0-.08] *.01*
MOR-DER-Pre	0 [0-0] *0*	0 [0-0] *0*	0 [0-.17] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*
MOR-DER-Suff	0 [0-.08] *.01*	0 [0-.08] *.01*	0 [0-.09] *.01*	0 [0-.17] *.04*	0 [0-.08] *.02*	0 [0-.17] *.05*

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
MOR-CON	0 [0-0] *0*	0 [0-.08] *.01*	0 [0-.08] *.01*	.08 [0-.09] *.06*	0 [0-.09] *.03*	.08 [0-.08] *.06*
MOR total (excl. PHON-MOR)	**.17 [0-.42]** ***.16***	**0 [0-.25]** ***.02***	**.33 [.08-.58]** ***.29***	**.08 [0-.25]** ***.13***	**.33 [0-.64]** ***.40***	**.17 [0-.42]** ***.19***
MOR total (incl. PHON-MOR)	**.17 [0-.42]** ***.14***	**0 [0-.25]** ***.02***	**.33 [.08-.58]** ***.30***	**.25 [0-.36]** ***.23***	**.42 [.16-.67]** ***.40***	**.25 [0-.42]** ***.21***

Mdn: Median, trimM: trimmed mean, MOR-INF-gender: Error on gender inflection, MOR-INF-tense: Error on tense inflection, MOR-INF-Person: Error on person marking, MOR-INF-Number: Error on number marking, MOR-INF-Possessive: Error on possessive marking, MOR-DER-base: Error on a word base, MOR-DER-Pre: Error on a derivational prefix, MOR-DER-Suff: Error on a derivational suffix, MOR-CON: Error on word contractions, PHON-MOR: Errors on morphology affecting phonology, MOR total (excl. PHON-MOR): total rate of morphological errors excluding PHON-MOR, MOR total (incl. PHON-MOR): total rate of morphological errors including PHON-MOR.

Semantic errors.

As shown in Table 7-8, semantic errors were very rare in all groups and languages, with few opportunities for homophone and segmentation errors in both words lists.

Language and subgroup comparisons. There were very few semantic errors across languages and subgroups, and no language (W = 1429, p = .081) or subgroup differences (DLDvsCA: W = 595, p = .65, DLDvsSA: W = 613, p = 39, CAvsSA: W = 596.5, p = .68) in the rate of semantic errors overall.

Specific error types. Table 7-12 presents a summary of the error types within the semantic category. Semantic errors were only produced by the FR-CA, EN-CA, FR-DLD and FR-SA groups. They regarded homophones. As expected in a single word dictation task, word segmentation errors were marginal.

Table 7-12: Error types within the semantic category, per language and subgroup, in the 12 dictated words

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
SEM-HOMO	0 [0-0] *0*	0 [0-.08] *.01*	0 [0-.08] *.01*	0 [0-0] *0*	0 [0-.09] *.01*	0 [0-0] *0*
SEM-SEG liaison	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*
SEM-SEG no liaison	0 [0-.08] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-.08] *.01*	0 [0-0] *0*

Mdn: Median, trimM: trimmed mean, SEM-HOMO: Homophone errors (within the same grammatical category), SEM-SEG- liaison: Segmentation errors (related to a ''liaison''), SEM-SEG no liaison: Segmentation errors (not related to a ''liaison'')

Mixed errors.

Mixed errors were a combination of errors at the overlap between different error types. As shown in Table 7-8, they were rare in French, but occurred frequently in words produced by the DLD and SA groups. Differences were evident across language and groups.

Language comparisons. There was a large and significant language difference (W = 386.5, p < .001, r = .65). Overall, English children produced a higher rate of mixed errors (*Mdn* = .17, range 0-.58) than their French peers, who produced hardly any (*Mdn* = 0, range 0-.18). This language difference was significant in the DLD (W = 285.5, p < .001, r = .86) and SA groups (W = 281, p < .001, r = .83) but not in the CA group (W = 185, p = .051, r = .33) where English children (*Mdn* = 0, range 0-.25) as well as French children (*Mdn* = 0, range 0-.18) produced a marginal rate of mixed errors.

Subgroup comparisons. Subgroups differences only appeared in English, where children with DLD produced a higher rate of mixed errors (*Mdn* = .33, range .08-.58) than both their CA (*Mdn* = 0, range 0-.25, W = 12, p < .001, r = .80) and SA peers (*Mdn* = .17, range .08-.33, W = 61.5, p = .004, r = .50). EN-SA controls also produced a higher rate of mixed errors than EN-CA controls (W = 256.5, p <.001, r = .68).

Specific errors types. Table 7-13 presents a summary of the mixed errors and non-codable errors, per specific error type and subgroup. Although non-codable errors were not considered as mixed errors in the analysis, they are also reported here for transparency. Within the mixed category, errors were present:

- In the EN-DLD and EN-SA subgroups, with orthographically-constrained graphemes, affecting phonology (PHON-ORTH)
- in the EN-DLD group with morphological markers affecting phonology (PHON-MOR)
- in English, with grammatical homophones (MOR-SEM)
- in English, with word choice (near-homophone or use of another word affecting both phonology and semantics – PHON-SEM)

- in the EN-SA and EN-DLD with rule-constrained inflections and derivations (MOR-ORTH)

In the DLD and SA samples, there were more occurrences of non-codable errors (unreadable or too remote from target) than in the CA groups.

Table 7-13: Error types within the mixed and non-codable errors, per language and subgroup, in the 12 dictated words

Mdn [range] ***trimM***	**FR-CA**	**EN-CA**	**FR-DLD**	**EN-DLD**	**FR-SA**	**EN-SA**
PHON-ORTH	0 [0-.09] *0*	0 [0-.08] *.01*	0 [0-.08] *.01*	.17 [0-.25] *.12*	0 [0-.09] *.01*	0.08 [0-.25] *.09*
PHON-MOR	0 [0-0] *0*	0 [0-0] *0*	0 [0-.08] *0*	.08 [0-.27] *.09*	0 [0-0] *0*	0 [0-.17] *.01*
PHON-SEM	0 [0-0] *0*	0 [0-.17] *.01*	0 [0-.08] *0*	0 [0-.17] *.02*	0 [0-0] *0*	0 [0-.08] *.01*
MOR-ORTH	0 [0-0] *0*	0 [0-0] *0*	0 [0-0] *0*	0 [0-.08] *.01*	0 [0-0] *0*	0 [0-.08] *.01*
MOR-SEM	0 [0-.09] *0*	0 [0-.08] *.02*	0 [0-0] *0*	.08 [0-.17] *.07*	0 [0-0] *0*	.08 [0-.08] *.06*
Non-codable	0 [0-.09] *0*	0 [0-0] *0*	0 [0-1] *.01*	0 [0-.18] *.03*	0 [0-.18] *.01*	0 [0-.17] *0*

Mdn: Median, trimM: trimmed mean, PHON -ORTH: Error with orthographically-constrained graphemes affecting phonology, PHON-MOR: Error with a morphological marker affecting phonology, PHON-SEM: Wrong word choice: use of another word, affecting semantics and phonology, MOR-ORTH: Error with rule-constrained inflections and derivations, MOR-SEM: Use of a grammatical homophone

7.2.3. Summary: quality of spelling errors produced in the written texts and 12 dictated words

As shown in

Table 7-14, in a written narrative task, French children produced a higher rate of morphological and semantic errors than their English peers. By contrast, in a constrained word dictation, qualitative differences appeared in the morphological and mixed categories, with French children producing a higher rate of morphological errors and English children producing a higher rate of mixed errors. This is consistent with the fine-grained coding, which revealed that the rate of morphological errors was largely driven by errors with inflectional morphology, whilst semantic errors largely related to word segmentation errors, present only in text. Mixed errors, on the other hand, were largely related to rule constrained phoneme-grapheme correspondences in English. Orthographic errors in both languages related largely to unpredictable and silent letters, and to long and unstressed vowels in English, whilst the application of spelling rules remained difficult in French.

Children with DLD and SA peers produced similar rates of errors in all categories except mixed errors in English, where the error rate was higher in the DLD than in the SA groups. The fine-grained coding revealed that the difficulties of English children with DLD as compared to their SA peers were largely to do with morphological endings omissions. This was apparent only in word dictation. In all other categories, children with DLD continued experiencing difficulties similar to those of younger peers, such as phoneme omissions/substitutions and orthographically-constrained grapheme errors in English, and errors on irregular grapheme/silent letters, word segmentation and derived words in French.

In the French word dictation, phonological and orthographic error rates differentiated children with DLD and CA peers, whilst in text production, differences were evident in the phonological and morphological categories. In English, DLD error rates differed from that of CA peers in all categories but the semantic one, whilst they were similar across all categories in text production, where children could choose the words spelled. Children with DLD produced similar rates of errors to CA peers in the semantic category (where homophones

and segmentation errors were marginal in all groups), and the morphological category in text production (where error rates were equally high in all groups in French, and equally marginal in all groups in English).

Table 7-14: Summary results of the Wilcoxon sum-rank comparisons conducted for the qualitative analysis of spelling errors, in text production and word dictation

			PHON	ORTH	MOR	SEM	MIX
Text production		**EN vs FR**	=	=	FR > EN	FR > EN	=
	FR	**DLD vs CA**	DLD > CA	DLD > CA	=	=	=
		DLD vs SA	=	=	=	=	=
		SA vs CA	=	=	=	=	=
	EN	**DLD vs CA**	=	=	=	=	=
		DLD vs SA	=	=	=	=	=
		SA vs CA	=	SA > CA	=	=	SA > CA
12 dictated words		**EN vs FR**	=	=	FR > EN	=	EN > FR
	FR	**DLD vs CA**	DLD > CA	=	DLD > CA	=	=
		DLD vs SA	=	=	=	=	=
		SA vs CA	=	=	SA > CA	=	=
	EN	**DLD vs CA**	DLD > CA	DLD > CA	DLD > CA	=	DLD > CA
		DLD vs SA	=	=	=	NA	DLD > SA
		SA vs CA	SA > CA	SA > CA	SA > CA	=	SA > CA

7.3. The relation of text length to error rate and type

It was of interest to further assess whether text length related to spelling error rates overall or to specific categories of errors. A series of Spearman correlations with Holm-Bonferroni correction for multiple tests were run, in French and English, to assess potential relations. Results are presented in Table 7-15 below. Text accuracy related to text length in both languages, indicating longer texts were also more accurate. None of the error types significantly related to text length in French. However, the percentage of mixed errors negatively correlated with text length in English, indicating shorter texts contained more of this error type. In English, the proportion of phonological, orthographic and mixed errors negatively correlated with text accuracy: more of these error types were found in less accurate texts. In French, accuracy negatively correlated with the proportion of orthographic errors only. Semantic errors in French were related to phonological errors, whilst orthographic errors were related to morphological ones. In English, only orthographic and mixed errors were related.

Table 7-15: Correlation table for the productivity, accuracy and error types measures

		English								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	**N Words**		.99***	.59***	.59***	.03	-.23	.05	.06	-.43*
2	**N Graph**	.98***		.60***	.60***	.02	-.24	.05	.04	-.46*
3	**Corr Words (%)**	.68***	.68***		.96***	-.47*	-.66***	-.30	-.19	-.73***
4	**Corr Graph (%)**	.62***	.64***	.95***		-.51***	-.62***	-.34	-.18	-.70***
5	**PHON**	-.10	-.11	-.15	-.16		.27	.33	.09	.13
6	**ORTH**	-.26	-.28	-.45*	-.50*	.25		.25	.08	.45*
7	**MOR**	-.03	-.02	-.19	-.14	.10	.47*		.10	.14
8	**SEM**	-.27	-.25	-.42	-.41	.44*	.35	.17		.11
9	**MIX**	.02	.04	-.27	-.32	.30	.26	.32	.10	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
		French								

*Notes: Significance levels of Spearman correlations are indicated as follows: *p < .05, **p<.01, *** p<.001, p-values were corrected for multiple tests using Holm-Bonferroni procedure (rcorr.adjust() function in the RcmdrMisc package (Fox, 2018));* 1. *N Words: number of words attempted; 2. N graph: number of graphemes attempted; 3. Corr Words: Proportion of correct words; 4. Corr Graph: Proportion of correct graphemes; 5. PHON: proportion of phonological errors on the total number of words attempted; 6. ORTH: Proportion of orthographic errors on the total number of words attempted; 7. MOR: Proportion of morphological errors on the total number of words attempted; 8. SEM: Proportion of semantic errors on the total number of words attempted; 9. MIX: Proportion of mixed errors on the total number of words attempted.*

Chapter 8. Spelling strategies across language and groups

Chapter 8 assesses the effect of language and DLD on spelling strategies, as outlined in Figure 8-1.

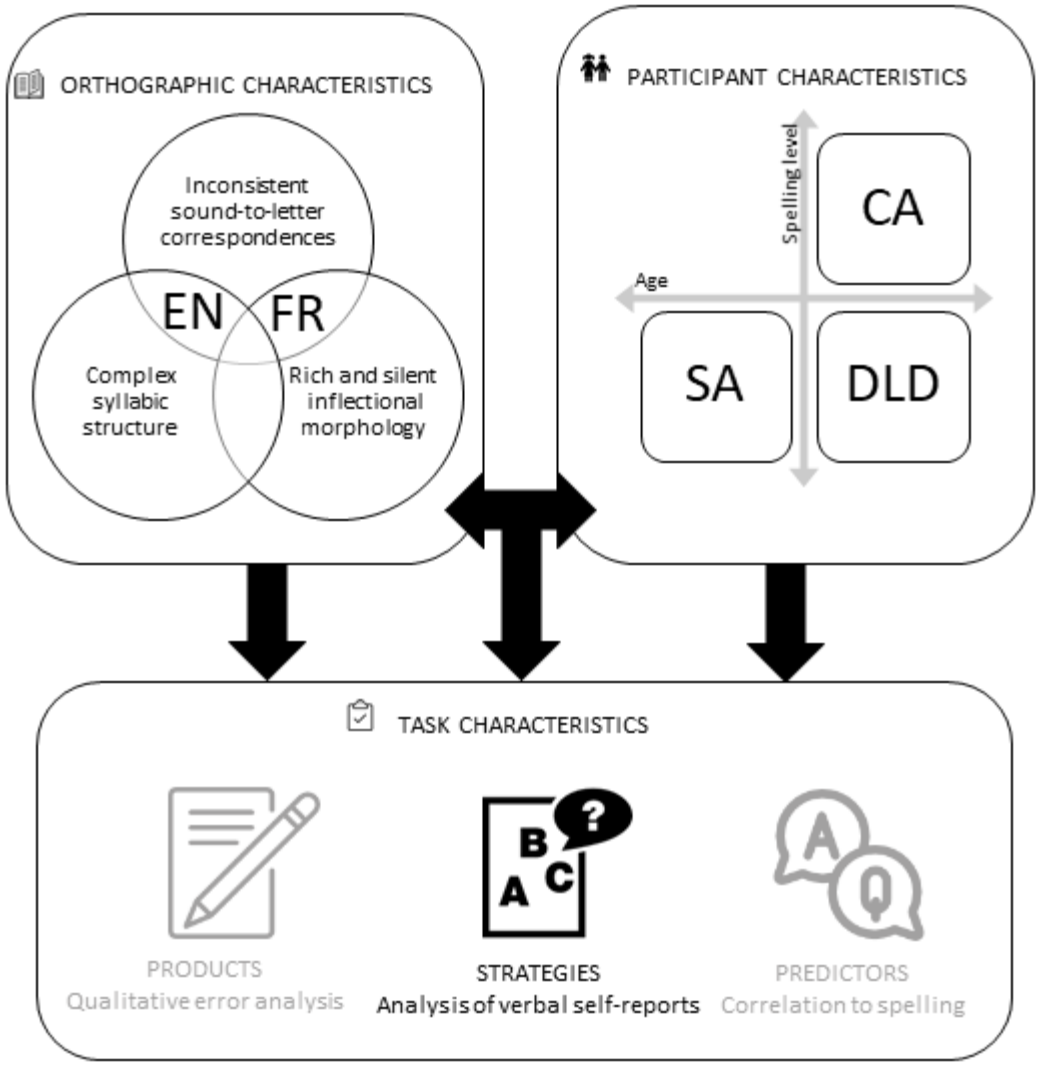

Figure 8-1: Outline of the thesis with a focus on spelling strategies.

8.1. Proportion of children using the different strategies within groups

Spelling strategies on twelve of the WIAT words were elicited as described in the methods chapter. They were coded in one of four categories, as detailed in 6.6. In the following section, the number of children who reported each strategy type at least once was compared across groups. This measure tells us about the range of strategy use in the different groups. It also tells us which strategies, if any, are more or less likely to be reported in certain groups. Pearson's Chi-Squares were run to explore whether a) French children were more or less likely to report certain strategy types than English children, b) within each language, which subgroups were more or less likely to report certain strategy types. A Bonferroni adjustment for multiple comparisons was applied, setting the significance level at $p < .005$ for all tests (Chen et al., 2017). Strategies are firstly broken down into phonological, orthographic, morphological and semantic strategies, and then further detailed depending on the specific type of knowledge used: phoneme-based, rime-based or syllable-based strategies at the phonological level; retrieval, memorisation, rule-based or analogy-based strategies at the orthographic level; derivation- or inflection- based strategies at the morphological level; and homophone distinctions at the semantic level. Table 8-1 gives the percentage of children, within each language and group, who reported the strategy type at least once, for all the different strategies coded as detailed in Table 6-16.

Table 8-1: Summary of Pearson's Chi-squares for the proportion of children using the strategy at least once within each group

	CA		DLD		SA		Language x number of children				Subgroup x number of children			
	FR	**EN**	**FR**	**EN**	**FR**	**EN**	***χ2***	***df***	***p***	***Odds Ratio***	***χ2***	***df***	***p***	***Odds Ratio***
N (children)	16	15	16	16	17	17								
PHON (%)	100	100	100	88	94	100	0.37	1	.55		FR: 1.92 EN: 4.17	2 2	.38 .12	
PHON-general (%)	56	33	50	56	35	76	0.84	1	.36		FR: 1.54 EN: 6.03	2 2	.46 .05	EN: SA>CA: 6.08 [1.11, 41.17]
PHON-phoneme (%)	88	93	63	81	94	100	2.1	1	.15		FR: 6.04 EN: 3.87	2 2	.05 .14	FR: DLD<SA: 0.11 [0.01, 1.12]
PHON-syllable (%)	81	67	69	38	53	6	9.9	1	.002*	EN<FR: 0.27 [0.11, 0.67]	FR: 3.02 EN: 12.9	2 2	.22 .002*	 EN : DLD>SA : 9.99 [0.89, 467] EN : SA<CA : 0.04 [0.01, 0.35]
PHON-rime (%)	25	13	6	25	6	41	3.39	1	.07		FR: 3.60 EN: 3.18	2 2	.17 .20	
ORTH (%)	100	100	100	100	100	100	-	-	-	-	-	-	-	-
ORTH-retrieval (%)	88	100	81	94	94	88	1.04	1	0.31		FR: 1.27 EN: 1.88	2 2	.53 .39	
ORTH-memorisation (%)	88	93	94	81	94	88	0.49	1	.48		FR: 0.60 EN: 1.05	2 2	.74 .59	
ORTH-regularity (%)	81	93	63	75	65	82	2.61	1	.11		FR: 1.59 EN: 1.89	2 2	.45 .39	
ORTH-rule (%)	94	93	56	25	82	29	9.12	1	.003*	EN<FR: 0.27 [0.10, 0.69]	FR: 6.81 EN: 18.1	2 2	.03 <.001*	FR: DLD<CA: 0.09 [0.01, 0.91] EN: DLD<CA: 0.03 [0.01, 0.28] EN : SA<CA: 0.03 [0.01, 0.33]

	CA		DLD		SA		Language x number of children				Subgroup x number of children			
	FR	**EN**	**FR**	**EN**	**FR**	**EN**	***χ2***	***df***	***p***	***Odds Ratio***	***χ2***	***df***	***p***	***Odds Ratio***
MOR (%)	100	100	50	50	71	94	0.84	1	.36		FR: 10.4	2	.006	FR : DLD<CA : -
														FR : SA<CA : -
											EN: 15.6	2	<.001*	EN : DLD<CA : -
														EN : DLD<SA : 0.07 [0.01, 0.65]
MOR-derivation (%)	81	80	25	31	41	59	0.51	1	.47		FR: 10.8	2	.005	FR: DLD<CA: 0.08 [0.01, 0.52]
														FR: SA<CA: 0.17 [0.02, 0.96]
											EN: 7.55	2	.02	EN: DLD<CA: 0.12 [0.02, 0.73]
MOR-inflection (%)	100	93	44	50	65	82	0.38	1	.54		FR: 12.2	2	.002*	FR: DLD<CA: -
														FR: SA<CA: -
											EN: 8.51	2	.01	EN: DLD<CA: 0.08 [0.02, 0.75]
														EN: DLD<SA: 0.22 [0.03, 1.28]
SEM (%)	100	100	56	50	76	47	1.99	1	.16		FR: 8.81	2	.01	FR : DLD<CA : -
														FR : SA<CA : -
											EN: 12.0	2	.002*	EN : DLD<CA : -
														EN : SA<CA : -
OTHER (%)	50	60	81	100	76	76	1.27	1	.27		FR: 4.29	2	.12	
											EN: 7.63	2	.02	EN : CA<DLD : 0.09 [0.01, 0.52]
														EN : CA<SA : 0.17 [0.02, 0.96]
Asking-dictionary (%)	25	7	31	6	12	6	5.15	1	.02	EN<FR: 0.23 [0.04, 0.97]	FR: 1.89	2	.39	
											EN: 0.01	2	.99	
No Response (%)	44	60	75	100	76	76	2.32	1	.13		FR: 4.88	2	.09	EN : CA<DLD : -
											EN: 7.63	2	.02	EN : SA<DLD: -

8.1.1. Percentage of children reporting phonological strategies

Relation to languages and subgroups. Most children (97%) used a phonological strategy at least once, regardless of their language ($\chi^2(1) = 0.37$, $p = .55$) and subgroup (FR: $\chi^2(2) = 1.92$, $p = .38$; EN: $\chi^2(2) = 4.17$, $p = .12$). Only one child in the FR-SA subgroup and two children in the EN-DLD subgroup did not use this strategy at all.

Fine-grained strategy breakdown. Reports of general sounding out ($\chi^2(1) = 0.84$, $p = .36$), phoneme-based ($\chi^2(1) = 2.10$, $p = .15$) and rime-based strategies ($\chi^2(1) = 3.39$, $p = .07$) did not vary with language. However, syllable-based strategies ($\chi^2(1) = 9.90$, $p = .002$) were more likely reported in the French sample (67%) than in the English one (35%, *OR* = 0.27 [0.11, 0.67]). In French, reports of general ($\chi^2(2) = 1.54$, $p = .46$), rime-based ($\chi^2(2) = 3.60$, $p = .17$), syllable-based strategies ($\chi^2(2) = 3.02$, $p = .22$) and phoneme-based strategies ($\chi^2(2) = 6.04$, $p = .05$) did not vary with the subgroup. In English, reports of general sounding-out ($\chi^2(2) = 6.03$, $p = .05$), phoneme-based ($\chi^2(2) = 3.87$, $p = .14$) and rime-based ($\chi^2(2) = 3.18$, $p = .20$) strategies did not vary with the subgroup. However, older TD children were more likely to report syllable-based strategies (66%) than younger SA TD peers (6%, $\chi^2(1) = 13.05$, $p < .001$, *OR* = 0.04 [0.0007, 0.35]).

8.1.2. Percentage of children reporting orthographic strategies

Relation to languages and subgroups. All children (100%) used an orthographic strategy at least once, regardless of their language and subgroup.

Fine-grained strategy breakdown. Reports of automatic retrieval ($\chi^2(1) = 1.04$, $p = .31$), memorisation ($\chi^2(1) = 0.49$, $p = .48$) and analogical strategies ($\chi^2(1) = 2.61$, $p = .11$) did not depend on language. However, French students were more likely to report rule-based strategies (78%) than English students (48%, $\chi^2(1) = 9.12$, $p = .003$, *OR* = 0.27 [0.10, 0.69]). In French, reports of automatic retrieval ($\chi^2(2) = 1.27$, $p = .53$), memorisation ($\chi^2(2) = 0.60$, $p = .74$) and analogical strategies ($\chi^2(2) = 1.59$, $p = .45$) and rule-based strategies ($\chi^2(2) = 6.81$, p

= .03) did not vary with subgroups. In English, reports of automatic retrieval ($\chi^2(2) = 1.88$, $p = .39$), memorisation ($\chi^2(2) = 1.05$, $p = .60$) and analogical strategies ($\chi^2(2) = 1.90$, $p = .39$) did not vary with subgroups. However, children with DLD (25%, $\chi^2(1) = 14.85$, $p < .001$, $OR = 0.03$ [0.0005, 0.28]) and SA peers (29%, ($\chi^2(1) = 13.50$, $p < .001$, $OR = 0.034$ [0.0007, 0.33]) were less likely to report rule-based strategies than CA peers (93%).

8.1.3. Percentage of children reporting morphological strategies

Relation to languages and subgroups. Most children (77%) used a morphological strategy at least once. This was the case in both the French (73%) and the English (81%) samples ($\chi^2(1) = 0.84$, $p = .36$). However, there were differences in the proportion of children reporting morphological strategies between subgroups. In French, children with DLD were less likely (50%) to report a morphological strategy than their CA (100%, $\chi^2(1) = 10.67$, $p = .001$) but not SA peers (71%, $\chi^2(1) = 1.46$, $p = .23$). In English, children with DLD were less likely (50%) to report a morphological strategy than both their CA (100%, $\chi^2(1) = 10.11$, $p = .001$) and SA peers (94%, $\chi^2(1) = 8.09$, $p = .004$, $OR = 0.07$ [0.001, 0.65]). It is also important to note that report rates of morphological strategies in the English SA group approached those of CA peers ($\chi^2(1) = 0.91$, $p = .33$). This was not the case in French ($\chi^2(1) = 5.55$, $p = .02$).

Fine-grained strategy breakdown. Reports of strategies using derivational ($\chi^2(1) = 0.51$, $p = .47$) and inflectional ($\chi^2(1) = 0.38$, $p = .54$) morphology did not vary with language. However, there were subgroup differences within each language. In French, children with DLD (25%, $\chi^2(1) = 10.16$, $p = .001$) were less likely to report using a strategy involving derivational morphology than their CA peers (81%), with an odds ratio of 0.08 (0.01, 0.52). Furthermore, children with DLD (43%, $\chi^2(1) = 9.89$, $p = .002$) were less likely to report using strategies involving inflectional morphology than CA peers, who all evoked inflectional morphology (100%). In English, children with DLD (31%) were less likely to report using strategies involving

derivational morphology than their CA peers (80%, $\chi^2(1) = 7.43$, $p = .006$), with an odds ratio of 0.12 (0.01, 0.73).

8.1.4. Percentage of children reporting semantic strategies

Relation to languages and subgroups. Most children (71%) reported a semantic strategy at least once. This was the case in both the French (77%) and English (65%) samples ($\chi^2(1) = 1.99$, $p = .16$). However, there were differences in the proportion of children reporting semantic strategies between subgroups. In French, children with DLD were less likely (50%) to report a semantic strategy than their CA (100%, $\chi^2(1) = 8.96$, $p = .003$) but not SA peers (76%, $\chi^2(1) = 1.52$, $p = .22$). In English, the same pattern was observed, with children with DLD less likely to report semantic strategies (50%, $\chi^2(1) = 10.11$, $p = .001$) than CA (100%) but not SA peers (47%, $\chi^2(1) = 0.03$, $p = .87$). It is also important to note that in both languages, reports of semantic strategies in the younger SA group differed from that of the older CA peers (FR: $\chi^2(1) = 4.28$, $p = .04$; EN: $\chi^2(1) = 11.05$, $p < .001$).

Semantic strategies were all related to homophone distinctions and were not further broken down.

8.1.5. Percentage of children reporting no response or an irrelevant response

Relation to languages and subgroups. A majority of children (74%) gave a response coded as "other" at least once. This was the case in both French (69%) and English (79%, $\chi^2(1) = 1.21$, $p = .27$). In French, there were no subgroup variations in the rate of such strategy reports ($\chi^2(2) = 4.29$, $p = .12$). In English, all children with DLD (100%) had at least one response coded in this category, against 60% in the CA group ($\chi^2(1) = 7.94$, $p = .005$) and 76% in the SA group ($\chi^2(1) = 4.28$, $p = .04$). All variations in this "other" category were related to instances of no response, the rate of responses suggesting dictionary- or adult-checking being marginal (11 children in French, three children in English).

8.2. Proportion of strategies reported in each category in the different groups

In the following section, results are presented for the number of strategies of each type within each group's reports. This measure tells us about the rate of each strategy use in the different groups. It also tells us which strategies, if any, are more or less frequently used in some groups than in others. Again, Pearson's Chi-Squares were run to explore whether a) French children were more or less likely to report some strategy types than English children, b) within each language, which subgroups were more or less likely to report certain strategy types. A Bonferroni adjustment for multiple comparisons was applied, setting the significance level at $p < .005$ for all tests (Chen et al., 2017). Strategies are firstly broken down into phonological, orthographic, morphological and semantic strategies, and then further detailed depending on the specific type of knowledge used: phoneme-based, rime-based or syllable-based strategies at the phonological level; retrieval, memorisation, rule-based or analogy-based strategies at the orthographic level; derivation- or inflection- based strategies at the morphological level; and homophone distinctions at the semantic level. Table 8-3 gives the percentage of strategies, within each language and group, reported in each category, according to the coding detailed in Table 6-16.

8.2.1. Number of strategies reported per language and subgroup

Before comparing strategy rates across groups and language, the mean number of strategies reported per child was compared across group and language, as well as the mean number of strategies given in first intention (before any prompting) and the mean number of different strategies used per child. Table 8-2 shows the summary of these measures as well as an indication of the amount of prompting used in each group. Robust ANOVAs revealed that children with DLD and SA peers reported a similar number of strategies ($p = .17$) but they both reported fewer strategies than their CA peers ($F = 73.68$, $p < .001$, $\xi = 0.91$ [0.76-0.99]). The pattern was the same for the number of strategies generated before prompting, with no

difference between the DLD and SA groups (p = .25) but a group effect with SA and DLD reporting fewer strategies than CA in the first instance (F = 67, p < .001, ξ = 0.11 [0-0.38]). Finally, the number of different strategies elicited during the task followed a similar pattern, with CA children producing a wider range of strategies than their DLD and SA peers (F = 28.29, p = .001, ξ = 0.76 [0.61-0.94]), who generated a similar diversity (p = .13). Despite concerns that children with DLD may generate fewer strategies and receive more prompting, productivity and breadth measures were actually similar in the DLD and SA groups, before and after prompting. The analysis per strategy type was thus pursued with the full set of strategies reported, before and after prompting. Table 8-3 presents a summary of the strategy counts and Pearson's Chi-squares further conducted on the full set of strategies.

Table 8-2: Summary measures for the productivity and breadth of strategies generated in each subgroup

	CA		**DLD**		**SA**	
	FR	**EN**	**FR**	**EN**	**FR**	**EN**
M(SD) strategies given for the 12 words	29.6 (4.6)	30.2 (7.1)	19.1 (7.3)	17 (5.7)	21.2 (6)	20.2 (4.4)
M(SD) strategies given before prompts	28.1 (5.0)	28.0 (7.2)	17.0 (5.5)	16.5 (5.3)	19.9 (5.9)	18.2 (5.3)
M(SD) different target strategies generated	11 (1)	10.7 (1.2)	7.9 (2.6)	8.1 (2.4)	9.2 (1.9)	8.9 (1.6)
N prompts given altogether in each group	12	19	26	23	12	29

Notes: In this table strategies were counted after excluding those classified as ''other'' (i.e. they only include target strategies relating to phonological, orthographic, morphological or semantic knowledge).

Table 8-3: Summary of Pearson's Chi-squares for the proportion of each strategy type reported within each group

	CA		DLD		SA		Language x number of strategies				Subgroup x number of strategies			
	FR	**EN**	**FR**	**EN**	**FR**	**EN**	***χ2***	***df***	***p***	***Odds Ratio***	***χ2***	***df***	***p***	***Odds Ratio***
N (strategies)	496	488	374	376	394	407								
PHON (%)	22	21	22	31	23	33	10.4	1	.001*	FR<EN: 0.74 [0.62, 0.89]	FR: 0.08 EN: 18.5	2 2	.96 <.001*	 EN : DLD>CA : 1.71 [1.24, 2.36] EN : SA>CA : 1.84 [1.34, 2.51]
PHON-general (%)	5	2	6	6	3	5	0.50	1	.48		FR: 3.86 EN: 6.02	2 2	.15 .049	 EN: DLD>CA: 2.34 [1.08, 5.34] EN: SA>CA: 2.05 [0.94, 4.66]
PHON-phoneme (%)	9	15	9	21	12	24	40.14	1	<.001*	FR<EN: 0.48 [0.38, 0.61]	FR: 3.14 EN: 22.02	2 2	.21 <.001*	 EN: DLD>CA: 1.86 [1.27, 2.73] EN: SA>CA: 2.25 [1.56, 3.25]
PHON-syllable (%)	7	5	7	2	7	0.2	22.52	1	<.001*	FR>EN: 2.53 [1.68, 3.88]	FR: 0.07 EN: 21.20	2 2	.96 <.001*	 EN: DLD<CA: 0.44 [0.18, 0.98] EN: SA<DLD: 0.10 [0.002, 0.73] EN: SA<CA: 0.04 [.001, 0.27]
PHON-rime (%)	1	0.6	0.3	2	0.3	3	9.34	1	.002*	FR<EN: 0.29 [0.10, 0.70]	FR: 3.06 EN: 8.13	2 2	.22 .02	 EN: SA>CA: 5.32 [1.45, 29.35]
ORTH (%)	43	52	48	33	54	39	8.06	1	.004*	FR>EN: 1.26 [1.07, 1.48]	FR: 10.1 EN: 35.7	2 2	.006* <.001*	FR : SA>CA : 1.54 [1.17, 2.02] EN : DLD<CA : 0.45 [0.33-0.59] EN : SA<CA : 0.58 [0.44, 0.76]
ORTH-retrieval (%)	10	14	14	12	13	11	0.003	1	.96		FR: 3.30 EN: 1.24	2 2	.19 .54	

	CA		DLD		SA		Language x number of strategies				Subgroup x number of strategies			
	FR	**EN**	**FR**	**EN**	**FR**	**EN**	***χ2***	***df***	***p***	***Odds Ratio***	***χ2***	***df***	***p***	***Odds Ratio***
ORTH-memorisation (%)	10	19	21	13	24	16	0.56	1	.45		FR: 38.38	2	<.001*	FR: DLD>CA: 2.42 [1.61, 3.65] FR: CA>SA: 3.00 [2.03, 4.48]
											EN: 6.15	2	.046	EN: DLD<CA: 0.62 [0.41, 0.62]
ORTH-analogy/regularity (%)	10	10	7	6	7	10	0.002	1	.97		FR: 3.97	2	.14	
											EN: 5.84	2	.054	EN: DLD<CA: 0.54 [0.30, 0.94] EN: SA>DLD: 1.79 [1.00, 3.27]
ORTH-rule (%)	13	10	6	2	9	2	18.53	1	<.001*	FR>EN: 1.96 [1.42, 2.73]	FR: 12.39	2	.002*	FR: DLD<CA : 0.41 [0.23, 0.70] FR: SA>DLD: 1.74 [0.97, 3.20]
											EN: 39.64	2	<.001*	EN : DLD<CA : 0.20 [0.08, 0.42] EN : SA<CA : 0.18 [0.07, 0.39]
MOR (%)	21	12	7	5	8	9	7.72	1	.005*	FR>EN: 1.42 [1.10, 1.85]	FR: 54.89	2	<.001*	FR: DLD<CA: 0.26 [0.16, 0.42] FR: SA<CA: 0.30 [0.19, 0.47]
											EN: 12.27	2	.002*	EN: SA>DLD: 1.82 [1.02, 3.39] EN: DLD<CA: 0.40 [0.22, 0.69]
MOR-derivation (%)	6	4	2	2	3	4	0.74	1	.39		FR: 11.38	2	.003*	FR: DLD<CA: 0.35 [0.15, 0.78] FR: SA<CA: 0.42 [0.19, 0.86]
											EN: 2.86	2	.24	
MOR-inflection (%)	15	8	4	3	5	5	7.42	1	.006	FR>EN: 1.52 [1.11, 2.10]	FR: 41.14	2	<.001*	FR: DLD<CA: 0.26 [0.14, 0.45] FR: SA<CA: 0.29 [0.16, 0.19]
											EN: 9.89	2	.007	EN: DLD<CA: 0.37 [0.17, 0.73]
SEM (%)	9	7	5	3	7	3	7.04	1	.008	FR>EN: 1.57 [1.10, 2.25]	FR: 5.31	2	.07	FR: DLD<CA: 0.52 [0.28, 0.94]
											EN: 11.49	2	.003*	EN: DLD<CA: 0.39 [0.18, 0.80] EN: SA<CA: 0.43 [0.20, 0.84]

	CA		DLD		SA		Language x number of strategies				Subgroup x number of strategies			
	FR	**EN**	**FR**	**EN**	**FR**	**EN**	***χ2***	***df***	***p***	***Odds Ratio***	***χ2***	***df***	***p***	***Odds Ratio***
OTHER (%)	4	7	18	28	9	16	20.81	1	<.001*	FR<EN: 0.58 [0.45, 0.74]	FR: 44.92	2	<.001*	FR: DLD>CA: 4.56 [2.74, 7.84] FR: SA<DLD: 0.43 [0.27, 0.67] FR: SA>CA: 1.94 [1.09, 3.52]
											EN: 66.45	2	<.001*	EN: SA<DLD : 0.49 [0.34, 0.70] EN : DLD>CA : 4.93 [3.23, 7.69] EN : SA>CA : 2.41 [1.53, 3.85]
Asking-dictionary (%)	1	0.2	2	0.3	0.5	0.7	5.10	1	.02	FR>EN: 3.04 [1.05, 10.72]				
No Response (%)	3	7	17	27	8	15	28.07	1	<.001*	FR<EN: 0.52 [0.40, 0.67]	FR: 48.08	2	<.001*	FR: DLD>CA: 5.95 [3.31, 11.26] FR: SA<DLD: 0.45 [0.27, 0.71] FR: SA>CA: 2.65 [1.38, 5.25]
											EN: 67.53	2	<.001*	EN: DLD>CA: 5.03 [3.27, 7.87] EN: SA<DLD: 0.47 [0.32, 0.67] EN: SA>CA: 2.35 [1.48, 3.78]

8.2.2. Percentage of phonological strategies

Relation to languages and subgroups. Phonological strategies represented 27% of the total strategies in English and 22% in French. In French, phonological strategies were less frequently reported than in English ($\chi^2(1) = 10.40$, $p = .001$) with an odds ratio of 0.74 [0.62, 0.89]. In French, there were no group variations in the rate of phonological strategy reports ($\chi^2(2) = 0.08$, $p = .96$). In English, report rates were higher in the DLD ($\chi^2(1) = 1.71$, $p < .001$, *OR* = 1.71) and in the younger SA group ($\chi^2(1) = 15.89$, $p < .001$, *OR* = 1.84 [1.34, 2.51]) than in the older CA group.

Fine-grained strategy breakdown. French children were less likely to report phonological strategies based on phoneme parsing ($\chi^2(1) = 40.14$, $p < .001$, *OR* = 0.48 [0.38, 0.61]) and rimes ($\chi^2(1) = 9.34$, $p = .002$, *OR* = 0.29 [0.10, 0.69]) than English children. However, French children were more likely to report phonological strategies based on syllabic parsing ($\chi^2(1) = 22.52$, $p < .001$, *OR* = 2.53 [1.69, 3.88]).

In French, no group variations were observed in the rate of phoneme-, rime-, syllable-based and general phonological strategies. However, in English, SA peers ($\chi^2(1) = 21.13$, $p < .001$, *OR* = 2.25 [1.56, 3.25]) reported phoneme-based strategies more often than CA peers and CA peers reported these strategies more often than children with DLD ($\chi^2(1) = 11.33$, $p < .001$, *OR* = 1.86 [1.27, 2.73]). SA children ($\chi^2(1) = 8.41$, $p = .003$, *OR* = 5.32 [1.45, 29.35]) were also more likely to report using rimes than CA peers. Syllabic chunking strategies were marginal in the English sample, with no significant subgroup variation.

8.2.3. Percentage of orthographic strategies

Relation to languages and subgroups. Orthographic was the most common strategy in both languages. It represented 42% of the total strategies in English and 48% in French. In French, orthographic strategies were more frequently reported than in English ($\chi^2(1) = 8.29$, $p = .004$) with an odds ratio of 1.26 [1.07, 1.48]. In French, younger SA peers reported a higher rate of

orthographic strategies than their older CA peers ($\chi^2(1) = 10.10$, $p = .002$, *OR* = 1.54 [1.17, .02]). In English, children with DLD ($\chi^2(1) = 32.71$, $p < .001$, *OR* = 0.45 [0.34, 0.59]) and SA peers ($\chi^2(1) = 16.01$, $p < .001$, *OR* = 0.58 [0.44, 0.77]) reported a lower rate of orthographic strategies than their CA peers.

Fine-grained strategy breakdown. There were no language variations in the rate of reports related to automatic retrieval ($\chi^2(1) = 0.01$, $p = .96$), memorisation ($\chi^2(1) = 0.56$, $p = .45$), and analogy strategies ($\chi^2(1) = 0.01$, $p = .96$). However, French children more frequently reported using rule-based strategies ($\chi^2(1) = 18.53$, $p < .001$, *OR* = 1.96 [1.42, 2.72]).

In French, memorisation strategies were more frequently reported in the DLD ($\chi^2(1) = 20.63$, $p < .001$, *OR* = 2.42 [1.61, 3.65]) and SA groups ($\chi^2(1) = 34.93$, $p < .001$, *OR* = 3.00 [2.03, 4.47]) than in the CA group. Rule-based strategies were also more likely reported in CA groups ($\chi^2(1) = 12.28$, $p < .001$, *OR* = 2.44 [1.44, 4.30]) than in the DLD group.

In English, rule-based strategies were less frequently reported in the DLD ($\chi^2(1) = 21.58$, $p < .001$, *OR* = 0.19 [0.08, 0.42]) and SA samples ($\chi^2(1) = 24.27$, $p < .001$, *OR* = 0.18 [0.07, 0.39]) than in the CA group. This was the only significant subgroup variation.

8.2.4. Percentage of morphological strategies

Relation to languages and subgroups. Morphological strategies represented 9% of the total strategies in English and 13% in French. In French, morphological strategies were more frequently reported than in English ($\chi^2(1) = 7.72$, $p = .006$) with an odds ratio of 1.43 [1.01, 1.85]. In French, both children with DLD ($\chi^2(1) = 35.96$, $p < .001$, *OR* = 0.26 [0.16, 0.42) and SA peers ($\chi^2(1) = 32.10$, $p < .001$, *OR* = 0.30 [0.19, 0.47]) reported less use of morphological strategies than CA peers. In English, children with DLD reported less use of morphological strategies than CA ($\chi^2(1) = 12.30$, $p < .001$, *OR* = 0.40 [0.22, 0.69]).

Fine-grained strategy breakdown. There was no language variation in the rate of reports of strategies involving derivational morphology ($\chi^2(1) = 0.74$, $p = .39$). However, strategies involving inflectional morphology were more likely reported in French than in English ($\chi^2(1) = 7.42$, $p = .006$, $OR = 1.53$ [1.11, 2.10]).

In French, strategies related to derivational morphology were less likely reported in the DLD ($\chi^2(1) = 7.77$, $p = .005$, $OR = 0.36$ [0.15, 0.77]) than in the CA group. The same pattern was observed in inflectional morphology, where reports were less frequent in the DLD ($\chi^2(1) = 26.03$, $p < .001$, $OR = 0.26$ [0.14, 0.45]) and SA groups ($\chi^2(1) = 23.92$, $p < .001$, $OR = 0.29$ [0.16, 0.49]) than in the CA group.

In English there were no group variations in the rate of reports related to derivational morphology. However, strategies related to inflectional morphology were less frequent in the DLD than in the CA group ($\chi^2(1) = 9.41$, $p = .002$, $OR = 0.37$ [0.17, 0.73]

8.2.5. Percentage of semantic strategies

Relation to languages and subgroups. Semantic strategies represented 5% of the total strategies in English and 7% in French. In French, semantic strategies were more frequently reported than in English ($\chi^2(1) = 7.04$, $p = .008$) with an odds ratio of 1.57 [1.11, 2.25]. In French, there was no significant group variation in the frequency of use of semantic strategies. In English, children with DLD ($\chi^2(1) = 7.60$, $p = .006$, $OR = 0.39$ [0.17, 0.80]) reported less use of semantic strategies than their CA peers.

Semantic strategies were all related to homophone distinctions and were not further broken down.

8.2.6. Percentage of children reporting no response or an irrelevant response

Relation to languages and subgroups. Responses coded as "other" represented 16% of the total strategies in English and 10% in French. In French, these responses were less frequent

than in English (χ^2(1) =20.81, p < .001) with an odds ratio of 0.58 [0.45, 0.74]. In French, children with DLD were more likely to report these than their SA (χ^2(1) =15.20, p < .001, *OR* = 2.35 [1.49, 3.77]) and CA peers (χ^2(1) =40.33, p < .001, *OR* = 4.56 [2.74, 7.84]).

Fine-grained strategy breakdown. French children were less likely to report not knowing the response or giving an irrelevant response (χ^2(1) = 28.07, p < .001, *OR* = 0.52 [0.40, 0.67]) than English peers.

In French, children with DLD were more likely to report not knowing the response than both CA (χ^2(1) = 46.57, p < .001, *OR* = 5.95 [3.32, 11.26]) and SA peers (χ^2(1) = 12.77, p < .001, *OR* = 2.25 [1.40, 3.66]).

A similar pattern was observed in English, where children with DLD more often reported not having an answer than their CA (χ^2(1) = 66.41, p < .001, *OR* = 5.03 [3.28, 7.87]) and SA peers (χ^2(1) = 18.17, p < .001, *OR* = 2.14 [1.48, 3.11]). SA also reported this type of response more frequently than CA peers (χ^2(1) = 15.05, p < .001, *OR* = 2.35 [1.48, 3.78]).

8.2.7. Summary: Strategy use for the different languages and subgroups

The prevalence of strategy use was assessed using two measures: the percentage of children reporting a strategy at least once and the total percentage of strategy counts within a group. Both measures highlighted the importance of syllable-based and rule-based strategies in French compared to English: more children reported these strategies in French than English and more of these strategies were counted within the French than in the English sample. Additionally, more semantic and inflection-based morphological strategies were counted in the French sample, whilst more phoneme-based and rime-based strategies were counted in English.

Cross-group differences were evident in the rate of children reporting morphological and semantic strategies. Fewer SA and DLD children reported morphological and semantic

strategies than their CA peers, especially in English. In English, there were also fewer children in the SA group reporting syllable and rule-based strategies than in the CA group. French and English children with DLD were less likely to resort to morphological strategies than CA peers. The rate of strategy reports within groups confirmed the importance of "sounding out" and phoneme-based strategies in English in the SA and DLD sample compared to CA peers. They also highlighted the relative weakness of children in the DLD and SA groups in using morphological, semantic and rule-based strategies. They further highlighted the overwhelming rate of no response in the group of children with DLD (27% of all DLD responses in English and 17% in French). Table 8-4 provides a summary of the significant chi-squares conducted to assess differences in frequency use in the different groups and categories, for the percentage of children reporting the strategy and the total percentage of strategies reported.

Table 8-4: Summary results of the Pearson's chi-squares conducted for the percentage of spelling strategies reported and percentage of children reporting these strategies, by strategy type

			PHON	ORTH	MOR	SEM	OTHER
% of children		**EN vs FR**	=	=	=	=	=
	FR	**DLD vs CA**	=	=	DLD < CA	=	=
		DLD vs SA	=	=	=	=	=
		SA vs CA	=	=	SA < CA	=	=
	EN	**DLD vs CA**	=	=	DLD < CA	DLD < CA	=
		DLD vs SA	=	=	DLD < SA	=	=
		SA vs CA	=	=	=	SA < CA	=
% of strategies		**EN vs FR**	EN > FR	FR > EN	FR > EN	=	EN > FR
	FR	**DLD vs CA**	=	=	DLD < CA	=	DLD > CA
		DLD vs SA	=	=	=	=	DLD > SA
		SA vs CA	=	SA > CA	SA < CA	=	SA > CA
	EN	**DLD vs CA**	DLD > CA	DLD < CA	DLD < CA	DLD < CA	DLD > CA
		DLD vs SA	=	=	DLD < SA	=	DLD > SA
		SA vs CA	SA > CA	SA < CA	=	SA < CA	SA > CA

Chapter 9. Predictors of spelling performance in French and English

Chapter 9 examines the linguistic predictors of spelling in French and English beyond Year 2 (age 7), as shown in Figure 9-1, using a sample and measures described in 6.2.3 and 6.3.

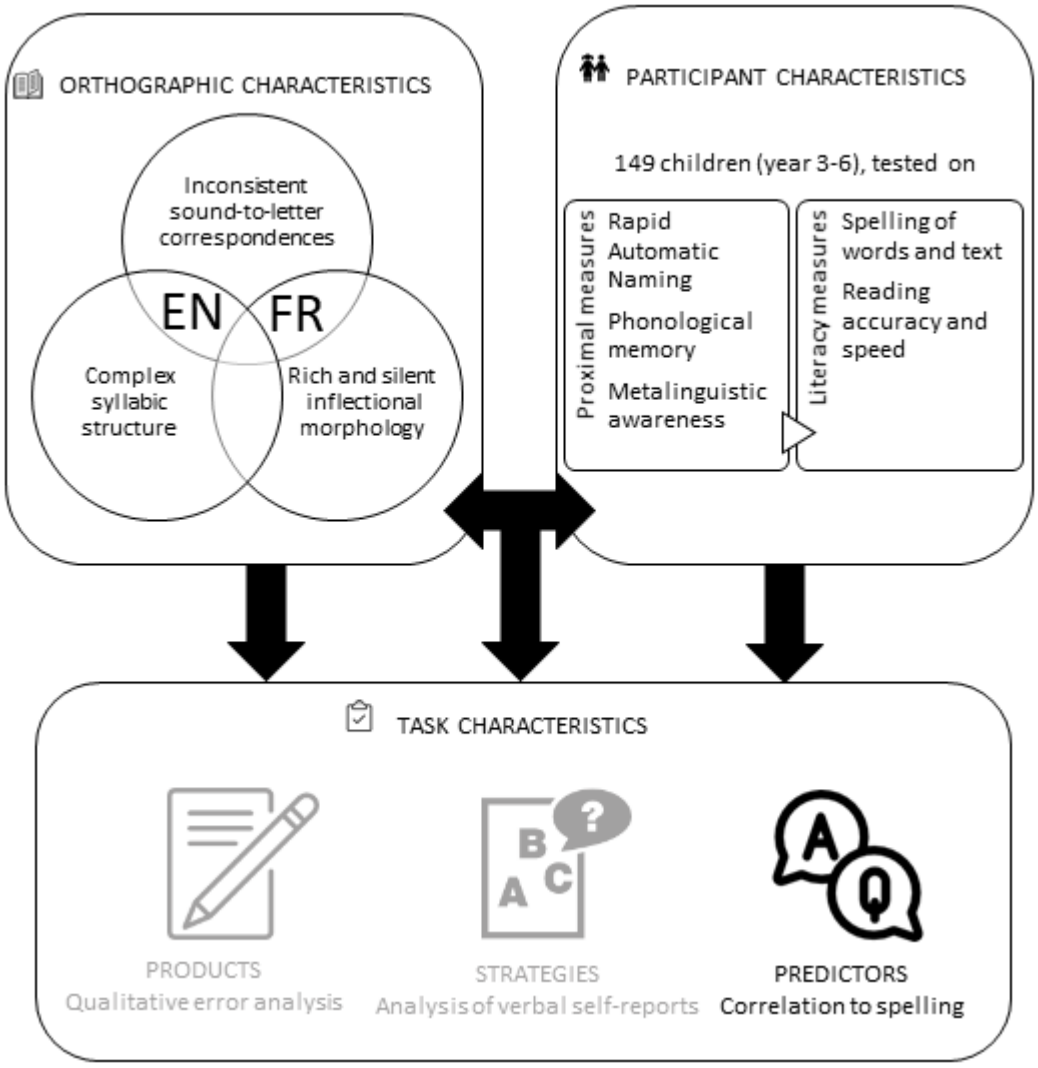

Figure 9-1: Outline of the thesis with a focus on predictors of spelling

9.1. Analytical approach

The analysis presented below was conducted on an extended sample of 149 participants (82 English and 67 French), who had received individual testing, and who were in at least their third year of schooling (see 6.2.3 for detail on participants selection and 6.3 for a description of the measures used in this chapter). Before analysis, all scores were converted to Z-scores. When norms were available for the test (standardised measures), individual children's scores were standardised against the mean and standard deviation for their age group. When no standardisation was available (bespoke measures), the mean and standard deviation of the typical sample for each country and age group were used as a norm-reference.

An exploratory principal component analysis (PCA) was conducted a) for all the literacy measures (spelling and reading measures) and b) for all the predictive measures (all metalinguistic awareness, RAN and phonological memory measures). The predictive value of specific metalinguistic components were assessed in this study, rather than the influence of overall language skills. Thus RAN, phonological awareness, morphological awareness and phonological memory tasks were used as predictive measures, rather than a broad language measure.

Correlation coefficients were then computed for the literacy and predictor measures of interest and for the composite scores obtained from the PCA. They were compared across languages. Spearman's correlations were used throughout the analysis to account for the non-normality of the data (e.g. ceiling effects on the phonological or inflections awareness tasks and skewness of the CBM spelling and reading speed measures).

A series of stepwise regression analyses were conducted, to assess predictors of spelling performance (in text and word dictation), using the composite scores computed during the PCA, as appropriate. For comparison, the model followed the stepwise approach of Moll et al. (2014), controlling for age and NVP differences in a first step, and then introducing the

factors derived from the component analysis. Models were built separately for French and English in the first instance. In order to assess the impact of language on predictors' weight in the model, language (French or English) was then introduced as an interaction term in the regression model including all children.

Table 9-1 summarises the sample characteristics and variables of interest, expressed in Z-score, for the French sample, for the English sample, and for all 149 children.

Table 9-1: Summary table of the variables considered in the present chapter

		EN (n = 82)				FR (n = 67)				ALL (n = 149)			
Sample Characteristics	**% monoling**			91.5				89.6				90.6	
	% male			46.3				53.7				49.7	
	% TD			63.4				73.1				67.8	
Measures	**Variable**	**M**	**SD**	**skew**	**kurt**	**M**	**SD**	**skew**	**kurt**	**M**	**SD**	**skew**	**kurt**
Control	**Age (yrs)**	9.44	1.08	-0.21	-0.12	9.95	0.81	-0.36	-0.68	9.67	1	-0.43*	0.02
	NVP	-0.03	1.08	-0.41	-0.29	0.29	0.98	-0.65*	0.65	0.12	1.05	-0.54**	0.11
	LangC	-0.65	0.94	0	-0.59	-0.7	1.21	-1.17***	1.01	-0.67	1.07	-0.79***	0.88*
Literacy	**WIAT**	-0.5	1.09	0.32	-0.71	-0.59	1.02	-0.4	-0.62	-0.54	1.05	0.03	-0.57
	CBM	0	0.98	-1.81***	3.75***	0	0.98	-0.83**	0.02	0	0.98	-1.38***	2.13***
	Read	-0.21	1.28	0.28	-0.55	-0.73	1.64	-1.08***	0.17	-0.45	1.48	-0.7***	0.74
	ReadSp	-0.18	1	3.58***	17.61***	-0.08	1	1.8***	3.04***	-0.13	1	2.8***	11.05***
Predictors	**NWRs**	-0.15	1.02	-0.38	0.1	0	0.98	-0.68	-0.76*	-0.08	1	-0.51***	-0.26
	NWRw	0	1.06	-0.41	-0.47	0	0.98	-0.33	-0.44	0	1.02	-0.38	-0.41
	RANd	-0.56	0.93	0.79**	0.19	0	0.98	1.7***	3.24***	-0.31	0.99	1.16***	2.13***
	RANo	-0.26	0.9	0.35	-0.24	0	0.98	1.03***	0.63	-0.14	0.95	0.73***	0.52
	Phonp	-0.18	1.13	-1.26***	1.07*	0.1	1.14	-2.12***	3.45***	-0.06	1.14	-1.63***	1.96***
	Phonr	-0.13	1.2	-0.53	-0.9	0.11	1.03	-1.35***	1.09	-0.02	1.13	-0.86***	-0.27
	Phons	-0.3	1.29	-0.99***	0.04	0	0.98	-2.41***	7.43***	-0.16	1.16	-1.49***	1.96***
	MorD	-0.16	1.18	-0.37	-0.42	0	0.98	-0.89**	-0.2	-0.09	1.09	-0.59***	-0.27
	MorI	0.01	0.98	-0.9***	0.97	0	0.98	-1.7***	2.06***	0.01	0.98	-1.29***	1.55***
	Orth	0.17	1.08	-0.14	-0.26	0	0.98	-0.02	-0.23	0.09	1.04	-0.07	-0.21

Notes: monoling: monolingual children; TD: percentage of typically developing children; NVP: Non-Verbal Performance on Raven's matrices; LangC: Language composite score; WIAT: Spelling score on WIAT spelling subtest; CBM: Curriculum-Based Measure for spelling score, based on the text production task described in the methods; Read: Reading score on a standardised reading test in both languages, ReadSp: Reading speed measured in seconds per word; NWRs: NonWord repetition score, measured in number of syllables repeated correctly; NWRw: NonWord Repetition measured in number of words repeated correctly; RANd: Rapid Automatic Naming digit score, RANo: Rapid Automatic Naming objects score; Phonp: Phonological awareness Phoneme isolation score; Phonr: Phonological awareness rime isolation score; Phons: Phonological awareness syllable isolation score; MorD: Awareness of morphological derivations; MorI: Awareness of inflectional derivations; Orth: Orthographic awareness; M: Mean; SD: Standard Deviation; skew: skewness; kurt: kurtosis

9.2. Exploratory Principal Component Analysis (PCA) and correlations

Literacy measures. A principal component analysis was conducted for the four literacy measures. On visual inspection, correlations between the measures seemed appropriate for a PCA (>.30 and <.90). Bartlett's test for sphericity $\chi^2(6) = 200.11$, $p < .001$ confirmed they were sufficiently large for the analysis and the determinant $|R| = 0.13$ confirmed they were not too large (Field, 2013, pp. 770-771). The Kaiser-Mayer-Olkin measure confirmed the adequacy of the sample size (overall KMO = .76, with all measures' KMO >.70, well above the .50 recommended threshold). An initial analysis was run with all components (variables) to determine the number of factors. Eigenvalues of 2.78 and 0.62 emerged for the first two unrotated factors, which explained 85% of the total variance. The other two factors' eigenvalues and contributions were marginal (0.42, 11% and 0.17, 4%). This, in combination with the scree plot, which inflected on the second component, lead to a two-factor solution. An oblique "oblimin" rotation accounted for the relation between components (-.52). The model was a good fit (.98), with a residuals' mean of |.08|. Table 9-2 shows the loadings of the four variables after rotation. The first factor received loadings from the two spelling measures and the word reading measure, suggesting it related to accuracy, whilst the second factor received unique loading from the reading speed measure and was related to speed.

Table 9-2: Summary of the Principal Components Analysis conducted for the literacy measures

	Oblimin rotated component loadings	
Measures	**Accuracy**	**Speed**
WIAT Spelling Z-score	**.95**	.04
CBM Spelling Z-score	**.87**	.04
Word Reading Accuracy Z -score	**.84**	-.12
Word Reading Speed	-.01	**.99**
Eigenvalue	2.38	1.02
% of variance	60	26

Note: Components with loading >.50 appear in bold.

Spearman correlations confirmed the reading and spelling measures within the accuracy component correlated highly (.64-.84 in English, .57-.78 in French – see Table 9-5). Because

of the quasi-overlap between the reading speed measure and the speed component, the original reading speed measure was kept for further analysis. Because the focus of the present study is on spelling, the two spelling measures will be used as outcome measures in the models, in turn, followed by the overall accuracy component measure.

Predictor measures. The same approach was taken to combine the ten chosen predictive measures. Visual inspection of their correlation matrix suggested orthographic awareness did not relate enough with other measures (|.01|-|.12|) to be included in the PCA. Bartlett's test for sphericity on the remaining nine measures confirmed they related well enough for analysis ($\chi^2(36) = 367.25$, $p < .001$) and the determinant of the matrix $|R| = 0.02$ confirmed there was no risk of multicollinearity. A KMO measure of .79 [.63-.92] confirmed the sample size was appropriate. An initial PCA was conducted with the nine variables kept to determine the number of components to be included. Four components had eigenvalues above .70 and the point of inflection of the scree plot indicated a four-factor solution. An oblique rotation was applied to account for the correlations between factors (ranging .21-.42). The four-factor model was a good fit (.96), with residuals' mean of |.08|. Table 9-3 shows the loadings of the nine variables onto the four factors after rotation. The first factor received very high loadings from the two nonword repetition scores, and, to a lesser extent, from the morphological awareness measures, and so it was considered to relate to phonological memory. The second component received exclusive loadings from the two RAN tasks and was named RAN. The third component was driven by the syllable and rime awareness tasks, with loadings from the derivations awareness task, which are all related to the manipulation of large sublexical units, it was thus called Awareness of Large Sublexical Units (ALSU). The fourth component was driven by the phoneme awareness task, and had loadings from the inflection awareness tasks, which all involve the manipulation of relatively small sublexical units, it was thus called Awareness of Small Lexical Units (ASSU). It is of interest that the morphological awareness

tasks had substantial loadings on most components, indicating they probably involved a range of the skills assessed throughout the metalinguistic tasks.

Table 9-3: Summary of the Principal Components Analysis conducted for the predictor measures

	Oblimin rotated component loadings			
Measures	**PM**	**RAN**	**ALSU**	**ASSU**
Phoneme awareness	-.09	.04	.09	**.94**
Rime awareness	.25	-.01	**.63**	.20
Syllable awareness	.01	-.05	**.88**	-.01
Derivation awareness	.35	-.20	.28	.25
Inflection awareness	.41	-.20	-.27	**.52**
RAN digits	.06	**.95**	.04	.01
RAN objects	-.02	**.89**	-.09	.03
NWR word score	**.95**	.03	.03	-.05
NWR syllable score	**.93**	.01	.06	-.02
Eigenvalue	2.32	1.83	1.49	1.38
% of variance	26	20	17	15

Note: Components with loading >.50 appear in bold. All measure loadings are obtained from Z-scores. PM: Phonological Memory, RAN: Rapid Automatic Naming, NWR: NonWord Repetition, ALSU: Awareness of Large Sublexical Units, ASSU: Awareness of Small Sublexical Units

Spearman's correlations confirmed the two nonword repetition scores (.82 in English, .85 in French), and the two RAN measures (.76 in English and .63 in French) correlated highly together, and to the component measure (range .84-.92). The phonological memory and RAN components were thus retained as an index of the NWR and RAN scores in further analysis. Correlation patterns were less clear for the ALSU and ASSU components. Correlations between rime and syllable awareness reached .61, but only .30 in French (.55 altogether). Furthermore, morphological awareness tasks correlated differently to the large units (syllable and rimes) in the two languages. In French, both derivations (.35 and .52) and inflection awareness (.28 and .64) correlated with the syllable and rime awareness, correlations being higher with rime awareness. In English, derivation awareness correlated with both syllable (.46) and rime awareness (.45), but inflection awareness did not (.24 and .17). Finally, although phoneme awareness and inflection awareness both loaded on the last factor, they were not highly related (.49 in French and .29 in English). Furthermore, phoneme awareness in both languages was related to other measures loaded onto the ALSU

component (rime and derivation awareness). Because these patterns of correlations were different in the two languages, the new factors' and individual measures' relation to the spelling and accuracy measures were further explored comparing Spearman's correlation coefficients across languages. Table 9-5 presents a summary of all the Spearman's correlation coefficient between measures (individual and factorised), for French and English.

Table 9-4 provides a summary of the composite measures derived from the PCA for the language groups of interest.

Table 9-4: Summary table of the variables derived from the PCA, for the language groups of interest

		EN (n = 82)				FR (n = 67)				ALL (n = 149)			
Sample Characteristics	**% monoling**			91.5				89.6				90.6	
	% male			46.3				53.7				49.7	
	% TD			63.4				73.1				67.8	
Measures	**Variable**	**M**	**SD**	**skew**	**kurt**	**M**	**SD**	**skew**	**kurt**	**M**	**SD**	**skew**	**kurt**
PCA composite	**Acc**	0.04	0.95	0.02	-0.82	-0.07	1	-0.77**	-0.27	-0.01	0.97	-0.4	-0.38
	Speed	0	1.04	3.33***	14.84*	0.02	0.98	1.57***	2.23***	0.01	1.01	2.61***	9.86***
	PM	-0.08	1.05	-0.63*	-0.03	0.11	0.93	-0.91**	0.03	0.01	1	-0.77***	0.07
	RAN	-0.16	0.97	0.34	0.1	0.2	1.01	1.5***	2.13***	0	1	0.89***	1.53***
	ALSU	0.08	1.08	-0.43	0.38	-0.07	0.82	-2.16***	6.46***	0.01	0.97	-0.85***	2.17***
	ASSU	-0.15	1	-1.04***	0.33	0.19	0.99	-1.89***	2.68***	0.01	1	-1.39***	1.1**

Table 9-5: Spearman pairwise correlations between the predictor and literacy measures considered (based on year group specific Z-score and Principal Component Analysis component scores)

rs	Age	NVP	AccC	WIAT	CBM	Read	SpC	Sp	PMC	NWRw	NWRs	RANC	RANd	RANo	ALSU	syll	rime	der	ASSU	phon	inf	orth
											English (n_{max} = 82)											
Age		.04	-.16	-.11	0	-.25	-.14	-.16	0	.03	-.05	-.27	-.33	-.29	.08	-.07	-.07	-.02	-.15	-.04	.1	.1
NVP	-.23		.52**	.51**	.32	.5**	-.21	-.23	.53***	.33	.45*	-.38	-.34	-.26	-.05	.46**	.62***	.45*	.37	.18	.36	.04
AccC	-.21	.36		.96***	.79***	.93***	-.54***	-.47**	.71***	.58***	.58***	-.48**	-.38	-.42*	-.23	.59***	.67***	.54***	.41*	.22	.26	-.12
WIAT	-.29	.35	.94***		.77***	.84***	-.51***	-.47**	.68***	.53***	.56***	-.48**	-.39	-.41*	-.22	.62***	.63***	.51***	.37	.18	.28	-.14
CBM	-.12	.31	.68***	.57***		.64***	-.74***	-.49***	.48**	.37	.31	-.53***	-.41*	-.49***	-.25	.5***	.56***	.44**	.43*	.28	.2	-.12
Read	-.09	.32	.91***	.78***	.63***		-.53***	-.5***	.72***	.58***	.63***	-.39	-.28	-.33	-.18	.51***	.62***	.55***	.39	.25	.22	-.07
SpC	.06	-.03	-.63***	-.52**	-.78***	-.66***		.87***	-.46**	-.34	-.38	.53***	.47**	.47**	.05	-.33	-.37	0.44*	-.37	-.36	-.24	-.01
Sp	.12	.04	-.51**	-.48**	-.43*	-.57***	.85***		-.45**	-.34	-.41*	.48**	.46**	.39*	0	-.26	-.3	-.39*	-.26	-.3	-.21	-.04
PMC	-.18	.3	.61***	.55***	.42	.65***	-.36	-.29		.9***	.91***	-.3	-.24	-.22	-.04	.54***	.69***	.66***	.3	.24	.33	-.11
NWRw	-.13	.21	.57**	.52**	.42	.59***	-.38	-.28	.92***		.82***	-.13	-.12	-.12	.04	.32	.53***	.46**	.2	.3	.28	-.09
NWRs	-.12	.17	.56**	.54***	.35	.59***	-.37	-.38	.9***	.85***		-.25	-.23	-.19	.05	.38	.51***	.52***	.19	.22	.33	0
RANC	.1	-.14	-.52**	-.55***	-.49*	-.5**	.61***	.62***	-.28	-.33	-.32		.92***	.91***	.11	-.44**	-.33	-.45**	-.32	-.21	-.33	.03
RANd	.03	.06	-.38	-.4	-.4	-.4	.58***	.61***	-.1	-.19	-.22	.84***		.76***	.02	-.29	-.24	-.35	-.22	-.22	-.32	.02
RANo	.1	-.2	-.5**	-.53***	-.42	-.47**	.5**	.52**	-.37	-.44*	-.41	.92***	.63***		.19	-.32	-.27	-.33	-.3	-.21	-.21	.05
ALSU	-.04	0	.22	.23	.34	.2	-.23	-.1	.23	.25	.24	-.18	-.22	-.15		-.45**	-.37	.07	-.04	.13	.68***	.08
syll	.12	.4	.46*	.4	.3	.51**	-.19	-.1	.55***	.46*	.49**	-.2	-.11	-.17	-.23		.61***	.46**	.53***	.21	.24	-.07
rime	-.33	.28	.62***	.61***	.39	.65***	-.43	-.47*	.68***	.54***	.59***	-.33	-.19	-.29	.11	.3		.45**	.54***	.32	.17	-.07
der	-.15	.27	.51**	.52**	.3	.53***	-.28	-.28	.58***	.49**	.45*	-.44*	-.25	-.41	.39	.35	.52**		.48**	.3	.32	-.19
ASSU	-.32	.28	.46*	.4	.16	.47*	-.2	-.26	.33	.18	.22	-.16	-.05	-.09	0	.29	.69***	.49**		.84***	.36	-.08
phon	-.44*	.19	.38	.36	.14	.39	-.25	-.36	.33	.27	.36	-.24	-.13	-.27	.12	0	.62***	.36	.78***		.29	-.01
inf	-.39	.39	.65***	.64***	.52*	.6***	-.44*	-.38	.61***	.52**	.53***	-.42	-.32	-.38	.55***	.28	.64***	.56***	.52**	.48**		.02
orth	.05	-.15	.03	0	-.05	-.01	.1	.09	-.13	-.11	-.03	.09	.1	.01	.13	-.17	-.1	.01	-.02	.06	.08	
											French (n_{max} = 67)											

*Notes: Significance levels of Spearman correlations are indicated as follows: *p < .05, **p<.01, *** p<.001, p-values were corrected for multiple tests using Holm-Bonferroni procedure (rcorr.adjust() function in the RcmdrMisc package (Fox, 2018)); NVP: Non-Verbal Performance, as measures by the Raven's matrices; AccC: Accuracy Component, computed following the exploratory principal component analysis (PCA); WIAT: WIAT spelling; CBM: Proportion of words correctly spelled in the texts produced using the writing Curriculum-Based Measure; Read: Reading accuracy as measured by the BAS-2 in English or the BALE in French, SpC: Reading speed component, following PCA; Sp: Reading speed measured in seconds per word attempted; PMC: Phonological memory component, following PCA; NWRw: NonWord Repetition, word score; NWRs: NonWord Repetition syllable score; RANC: Rapid Naming component, following PCA; RANd: Rapid Naming for digits; RANo: Rapid Naming for objects; ALSU: Awareness of Large Sublexical Unit component, following PCA; syll: syllable awareness; rime: rime awareness; der: derivation awareness; ASSU: Awareness of Small Sublexical Units component, following PCA; phon: phoneme awareness; inf: inflection awareness; orth: orthographic awareness*

9.3. Comparisons of Spearman's correlation coefficient across languages

The cross-linguistic differences between correlation coefficients were explored by computing a standardised difference (Z-score) in coefficient between the two languages. Table 9-6 presents the results of these differences in correlation coefficients, for the outcome measures and predictors of interest. Patterns of correlations between the outcome and predictor measures were similar across languages, except for the inflection awareness measure and the awareness of large sublexical units component, whose relationship to the spelling and accuracy measures was consistently higher in French than in English. In fact, the awareness of large units was negatively related to spelling measures in English, whilst it was positively related in French. We also note that the WIAT-spelling and CBM-spelling scores were more strongly related in English than in French.

Table 9-6: Standardised differences in correlation coefficients (Spearman's r) between French and English, for the literacy measures (WIAT-Spelling, CBM-Spelling and Accuracy component) and predictors of interest

r_s	FR	EN	*Z*	*p*	
WIAT					
age	.29	.11	1.12	.26	
NVP	.35	.51	-1.17	.24	
CBM	.57	.77	-2.22	.03	*
Read	.78	.84	-1.05	.3	
Sp	-.48	-.47	-0.08	.94	
PMC	.55	.68	-1.25	.21	
RANC	-.55	-.48	-0.57	.57	
ALSU	.22	-.23	2.72	.006	**
syll	.40	.61	-1.7	.09	
rime	.61	.63	-1.19	.85	
der	.52	.51	0.08	.94	
ASSU	.40	.37	0.21	.83	
phon	.36	.18	1.3	.19	
inf	.64	.28	2.8	.005	**
orth	0	.14	-0.84	.4	
CBM					
age	-.12	0	-0.72	.47	
NVP	.31	.32	-0.07	.95	
Read	.63	.64	-0.1	.92	
Sp	-.43	-.48	0.38	.71	
PMC	.42	.48	-0.45	.65	
RANC	-.49	-.53	0.32	.75	
ALSU	.34	-.25	3.62	.0003	***

r_s		FR	EN	*Z*	*p*	
	syll	.30	.50	-1.43	.15	
	rime	.39	.56	-1.31	.19	
	der	.30	.44	-97	.33	
	ASSU	.16	.43	-1.77	.08	
	phon	.14	.28	-0.87	.38	
	inf	.52	.20	2.22	.03	*
	orth	-.05	-.12	0.42	.67	
AccC						
	age	-.21	-.16	-0.31	.76	
	NVP	.36	.52	-1.19	.24	
	WIAT	.94	.96	-1.24	.22	
	CBM	.68	.79	-1.44	.15	
	Sp	-.51	-.47	-0.31	.75	
	PMC	.61	.71	-1.06	.29	
	RANC	-.52	-.48	-0.32	.75	
	ALSU	.22	-.23	2.72	.006	**
	syll	.46	.59	-1.07	.28	
	rime	.62	.67	-0.51	.61	
	der	.51	.54	-0.25	.81	
	ASSU	.46	.41	0.37	.71	
	phon	.38	.22	1.05	.29	
	inf	.65	.26	3.03	.002	**
	orth	.03	-.12	0.9	.37	

*Notes: Significance levels of the z-test are indicated as follows: *p < .05, **p<.01, *** p<.001; age: Age in years; NVP: Non-Verbal Performance, as measures by the Raven's matrices; AccC: Accuracy Component, computed following the exploratory principal component analysis (PCA); WIAT: WIAT spelling; CBM: Proportion of words correctly spelled in the texts produced using the writing Curriculum-Based Measure; Read: Reading accuracy as measured by the BAS-2 in English or the BALE in French; Sp: Reading speed measured in seconds per word attempted; PMC: Phonological memory component, following PCA; NWRw: NonWord Repetition, word score; NWRs: NonWord Repetition syllable score; RANC: Rapid Naming component, following PCA; RANd: Rapid Naming for digits; RANo: Rapid Naming for objects; ALSU: Awareness of Large Sublexical Units component, following PCA; syll: syllable awareness; rime: rime awareness; der: derivation awareness; ASSU: Awareness of Small Sublexical Units component, following PCA; phon: phoneme awareness; inf: inflection awareness; orth: orthographic awareness*

9.4. Regression analyses

On the basis of the principal component analysis and correlation comparisons conducted so far, a series of regression models were built to predict performance on the WIAT-spelling, CBM-spelling and accuracy component, in turn, from the four components computed in the PCA (PM, RAN, ALSU, ASSU). A stepwise approach was used. Age and NVP were introduced in a first step, followed by metalinguistic skills, introduced in a second step. The English and French models are presented in turn for each spelling measure and for the overall accuracy measure.

9.4.1. Predictors of the WIAT-spelling score

English. After controlling for age and NVP, the model with phonological memory, RAN, and awareness of small and large units accounted for a significant R^2 = 34.79% of variance (F(4, 62) = 10.69, p < .0001). The unique contribution to variance for each variable of interest, over and above the other variables, is reported in Table 9-7. Phonological memory was the most important unique contributor to WIAT spelling in English (16.61%) followed by RAN (7.19%). Awareness of small (0.17%) and large sublexical units (0.23%) did not contribute significantly to the model.

Table 9-7: Stepwise regression model for the WIAT-spelling in English

	Model Step 1					**Model Step 2**				
	R²	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***R²***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant		0.95	1.11	0.85	.4		1.19	0.97	1.23	.23
Age		-0.14	0.12	-0.14	0.12	.0213	-0.17	0.1	-1.68	.10
NVP		0.5	0.11	4.38	<.0001***	.0072	0.11	0.11	0.97	.33
PM						.1661	0.51	0.11	4.69	<.0001***
RAN						.0719	-0.38	0.12	-3.08	.003**
ASSU						.0017	0.05	0.11	0.47	.64
ALSU						.0023	-0.05	0.09	-0.55	.58
Model	.2137			9.69	< .001***	.5616			12.38	< .0001***
Change in *R²*						.3479			10.69	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

French. After accounting for age and NVP differences, the model with PM, RAN, ASSU and ALSU accounted for a significant R^2 = 48.46% of unique variance (F(4, 63) = 20.282, p < .0001). The unique contribution to variance for each variable of interest, over and above the other variables, is reported in Table 9-8. RAN was the most important unique contributor to WIAT-spelling (9.03%), followed by phonological memory (5.97%) and ASSU (2.86%). Awareness of large sublexical units (0.3%) did not contribute significantly to the model.

Table 9-8: Stepwise regression model for the WIAT-spelling in French

	Model Step 1					**Model Step 2**				
	R²	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***R²***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant		1.87	1.5	1.25	.216		1.16	1.01	1.15	.255
Age		-0.25	0.15	-1.7	.094	.0186	-0.18	0.1	-1.77	.083
NVP		0.3	0.12	2.45	.017*	.011	0.12	0.09	1.36	.18

	Model Step 1					Model Step 2				
	R^2	*B*	*SE B*	t/F_{R^2}	*p*	R^2	*B*	*SE B*	t/F_{R^2}	*p*
PM						.0597	0.35	0.11	3.16	.002**
RAN						.0903	-0.34	0.09	-3.89	<.0001***
ASSU						.0286	0.22	0.1	2.19	.033*
ALSU						.003	0.07	0.1	0.71	.479
Model	.163			6.14	.003**	.6476			18.07	< .0001***
Change in R^2						.4846			20.28	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

9.4.2. Predictors of the CBM-spelling score

English. After accounting for age and NVP, the predictors of interest accounted for a significant 41.24% of variance in the CBM spelling scores ($F(4, 62) = 12.59$, $p < .0001$). The unique contribution to variance for each variable of interest, over and above the other variables, is reported in Table 9-9. As observed in the WIAT-spelling, RAN (12.47%) and PM (11.01%) were the most important contributors to CBM spelling scores. Awareness of small (2.13%) and large units (2.31%) did not contribute significantly to the model.

Table 9-9: Stepwise regression for the CBM-spelling in English

	Model Step 1					Model Step 2				
	R^2	*B*	*SE B*	t/F_{R^2}	*p*	R^2	*B*	*SE B*	t/F_{R^2}	*p*
Constant		-0.16	0.96	-0.17	.865		0.2	0.81	0.25	.803
Age		0.03	0.1	0.25	.8	.0005	-0.02	0.09	-0.27	.792
NVP		0.24	0.1	2.36	.021*	.014	-0.12	0.09	-1.31	.195
PM						.1101	0.36	0.1	3.67	.001***
RAN						.1247	-0.42	0.11	-3.9	< .001***
ASSU						.0213	0.17	0.1	1.61	.112
ALSU						.0231	-0.13	0.08	-1.68	.098
Model	.0798			2.86	.0643	.4922			10.02	< .0001***
Change in R^2						.4124			12.59	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

French. After controlling for age and NVP, the model explained a significant 45.91% of variance in the CBM-spelling scores ($F(4, 63) = 14.085$, $p < .0001$). The unique contribution to variance for each variable of interest, over and above the other variables, is reported in Table 9-10. The pattern of contribution was different to the one observed in the WIAT-spelling model: Awareness of large sublexical units appeared as the largest contributor to the model, with 12.64% unique contribution to R^2, followed by phonological memory (7.76%) and RAN

(5.89%). Awareness of small sublexical units (2.33%) did not contribute to the model significantly.

Table 9-10: Stepwise regression model for the CBM-spelling in French

	Model Step 1					**Model Step 2**				
	R²	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***R²***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant		0.92	1.57	0.58	.561		0.16	1.17	0.14	.89
Age		-0.1	0.16	-0.63	.53	.0002	-0.01	0.12	-0.13	.901
NVP		0.21	0.13	1.65	.104	.0319	0.2	0.1	1.98	.053
PM						.0776	0.39	0.13	3.09	.003**
RAN						.0589	-0.27	0.1	-2.69	.009**
ASSU						.0233	-0.2	0.12	-1.69	.096
ALSU						.1264	0.47	0.12	3.94	<.001***
Model	.0602			2.017	.1415	.5193			10.62	< .0001***
Change in *R²*						.4591			14.08	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

9.4.3. Predictors of the accuracy composite

English. After accounting for age and NVP, the model predicted a significant 38.63% of variance in the accuracy composite ($F(4, 61) = 15.04$, $p < .0001$). The unique contribution to variance for each variable of interest, over and above the other variables, is reported in Table 9-11. Consistent with the WIAT-spelling and CBM-spelling models, phonological memory (21.44%) and RAN (6.37%) were the most important contributors to the model. The other metalinguistic measures (ASSU: .41%, ALSU: .45%) did not contribute significantly to the model.

Table 9-11: Stepwise regression model for the accuracy composite in English

	Model Step 1					**Model Step 2**				
	R²	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***R²***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant		1.69	0.96	1.77	.082		1.71	0.77	2.23	.029*
Age		-0.16	0.1	-1.57	.122	.0273	-0.17	0.08	-2.06	.044*
NVP		0.44	0.1	4.39	<.0001***	.0038	0.07	0.09	0.77	.444
PM						.2144	0.49	0.09	5.78	<.0001***
RAN						.0637	-0.31	0.1	-3.15	.003**
ASSU						.0041	0.07	0.09	0.79	.432
ALSU						.0045	-0.06	0.07	-0.84	.407
Model	.2478			10.05	.0002***	.6341			16.46	< .0001***
Change in *R²*						.3863			15.04	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

French. After controlling for age and NVP, the model explained a significant 56.01% of variance in the accuracy composite score ($F(4, 62) = 26.73$, $p < .0001$). Unique contribution to variance for each variable of interest, over and above the other variables, are reported in Table 9-12. Consistent with the WIAT-spelling model, PM (10.44%) and RAN (6.36%) were the only unique significant contributors to the model, with ASSU and ALSU only contributing 1.89% and 1.01% respectively.

Table 9-12: Stepwise regression model for the accuracy composite in French

	Model Step 1					**Model Step 2**				
	R^2	***B***	***SE B***	***t/F_{R^2}***	***p***	***R^2***	***B***	***SE B***	***t/F_{R^2}***	***p***
Constant		1.22	1.52	0.8	.426		0.19	0.94	0.2	.84
Age		-0.14	0.15	-0.91	.366	.0007	-0.03	0.09	-0.36	.723
NVP		0.32	0.12	2.6	.012*	.0197	0.16	0.08	1.94	.057
PM						.1044	0.46	0.1	4.46	<.0001***
RAN						.0636	-0.31	0.09	-3.49	.001***
ASSU						.0189	0.19	0.1	1.9	.063
ALSU						.0101	0.13	0.1	1.39	.17
Model	.1361			4.88	.11	.6962			2.29	< .0001***
Change in *R^2*						.5601			26.73	< .0001***

Notes: R^2 for age, NVP, PM, RAN, ASSU and ALSU are given over and above the other contributors to the model, by computing the difference in R^2 with and without their contribution in the full model.

9.5. Regressions with between language interactions

Models were run with the full French and English dataset using the same model that had previously been explored in each language separately. Language was introduced as an interaction term stepwise for each of the predictor variables of interest (PM, RAN, ASSU and ALSU). The results of the models are presented for each outcome variable, in turn.

9.5.1. WIAT-spelling

The models for the WIAT spelling confirmed the fit of the models observed in French and English. The addition of language as an interaction term did not significantly improve the model for any of the variables (PM: $F(2, 124) = 0.25$, $p = .78$; RAN: $F(2, 124) = 0.14$, $p = .87$; ASSU: $F(2, 124) = 0.46$, $p = .63$; $F(2, 124) = 0.46$, $p = .63$). Table 9-13 presents the series of models with interactions for the WIAT-spelling.

9.5.2. CBM-spelling

The models for the CBM spelling confirmed the results obtained in the separate French and English models, with an interaction between French and English on the ALSU variable. This interaction was the only one that significantly improved the model, from R^2 = 40% to R^2 = 46% (PM: $F(2, 128) = 0.16$, $p = .85$; RAN : $F(2, 128) = 0.52$, $p = .60$; ASSU: $F(2, 128) = 1.64$, $p = .20$; ALSU: $F(2, 128) = 6.91$, $p = .001$***). Table 9-14 presents the series of models with interactions for the CBM-spelling. The significant interaction was further explored by plotting the French and English change in slope against CBM-spelling scores (with all other measures' slope centred on the constant), in Figure 9-2. As previously observed in the correlations, awareness of large unit seemed to have a positive effect in French, but a null effect in English.

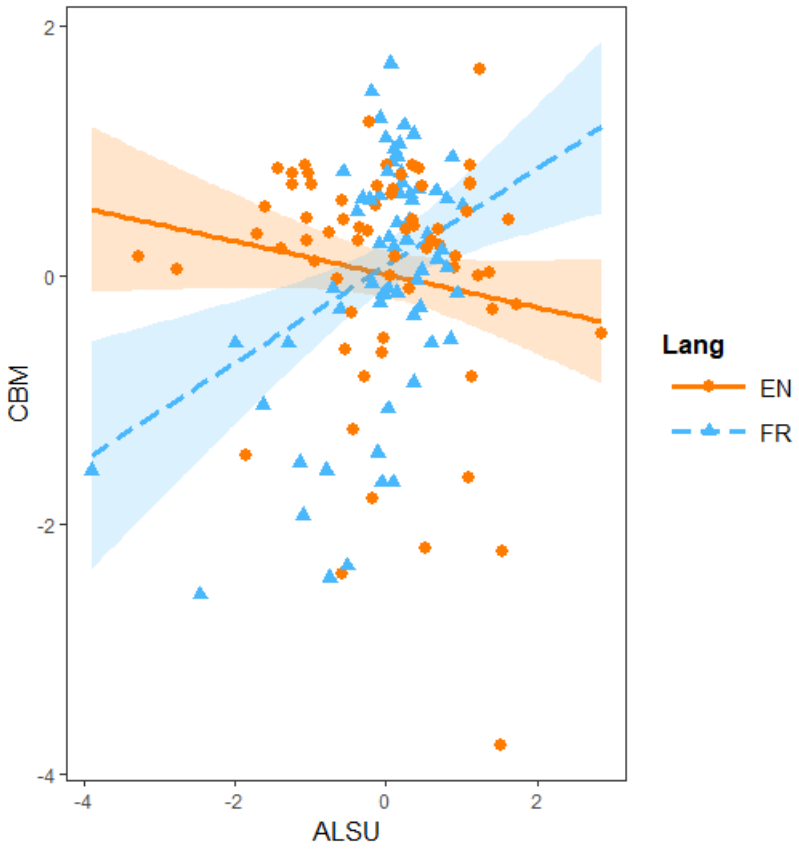

Figure 9-2: Interaction between Language and ALSU in the CBM regression model.

The red line represents the English inflection whilst the blue line represents the French inflection on the regression slope (all other variables being held to the constant). The shaded area around the lines represents the 95% confidence interval. The red dots and blue triangles represent datapoints.

9.5.3. Accuracy composite

Consistent with the WIAT model, the language interaction did not significantly improve the model for the accuracy composite (PM: $F(2, 122) = 1.32$, $p = .27$; RAN: $F(2, 122) = 1.45$, $p = .24$; ASSU: $F(2, 122) = 1.89$, $p = .16$; ALSU: $F(2, 122) = 2.52$, $p = .085$). Table 9-15 presents the detail of the stepwise regression model conducted.

Table 9-13: Stepwise regression model for the WIAT-spelling with language interaction

	Model Step 1				**Model Step 2**				**Model Step 3**				**Model Step 4**				**Model Step 5**			
	B	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant	1.26	0.61	2.06	.04*	1.2	0.64	1.89	.06	1.19	0.65	1.82	.07	1.17	0.63	1.84	.07	1.12	0.64	1.75	.08
Age	-0.18	0.06	-2.93	.004**	-0.17	0.07	-2.57	.01*	-0.17	0.07	-2.48	.01*	-0.17	0.07	-2.54	.01*	-0.16	0.07	-2.43	.02
NVP	0.12	0.06	1.82	.071	0.12	0.07	1.79	.08	0.12	0.07	1.82	.07	0.12	0.07	1.87	.06	0.13	0.07	1.95	.05
PM	0.45	0.07	6.08	<.001***	0.47	0.09	5.28	<.001***	0.45	0.07	6.02	<.001***	0.44	0.07	6	<.001***	0.45	0.07	6.02	<.001***
RAN	-0.37	0.06	-5.78	<.001***	-0.36	0.07	-5.14	<.001***	-0.36	0.1	-3.58	<.001***	-0.36	0.07	-5.15	<.001***	-0.35	0.07	-4.87	<.001***
ASSU	0.12	0.07	1.69	.094	0.13	0.07	1.8	.08	0.13	0.07	1.73	.09	0.09	0.09	0.96	.34	0.13	0.07	1.71	.09
ALSU	-0.004	0.06	-0.07	.946	-0.003	0.06	-0.04	.97	-0.004	0.06	-0.06	.95	-0.01	0.06	-0.16	.87	-0.04	0.08	-0.53	.6
Lang (FR)					-0.07	0.14	-0.47	.64	-0.07	0.14	-0.49	.62	-0.07	0.14	-0.52	.61	-0.08	0.14	-0.56	.58
PM x Lang					-0.06	0.13	-0.48	.63												
RAN x Lang									0.01	0.13	0.1	.92								
ASSU x Lang													0.09	0.12	0.7	.48				
ALSU x Lang																	0.11	0.14	0.81	.42
R^2	.5944		30.29	<.001***	.5961		22.5	<.001***	.5953		22.44	<.001***	.5970		22.59	<.001***	.5975		22.63	<.001***
F* change in *R^2							0.25	.7797			0.14	.8709			0.46	0.6327			0.46	.6327

Notes. Change in R^2 is given in comparison to model 1 (with no interaction terms) for all other models.

Table 9-14: Stepwise regression model for the CBM-spelling measure with language interaction

	Model Step 1				**Model Step 2**				**Model Step 3**				**Model Step 4**				**Model Step 5**			
	B	***SE B***	***t/F$_{R^2}$***	***p***	***B2***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant	0.47	0.65	0.72	0.47	0.57	0.68	0.85	0.4	0.7	0.69	1.01	0.32	0.58	0.67	0.87	0.39	0.3	0.65	0.47	0.64
Age	-0.05	0.07	-0.72	0.47	-0.06	0.07	-0.88	0.38	-0.08	0.07	-1.06	0.29	-0.06	0.07	-0.87	0.39	-0.03	0.07	-0.48	0.63
NVP	0.01	0.07	0.19	0.85	0.01	0.07	0.09	0.93	0	0.07	-0.06	0.95	0.01	0.07	0.09	0.93	0.03	0.07	0.49	0.63
PM	0.34	0.08	4.11	<.001***	0.34	0.1	3.44	<.001***	0.34	0.08	4.18	<.001***	0.34	0.08	4.22	<.001***	0.32	0.08	4.15	<.001***
RAN	-0.37	0.07	-5.34	<.001***	-0.39	0.08	-5.12	<.001***	-0.45	0.11	-4.23	<.001***	-0.39	0.07	-5.2	<.001***	-0.34	0.07	-4.59	<.001***
ASSU	0.05	0.08	0.66	0.51	0.04	0.08	0.5	0.62	0.03	0.08	0.43	0.67	0.15	0.1	1.44	0.15	0.03	0.08	0.32	0.75
ALSU	0.04	0.07	0.59	0.56	0.04	0.07	0.59	0.55	0.05	0.07	0.71	0.48	0.06	0.07	0.79	0.43	-0.13	0.08	-1.62	0.11
Lang (FR)					0.09	0.15	0.57	0.57	0.11	0.15	0.68	0.5	0.09	0.15	0.6	0.55	0.07	0.15	0.47	0.64
PM x Lang					-0.01	0.14	-0.07	0.95												
RAN x Lang									0.12	0.14	0.85	0.4								
ASSU x Lang													-0.23	0.13	-1.72	0.09				
ALSU x Lang																	0.52	0.14	3.67	<.001***
R^2	0.4008		14.27	<.001***	0.4023		10.6	<.001***	0.4057		10.75	<.001***	0.416		11.22	<.001***	0.46		13.42	<.001***
F* change in *R^2							0.16	0.849			0.52	0.5953			1.64	0.2			6.91	.001***

Notes. Change in R^2 is given in comparison to model 1 (with no interaction terms) for all other models.

Table 9-15: Stepwise regression model for the accuracy composite with language interaction

	Model Step 1				**Model Step 2**				**Model Step 3**				**Model Step 4**				**Model Step 5**			
	B	***SE B***	***t/F$_{R^2}$***	***p***	***B2***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***	***B***	***SE B***	***t/F$_{R^2}$***	***p***
Constant	1.61	0.53	3.03	.003**	1.37	0.55	2.5	.01*	1.3	0.56	2.32	.02*	1.38	0.54	2.54	.01*	1.29	0.55	2.37	.02*
Age	-0.17	0.05	-3.04	.003**	-0.13	0.06	-2.25	0.03	-0.12	0.06	-2.04	0.04	-0.13	0.06	-2.32	.01*	-0.12	0.06	-2.11	.037*
NVP	0.08	0.06	1.39	0.17	0.1	0.06	1.71	0.09	0.1	0.06	1.77	0.08	0.09	0.06	1.63	0.11	0.1	0.06	1.82	0.07
PM	0.48	0.06	7.5	<.001***	0.45	0.08	5.89	<.001***	0.48	0.06	7.44	<.001***	0.47	0.06	7.46	<.001***	0.48	0.06	7.53	<.001***
RAN	-0.34	0.06	-5.8	<.001***	-0.3	0.06	-4.8	<.001***	-0.26	0.09	-2.93	0.004	-0.31	0.06	-4.9	<.001***	-0.29	0.06	-4.52	<.001***
ASSU	0.12	0.06	1.88	0.06	0.14	0.07	2.1	.04*	0.15	0.07	2.23	.004**	0.08	0.08	1.04	0.3	0.14	0.06	2.13	.0353*
ALSU	0.01	0.05	0.17	0.87	0.01	0.05	0.09	0.93	0	0.06	0.01	0.99	0	0.06	-0.02	0.99	-0.06	0.07	-0.86	0.39
Lang (FR)					-0.19	0.12	-1.54	0.13	-0.2	0.12	-1.61	0.11	-0.18	0.12	-1.49	0.14	-0.19	0.12	-1.58	0.12
PM x Lang					0.07	0.11	0.64	0.52												
RAN x Lang									-0.1	0.12	-0.83	0.41								
ASSU x Lang													0.13	0.1	1.24	0.22				
ALSU x Lang																	0.19	0.12	1.67	0.1
R^2	0.6474		37.34	<.001***	0.655		28.48	<.001***	0.6558		28.58	<.001***	0.6582		28.88	<.001***	0.6616		29.33	<.001***
F change in R^2							1.3159	0.2721			1.4535	0.2378			1.8888	0.1557			2.52	0.08471

Notes. Change in R^2 is given in comparison to model 1 (with no interaction terms) for all other models.

9.6. Summary: predictors of spelling in French and English at the end of primary school

Principal component analysis highlighted a complex pattern of relation between predictive measures of literacy in French and English. Four factors were extracted from the original nine measures. Two of them had clear loadings from either RAN or Non-word repetition measures. However, the other two factors, awareness of large and small units, provided a contrasting fit to morphological and phonological awareness tasks in the two languages.

Correlation analysis highlighted the importance of inflection awareness and large units in French as compared to English, in both the word dictation and text production tasks, whilst non-word repetition, rapid naming, and rime, syllable, phoneme and derivation awareness correlated with spelling measures in both languages.

Regression models with non-word repetition, rapid naming and metalinguistic awareness provided a reasonable fit to explain spelling in both the word dictation and text production tasks. Language interactions in the CBM model suggested awareness of large units was particularly important in explaining spelling in French but not in English. All other processes assessed (phonological memory and rapid naming) showed similar weight in spelling performance in both languages.

Chapter 10. Discussion

10.1. Summary of experimental studies

The present thesis gathers three experimental studies aiming to explore spelling errors, strategies and predictors in children with and without DLD at the end of primary school. Parallel data was collected from distinct French and English samples. The overall aim of these three studies was to assess the relative contribution of different sources of linguistic knowledge to the spelling performance of 1) French vs English students on the one hand, and of 2) children with contrasting linguistic and metalinguistic abilities on the other hand, in these two languages.

Study 1 (Chapter 7) assessed the quantity and quality of spelling errors in the texts produced and words dictated by 17 children with DLD, compared to 17 CA and 17 SA peers, with parallel datasets from distinct French and English samples. In line with previous studies, children with DLD were expected to present with a delay in their spelling scores (i.e. scores in line with SA peers, but below CA peers). However, qualitative differences in the types of spelling errors produced were expected to vary in rate across the four different categories identified (phonological, morphological, orthographic and semantic errors). Namely, we expected children with DLD to produce more errors with morphological inflections than both CA and SA peers, in line with previous empirical studies. Cross-language differences in the rate of certain error types were also expected: more errors with word ending morphological inflections in French and more within-word orthographic errors in English.

Study 2 (Chapter 8) elicited the spelling strategies of the same groups of children on a curated list of 12 words representative of each orthographic system. The same linguistic framework, derived from Apel and Masterson (2001), was used to analyse both errors and spelling strategies, considering four categories of strategies: phonological, morphological, orthographic and semantic. Children with DLD were expected to report less strategies, and less variety in strategy choices than CA peers, reflecting underspecified linguistic knowledge for spelling. It was anticipated that comparison with SA peers would allow to differentiate the effect of spelling and language abilities on the rate and type of strategies reported. Cross-language differences were also expected to reflect 1) the complexity of the French morphological system and 2) the depth of the English orthographic system.

Study 3 (Chapter 9) used principal component, correlation and regression analyses on an extended sample of 149 students (82 English and 67 French, including students with typical and atypical language skills), to assess the relative weight of phonological awareness (measured by phoneme, syllable and rime isolation tasks), morphological awareness (measured by sentence completion with inflected and derived words), phonological short-term memory (measured by a non-word repetition task) and Rapid Automatic Naming (of objects and numbers) on spelling in text and in word dictation. The results were expected to reflect differentiated mechanisms at the end of primary school in French and English, at a time when children would have been exposed to their respective orthographies for an extended period of time.

To our knowledge, the present thesis provides the first direct qualitative analysis of spelling errors and strategies across French and English (Joye et al., 2018). It also builds on the recent studies of predictors of literacy across languages and uses correlation and regression analyses to assess a wide range of predictors of spelling performance in French and English (Desrochers et al., 2018; Moll et al., 2014). The linguistic framework chosen (Apel &

Masterson, 2001) allowed for a comparison across languages (French vs English) and linguistic abilities (DLD vs CA vs SA). The results' implications for theories of spelling development and markers of language difficulties across languages are discussed in this chapter. For each section results are discussed firstly by language (French vs English) and then by ability grouping when appropriate (DLD vs CA vs SA).

10.2. Accuracy and productivity

Against expectations, French children produced shorter texts than their English peers with a higher rate of spelling errors per word (Chapter 7, section 7.1.1). However, when children's spelling was assessed in a reduced set of 12 selected words, cross-language differences disappeared in all groups but CA (Chapter 7, section 7.1.2). On average, in both languages, there was one misspelling every word -every four/five graphemes- in the 12 dictated words, against every word -5 graphemes- in the French texts and every 6 words -14 graphemes- in the English ones. In other words, spelling accuracy rates differed across languages in text production but not in the dictation of a curated set of words. It should be noted here that the sample of children recruited presented slightly different spelling profiles to start with. As shown in Table 6-2, the raw and standard spelling scores of the French sample was significantly lower than that of the English sample. This difference was driven by the English CA group, who performed slightly above the mean, and the French DLD children, who performed significantly lower than their English peers. The reading scores followed the same trend, despite language and non-verbal ability scores being equal across languages. This participant selection difference may be reflected in the text productivity and accuracy measures. One can also not exclude that differences in instruction and handwriting styles may have played a role in the lower text productivity and accuracy observed in the French sample (see section 2.2 of the literature review). Children were asked to write about their best or worst day at school in a very short 5 minutes timeframe. One cannot discard that

familiarity with free writing tasks, a tight time constraint and handwriting fluency may have played a role in children's text productivity and accuracy.

Beyond instruction and handwriting considerations, this result highlights the importance of considering different tasks when looking at spelling accuracy across languages, and for word dictation, as broad a set of words as possible. In spelling as in reading, different processes are assessed with different sets of words. The spelling of irregular words may be particularly appropriate when it comes to assessing orthographic representations, whereas spelling regular words or morphologically-complex words allows for the assessment of sound- and meaning-to-letter correspondences and rules (Kohnen, Nickels, & Castles, 2009). The further presence of homophones and morphologically-inflected words in the word sample additionally calls on a wider range of language-related - semantic and morphological - spelling skills (Apel & Masterson, 2001). The word list chosen in the present study, presented in their sentence context, aimed to call on the full range of processes described above with a limited number of words. Although 12 words are arguably too few, and perfect one-to-one matching across the two languages was not possible, quantitative results suggest the chosen words did tap into a representative set of mechanisms. Future cross-language studies may focus on developing a well-matched set of words and pseudowords to further assess the relative weight of these processes in the spelling of French and English. Recent corpus studies documenting characteristics of different linguistic units may provide useful tools for such cross-language studies (see for example the Silex database for French silent letter endings: Gingras & Sénéchal, 2017; or the Morpholex database for French and English derivational morphology: Sánchez-Gutiérrez, Mailhot, Deacon, & Wilson, 2018a, 2018b). By contrast, text production taps into both single word and sentence spelling mechanisms (Fayol, 1991; Morin et al., 2018). In terms of word spelling, children may be able to choose words they feel confident to spell. On the other hand, they also need to represent morphosyntactic elements to combine them, which may be particularly difficult in a rich and largely silent morphological

system like that of French. Much of the cross-language research to-date has focused on word-level spelling skills (Caravolas et al., 2003; Caravolas & Samara, 2015; Marinelli et al., 2015; Wimmer & Landerl, 1997). By highlighting differences in word and text spelling scores across French and English, the results support the idea of differentiated processes in text and word spelling, providing further evidence for cross-language differences in the weight of these processes.

Productivity and accuracy measures also differentiated children with DLD from their CA peers, but not SA peers. Indeed, on all measures of productivity and accuracy, and in both the texts and dictated words, CA children obtained better scores than SA and DLD peers, who performed similarly. This pattern was observed in both languages. This is consistent with quantitative results obtained from a meta-analysis conducted during the course of the present PhD (Joye et al., 2018): across the studies comparing the spelling scores of children with DLD and younger children matched on language (Connelly, Dockrell, Walter, & Critten, 2012; Critten et al., 2014; Mackie & Dockrell, 2004; Mackie et al., 2013), no group difference could be found (mean effect size g = −0.20, [−0.54, 0.15]). On the contrary, in studies comparing the spelling scores of children with DLD to that of same-age peers, significant and large differences were found overall (mean effect size g = −1.42, [−1.60, −1.24]). This pattern is consistent with the hypothesis of a lag in the spelling development of children with DLD, in line with overall language and literacy development. In the present study, spelling raw scores were used as the matching measure between DLD and SA groups. It is thus unsurprising that children with DLD performed in line with their SA peers on their word dictation and text spelling scores. This matching allowed to perform further qualitative analyses, so as to highlight any deviance in the pattern of spelling development of children with DLD. Results from qualitative analysis are commented below.

10.3. Qualitative differences in spelling error types

Qualitative error analysis provided results complementary to the quantitative measures. Consistent with our hypotheses, cross-language differences were observed in the rates of morphological errors, with morphological errors being more frequent in French. In English, orthographic and mixed errors were the most prominent error type, whereas in French, both morphological and orthographic errors were largely represented in children's spelling. To our knowledge, this is the first direct evidence of cross-language French-English differences using a multi-linguistic error coding system. Again, the two spelling tasks resulted in different profiles of errors: semantic errors only appeared as a prominent error type in French text production, whilst French and English mixed error rates only differed in word dictation. Fine-grained coding further showed that orthographic errors in English were largely related to vowel spellings, whilst orthographic rules and silent letters were particularly difficult in French. Word segmentation errors were also prominent in the French texts of young and DLD spellers. Because of the largely silent nature of the French inflectional system, errors with inflections appeared mainly in the morphological category in French, whilst they appeared in the mixed category in English (with rule-constrained and phonologically-inaccurate morphological errors). Across categories, these results were consistent with previous qualitative analyses and observations of spelling errors in French and English reviewed in Chapter 2 (Broc, 2015; Caravolas et al., 2003; David & Doquet, 2016; Fraquet & David, 2013; Stage & Wagner, 1992; Treiman, 1993). It also relates back to the data on the French and English orthographic and linguistic systems outlined in Chapter 2: a) the depth of the orthographic system and in particular the complexity of the vowel system in English represents a constraint in word spelling, b) a relatively deep orthographic system and silent morphology in French represents a challenge, especially for text spelling, c) the prosodic and syllabic structure of French may trigger difficulties with representing word boundaries in written language, in the early stages of learning to spell.

The use of a multi-linguistic system of spelling error analysis also allowed for the distinction of linguistic profiles within each language, as previously done for English in Silliman et al. (2006). Even if children with DLD produced more spelling errors overall than CA peers (see 10.2), some error types differentiated children with DLD and CA, whilst others did not. Error types that differentiated children with DLD from CA included: in French, phonological, orthographic (only in text production) and morphological errors (only in word dictation); and in English, phonological, orthographic, morphological and mixed errors (but only in word dictation). Semantic errors were too marginal in English to differentiate between groups. Similarly, spelling accuracy was likely too high in English text production (.81 for the DLD students, .95 for the CA students) to allow for a differentiation of errors types. In both languages, a spread of errors across the phonological, orthographic and morphological category was thus evident in the DLD sample. Results for each of these error types are discussed below with regards to processes affected in the spelling of children with DLD.

As previously found across languages, children with DLD were more likely to produce phonologically-incorrect spellings than CA peers (Broc et al., 2013; Nauclér, 2004; Silliman et al., 2006). Whilst phonological errors are typically marginal in late primary school, they are a persisting area of difficulty for children with DLD. It is likely that underspecifications in the phonological forms of words in children with DLD lead to the overrepresentation of this error type in their spelling, as compared to children of the same age. Similarly, underspecifications of morphological and orthographic knowledge may explain lower scores across these error types (consistent with Dockrell & Connelly, 2015; Larkin et al., 2013; Mackie & Dockrell, 2004; Mackie et al., 2013). Overall, the poor spelling performance of children with DLD as compared to same-age peers seems to be homogeneous across linguistic domains (phonological, orthographic and morphological). Against expectations, no cross-group differences were found in the rate of morphological errors in the French text production sample. Morphology was expected to be a particular area of difficulty in the French spelling samples, given the

literature documenting these difficulties in French oral language early on (Hamann et al., 2003; Jakubowicz & Tuller, 2008) on the one hand, and in English oral and written language (Critten et al., 2014; Larkin et al., 2013; Mackie & Dockrell, 2004; Windsor et al., 2000) on the other hand. On the contrary, results point to difficulties in this area in French across all groups (in the DLD no more than in the other groups). Developmental considerations may explain this result. Indeed, Broc et al. (2014) found differences in the rate of morphological errors between children with DLD and TD peers only appeared in secondary school written samples. It is likely that differences only become apparent when morphological processes are mastered in French typical children. There is evidence that some morphological processes are not mastered in spelling until the end of primary school at least (see Fayol et al., 1999 on noun and verb phrase plural agreement). Qualitative data on a wider range of spelling errors produced by French children across primary and secondary school (similar to those of Bahr et al., 2012) may provide further clarifications of the typical development of linguistic processes in French spelling, and help define when to best assess morphological spelling processes in future studies with a population of children with DLD. Similarly, it was a surprise not to find a difference in orthographic scores between the CA and DLD samples in word dictation. The fact that words were curated specifically for their orthographic difficulty may explain this absence of difference. Consultation of the *Echelle d'acquisition en Orthographe LExicale* (EOLE, Pothier & Pothier, 2004) revealed that several words from the curated list were indeed not mastered by a majority of students at the end of primary school (e.g. *plomb*, mastered by 52% of final year primary students, *excitation*, 5%; *soupçon*, 31%). These words likely represented a challenge for both the CA and DLD samples.

As per DLD vs SA comparisons, error rates in almost none of the linguistic categories significantly differentiated these two subgroups. Overall, quantitative and qualitative results aligned: children with DLD largely produced the type of errors expected for their spelling age. The only exception was with mixed errors in English word dictation, where DLD produced

more errors than SA peers. There was also a non-significant trend towards more phonological errors in the French-DLD than in the French-SA groups (in both text production and word dictation), and more orthographic errors in the English-DLD than in the English-SA group in word dictation. Again, there was a task difference: English SA and DLD spelling error type profiles were not significantly differentiated in text production, but they were in word dictation. Fine-grained coding indicated that mixed errors in the English DLD children's dictated words were largely driven by the misapplication of rule-constrained phoneme-grapheme correspondences (PHON-ORTH) and phonologically-implausible morphological errors (PHON-MOR), whilst word choice errors and errors with rule-constrained morphemes appeared at a similar rate than in SA peers. This suggests that the difficulties experienced by English children with DLD with spelling, over and beyond literacy-matched peers, may relate to both phonological and orthographic processes. Whilst phoneme-grapheme correspondences (including rule-constrained ones) are roughly mastered by children in the first two years of primary school in English, this is a persisting area of difficulty for children with DLD. Similarly, error with morphological inflections are largely phonologically-plausible by the end of second grade in the typical English sample (consistent with Treiman, 1993, and staged theories of spelling development Ehri, 1987; Gentry, 1982), but morpheme spelling still suffers phonological inaccuracy in the DLD sample. Consistent with previous studies (Larkin et al., 2013; Silliman et al., 2006; Windsor et al., 2000), omission of morphological inflections took a large part in this error type. Morphological inflections in English have been argued to be relatively phonologically-discreet units and hard to perceive for children with DLD (Leonard, 2014). The prominence of this error type in children with DLD as compared to SA peers in the present sample may thus reveal the persisting difficulties of children with DLD with perceiving and representing these units in their writing, over and above what might be expected given their spelling level. Alternatively, they may reflect difficulties applying conventional spelling more widely, and learning less transparent phoneme-to-grapheme

correspondences. Inflectional morphemes in English, beyond being phonologically-discreet, also have a range of phonological realisations (/t/, /d/ or /ɪd/ for –ed, /z/, /s/, /ɪz/ or /əz/ for –s, see section 2.1.4), which may affect the formation of phoneme-grapheme correspondences for these.

10.4. Reported strategy types and rates

The analysis of the reported spelling strategies further highlights cross-language differences. Most children were able to draw on phonological strategies to explain their word spelling choice, but the rate of such reports was higher in English than in French. In contrast, orthographic and morphological strategies were more frequently reported in French than English. At a finer grain level, syllable chunking, rule-based and inflectional morphology strategies were more often reported in French, whilst phonemic and rime chunking strategies were more often reported in English. This result likely reflects the importance of contextual and word ending rules in the French orthographic system, and the importance of phonological processes in English spelling. It cannot be excluded, however, that differences in strategy choices could be driven by different instruction types or word choice. Word list characteristics and teaching practice are indeed important factors to consider in examining children's strategy choices. The aim of the present study was not to assess causal factors but to give a snapshot of the strategies used on a representative set of words in the two languages and in different age and language-ability groups. Studies may explore strategies across French and English further with tasks eliciting strategies using pseudowords well-matched for their psycholinguistic characteristics. The use of pseudowords may allow for the assessment of underlying processes independent of word knowledge. The impact of instruction types on spelling strategy choices may also be further explored using classroom observations, and/or teachers' questionnaires, or more robustly, intervention studies.

Looking at the different age and ability groups also provides some insight into the development of such strategies in both languages. It is striking that the majority (94%) of young English SA children were able to report morphological strategy use in their spelling, whereas only two thirds of French children the same age reported this type of strategies. By contrast, in both languages, this strategy type was only used by half of the children with DLD. This likely reflects the complexity of the French morphological system, as well as the particular difficulty of children with DLD expressing this strategy type. Fine-grained analyses further highlight developmental shifts in linguistic units use. In French, syllabic chunking is used early on (by 53% of SA French children) and remains an important strategy throughout primary school. By contrast, in English, rime is likely used early on (by 41% of SA English children), but its rate of use decreases to 13% in the CA group, as syllabic chunking becomes more frequent (used by 67% of CA English children). In both languages, the frequency of children using phoneme-based strategies decreases in the older typical CA groups. In English, consistent with previous studies, phonological strategies were markers of early and less efficient spelling (with higher rates in the DLD and SA groups) (Donovan & Marshall, 2015; Rittle-Johnson & Siegler, 1999). By contrast, in French, children with DLD were less likely to rely on phonological strategies than their SA peers, likely reflecting their difficulties with this process and the relatively little emphasis on phonological parsing in spelling instruction at the end of primary school in French. In both languages, children with DLD were more likely to report being unable to provide an answer, likely reflecting their poor expressive language skills. However, they provided the same rate and breadth of responses than their SA peers, before and after prompting. To our knowledge, this study provided the first exploration of spelling strategy use in a population of children with DLD. Although this population had a high rate of no response and needed prompting to answer, they were able to elicit strategies similar to those of younger children with the same spelling levels. Prompted responses may be less representative of the spontaneous strategies used by children. Future research may

develop visual and graded prompting methods to support strategy report in this group of children. Dynamic assessment of spelling strategies, including small sequences of teaching followed by application/elicitation of the strategy learnt may also provide a useful tool to test the learnability of spelling strategies in this groups of children (Hasson, 2018).

10.5. Predictor analyses: same processes, different linguistic units

Consistent with existing research (Desrochers et al., 2018; Moll et al., 2014), the present study identified phonological memory, rapid automatic naming and awareness of linguistic units as significant predictors of word spelling. The addition of a text production task further confirmed the importance of these skills for spelling in text as well. Strikingly, language interactions in the weight of predictors only became apparent in the regressions assessing spelling measures from the text production task, although there were indications of cross-language variations in the correlation analysis. Together with the cross-language differences already observed in word and text spelling accuracy, these results support a differentiation between the skills involved in word and text spelling for French and English. Consistent with previous studies, they suggest the *same processes* are involved in both tasks and both languages: retrieval of sound-to-letter mappings (indexed by RAN) and manipulation of sound units (indexed by phonological memory). However, unlike previous studies, they suggest *different units* may be critically retrieved and manipulated in French and English, in particular in text spelling: namely morphological inflections and "large" meta-linguistic units may be particularly critical in French spelling as compared to English. The principal component analysis did not provide a perfect fit for the distinction between "large" and "small" units used in the regression, so one should be cautious in interpreting these results. Nevertheless, correlation analyses provided good support for this predictor differentiation. The emphasis on inflectional morphology and syllable chunking in French children's reported strategies (as opposed to rime and phonemic chunking in English) and the cross-language differences observed in the qualitative spelling error analysis further support the hypothesis

of a difference in the linguistic units recruited in spelling in French and English, especially in text spelling. Future studies could explore these cross-language differences further using factors analysis independently for both languages (in order to highlight any differences in component loadings), and across ability and age groups (with a sufficient number of participants). It was impossible to conduct these analysis independently for CA, SA and DLD groups in the present study, due to small numbers. Future studies may want to further differentiate profiles and control for the variability that a sample including children with DLD may provide.

10.6. Implications and future directions

10.6.1. Towards a dynamic linguistic framework for assessing and teaching spelling in DLD

Both spelling error and strategy analyses provide a homogeneous set of results regarding the mechanisms involved in the spelling difficulties of children with DLD. Across domains (phonological, orthographic, semantic and morphological), children with DLD perform below same-age peers and at a level similar to spelling-matched peers, with the exception of morphological inflections and irregular phoneme-grapheme correspondences in English, which seem to remain a particular area of difficulty. The linguistic framework provided by Apel & Masterson (2001) provided an interesting base for assessing these mechanisms, but results suggest that difficulties across linguistic domains interact in a dynamic way in children with DLD, and that no domain is specifically affected by DLD, over and above what might be expected given children's spelling level (except for morphological inflections in English). One practical implication of these results is that children with DLD may benefit from a holistic word approach to teaching spelling. It is unclear from the current results that any particular domain of spelling should indeed be a target for intervention in children with DLD. One might thus prefer approaches where the phonological, morphological, orthographic and semantic

aspects of words are taught and meaningfully related. Repeated exposures to word forms in a variety of semantic and syntactic contexts may be needed, as well as linking oral and written forms, teaching relevant morphemes and semantic distinctions (Parsons, 2014; Westwood, 2014), in other words, 'word study' in the broad sense may be most appropriate to address the spelling difficulties of children with DLD (Moats, 2009). The explicit teaching of self-help strategies usually reported by children, such as the use of phonetic strategies (sounding out) for regular word, analogies, chunking, visual imagery, multi-sensory approaches or mnemonic have be shown to be effective in children with learning difficulties (Westwood, 2014). It is likely that such strategies may help to enrich the poor word representations of children with DLD.

10.6.2. A developmental and cross-language perspective on spelling ability

Another important finding of the present thesis relates to the cross-language differences that may appear throughout primary school in the processes underpinning spelling in French and English students. To our knowledge, this thesis provides the first exploration of such processes across French and English with an extensive primary school dataset and a broad linguistic framework. It is evident from the results presented in chapters 7, 8 and 9 that dramatic changes in spelling errors and strategy choices occur throughout primary school: English students move on from relying heavily on phoneme-based strategies (with high error rates) to using larger chunks of words and rule-based strategies, with an increased accuracy across all error types as they get older; morphological inflection strategies also seem to be reported relatively early on, and used with relative efficiency even in the youngest spellers of English. In French, by contrast, phoneme-based strategies and errors are relatively marginal in the younger age-group, but children use syllabic chunking, morphological and rule-based strategies heavily early on, despite the rate of orthographic errors being very high in the SA group, and the rate of morphological errors remaining very high in the CA group. Because the present thesis focused on a population of children with DLD, observation of the

CA and SA scores only provide indicative evidence of developmental shifts. However, the static linguistic framework used in the present study may provide a base for further parallel qualitative analyses of strategies and errors in spelling French and English. Extending this approach with a developmental perspective may provide further insight into 1) differential developmental mechanisms across languages and 2) the importance of explicit knowledge of spelling strategies for efficient spelling. In the present study, some report of strategies seem to precede their efficient use in spelling (e.g. young French spellers are able to use rule-based strategies early on, even though orthographic errors still appear at a high rate in that age group), but for some domains, spelling knowledge and efficiency seem to be related (e.g. young English spellers are able to report the use of morphological inflections in their spelling and produce very few morphological inflection errors in their spelling as a group). Relating error types and strategy reports further may help disentangle the link between explicit knowledge and efficiency in use. The sample size did not allow for such comparisons in the present study, but future correlational/regression studies across languages may also contrast predictors in early and late primary school to ascertain developmental shifts in the processes underpinning spelling.

10.7. Limitations

There are challenges to the reliable assessment of metalinguistic skills at the end of primary school. As highlighted in the factor analyses, awareness of different linguistic units is highly related. Challenging tasks involving the manipulations of such units for older children (such as unit extraction) arguably also involve processing skills like phonological memory. It is thus difficult to tease apart different linguistic units on the one hand, and those linguistic units from the processes necessary for their manipulation on the other hand.

There are also challenges to the elicitation of spelling strategies in children with language difficulties. Prompting was used in the present study, inevitably orientating students to the

target strategies. More naturalistic approaches (with no prompting at all) or a more directed approach (involving a test-teach-retest approach) may prove useful in future to balance out potential teaching effects.

Although the spelling error analysis scheme used in the present study attempted to be comprehensive, it involved collapsing a number of errors into categories for analysis, reducing the capacity to pick up on differences at a finer grain across groups (e.g. specifically comparing the rate of -ed errors for example). There is also a strong element of inferencing and subjectivity in spelling error analysis, which cannot be fully overcome even with a second independent rater. The use of theoretically-grounded scales which have been standardised on large samples of students may be a way forward in this field of study (Bahr et al., 2012).

10.8. Conclusion

The present study assessed the errors, strategies and predictive skills involved in the spelling of French and English children at the end of primary school. Together, results point to similar processes, but different linguistic units involved in efficient spelling in these two languages. Specifically, inflectional morphology was a particular constraint in spelling French, whilst irregular phoneme-grapheme correspondences were a particular constraint in spelling English. French children also produced shorter and less accurate texts than English peers, but their spelling accuracy aligned in word dictation. A second research objective regarded specific markers of developmental language disorder in the spelling of French and English students, as compared to both same-age and same-spelling-level matches. The results highlight the difficulties of both French and English children with phonological, orthographic and morphological spelling processes in both languages, in line with younger peers matched on spelling level - with the exception of morphological inflections in English. They suggest a broad spelling deficit in DLD, rather than specific difficulties in one or several domains. Altogether, the results contribute to the refinement of theories of spelling development

across languages beyond the early grades, and to the literature on the characterisation of spelling difficulties in children with DLD.

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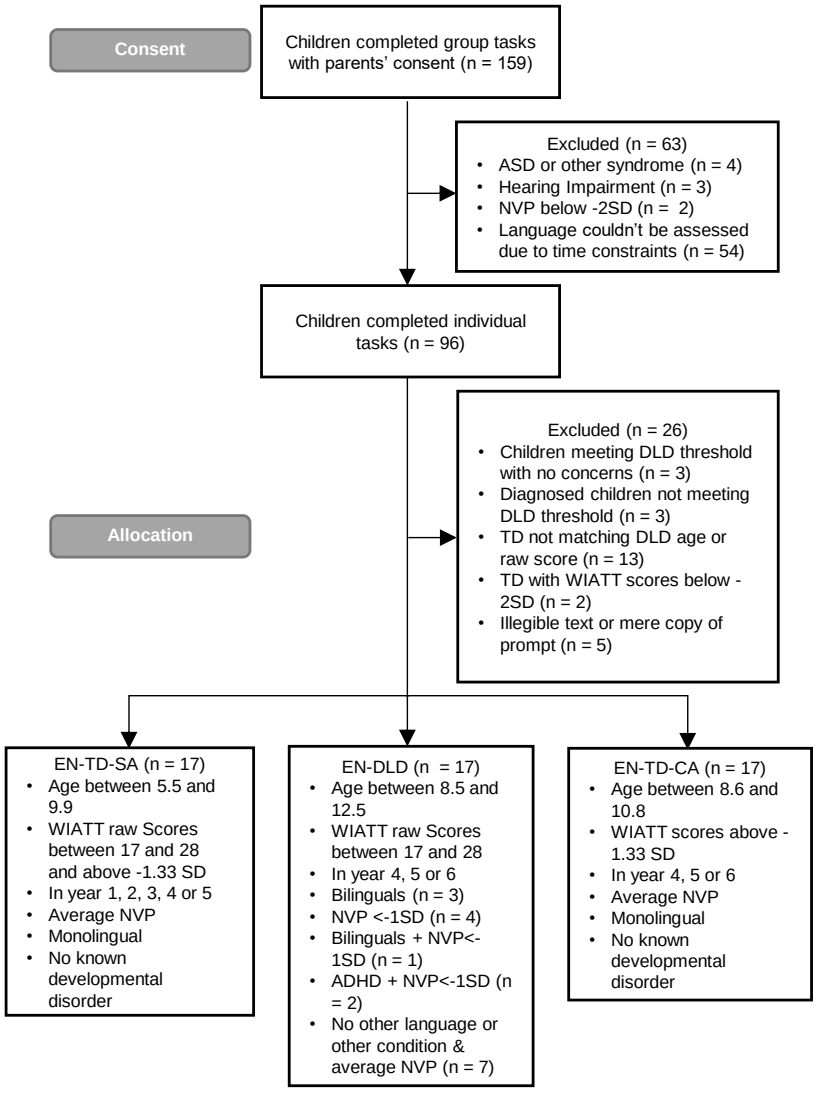
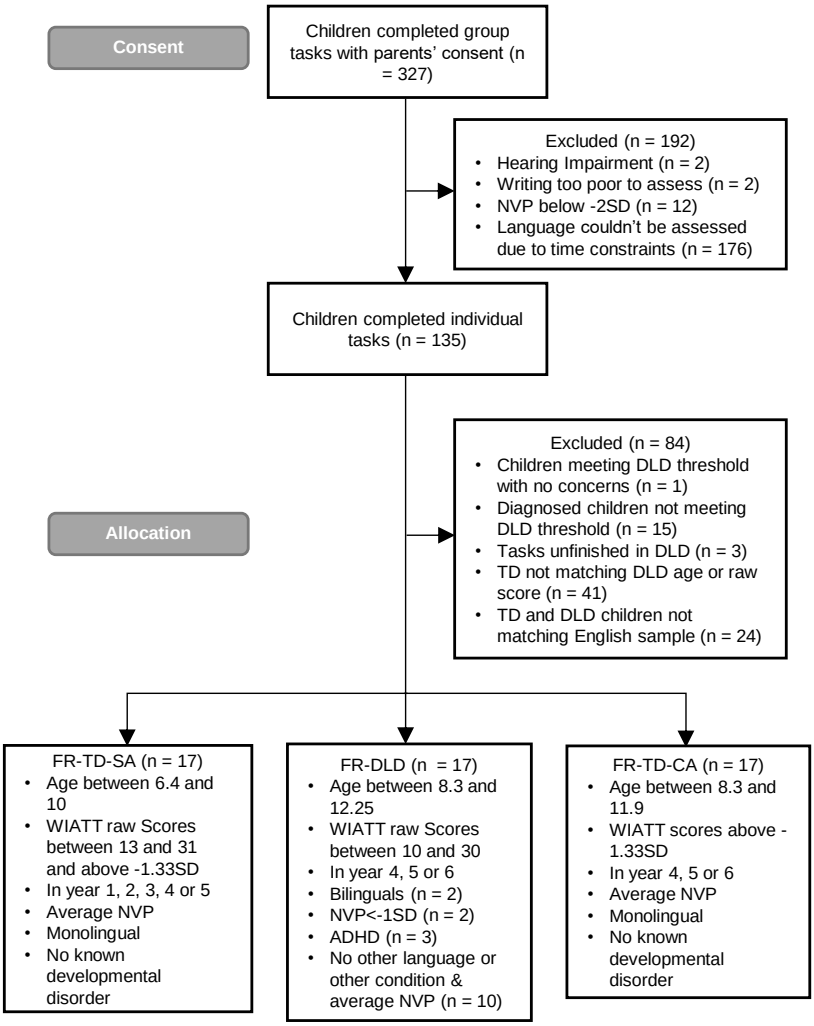
Appendices

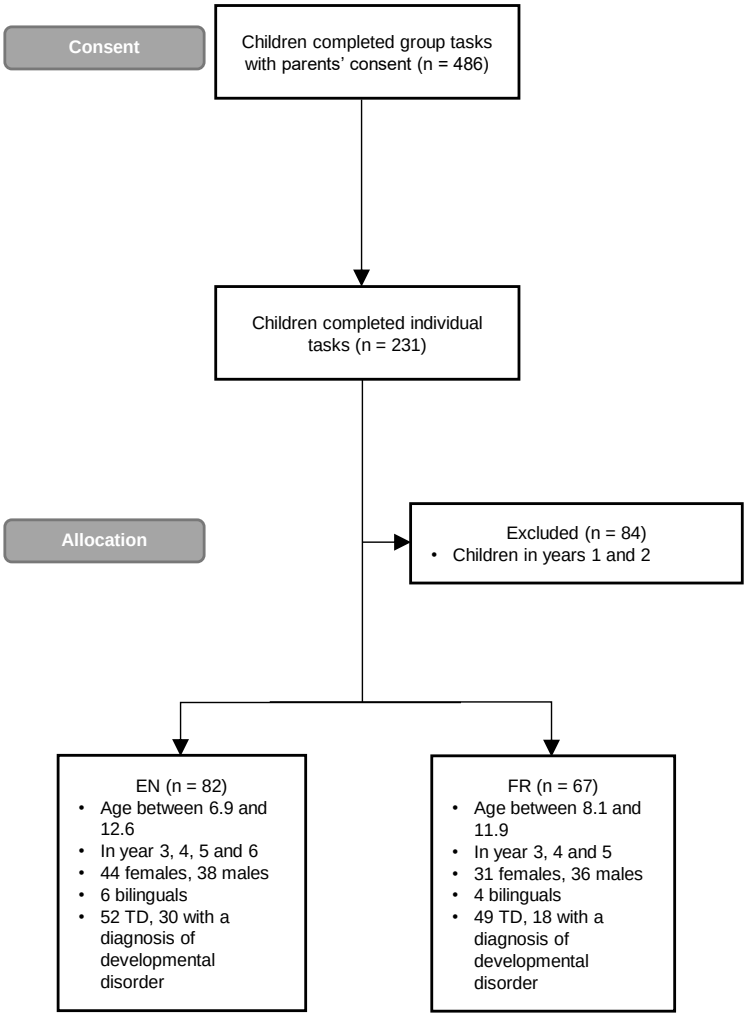
Appendix A: Flowchart for the recruitment of the English groups



Appendix B: Flowchart for the recruitment of the French groups



Appendix C: Flowchart for the predictors study recruitment



Appendix D: Information letter to headteachers (English)

Letter of information: Research Project
Spelling and language development in French and English

As part of my PhD at the UCL Institute of Education, I am running a project to assess the spelling and language development of French and English students. This project looks specifically at some of the knowledge and strategies that are involved in the spelling development of children in the last 3 years of primary school, in both languages, and in children with and without a Developmental Language Disorder (DLD). We hope that knowing more about the spelling strategies children use will contribute to support their spelling development, in both countries. I am writing to invite your school to participate to this project.

The project involves authorising me to come into the school and assess children on a range of tasks, with parent's consent. It is organised in two sessions:

- A group session of 45 minutes to an hour, where children are requested to write words under dictation, to write a short piece of text, to complete a short non-verbal reasoning task and to choose a spelling for invented words.
- An individual session of an hour, where children complete language tasks, manipulate sounds and chunks of words, and tell me about their spelling strategies.

The timetable for these two sessions can be arranged at the teacher's convenience.

I can provide a recent DBS certificate, which can be checked through the DBS update services. The project has been approved by the research ethics committee of the UCL Institute of Education. All results will be anonymous and will be securely kept until the end of the project. The results will be analysed for the purpose of the research project only, and will not be disclosed to any third-party. Children, parents and schools will have the right to withdraw from the project at any time.

I will be available to answer any questions you may have on the project. Please feel free to contact me.

Many thanks,

Nelly Joye

Appendix E: Information letter to headteachers (French)

Invitation à participer : Projet de recherche
« Orthographe et langage »

Dans le cadre de mon doctorat à l'Institut d'Education de l'université de Londres (Royaume-Uni), je travaille sur le développement du langage et de l'orthographe chez des enfants Anglais et Français. Mon projet s'intéresse plus particulièrement aux connaissances et stratégies qu'utilisent les enfants du CP au CM2, avec et sans trouble du langage, pour orthographier dans ces deux langues. Les enfants qui ont des troubles du langage présentent en effet des difficultés dans l'apprentissage de l'orthographe dans ces deux langues. La nature de leurs difficultés dans chacune de ces deux langues reste toutefois à explorer. Je cherche donc à rencontrer des enfants avec et sans trouble du langage, en France et en Angleterre. Je souhaite inviter votre école à participer à ce projet.

Le projet se déroule en deux sessions pour chaque enfant :

- Une session de groupe, d'une durée de 45 minutes, incluant une tâche de dictée de mots, une tâche de narration écrite, une épreuve de raisonnement non-verbal et une tâche de conscience orthographique.
- Une session individuelle, d'une durée de 1h, incluant trois épreuves de langage (répétition de phrase, compréhension de phrase et compréhension de mots), des épreuves de conscience morphologique, de conscience phonologique, de répétition de non-mots, de dénomination rapide d'images et chiffres, et une épreuve de jugement orthographique avec verbalisation des stratégies utilisées.

Les sessions seront réparties dans l'emploi du temps à la convenance de l'enseignant. Elles auront lieu au sein de l'école, dans une salle au calme.
Je peux produire, à votre demande, un extrait de casier judiciaire vierge (bulletin n°3). Le projet a été approuvé par le comité d'éthique de l'Institut d'Education. Tous les résultats seront anonymes et seront stockés dans un lieu sûr, jusqu'à la fin du projet. Un compte-rendu des performances de la classe pourra être fourni à l'enseignant à sa demande, sans référence aux performances individuelles des participants et dans le respect de leur anonymat.

Je vous remercie pour l'attention portée à ma requête et reste disponible pour répondre à vos questions.
Bien à vous,

Nelly Joye

Appendix F: Information leaflet for parents and children (English)

UCL
Institute of Education

I am a PhD student at the UCL Institute of Education.

I am running a project on spelling and oral language in French and English students.

Knowing more about spelling and language will help us support children better, in both countries.

Your child can help by doing a few spelling and language tasks with me.

What am I doing? I am researching how spelling develops in French and English and what strategies might help children to spell.

What will your child do? You child will be asked to do things such as writing a short text, spelling real or invented words, explaining how he/she went on to spell words, or repeating sentences or invented words. Most children really enjoy spending time doing these activities. Your child will receive a certificate to acknowledge their help and involvement.

How long will it take? Altogether, your child will spend 1 hour and a half to 2 hours with me doing these tasks, taking breaks as needed.

Will your child's name be used in the study? No. your child will have a code and his answers will not be identifiable.

Would you like your child to participate? If you and your child would like to participate, there is a form at the end of this leaflet. Please fill the form if you would like your child to participate in the study.

What if you change your mind? You can decide you don't want your child to participate at any time point, by contacting me.

What if you want to know more about the study? Please contact me, Nelly Joye, on this number: (mobile:), or at this email address:

Parent Consent form

I give my consent for my child to participate in the research project on spelling and language.

- Your child's name: .....
- Your child's date of birth: .....
- Your child's class: .....

Does your child have any diagnosis that might affect their spelling or language (Language Impairment, ADHD, Autism, dyslexia, hearing impairment, others)?

.....

Do you speak any other language(s) than English at home?

.....

Date ..... Signature:

Child consent form

Are you happy to take part?

Yes, I would like to take part ☐

Please print your name here:

Thank you for replying!

Appendix G: Information leaflet for parents and children (French)

UCL
Institute of Education

Je suis orthophoniste et doctorante à l'institut d'éducation à l'université de Londres (Angleterre).

Je mets en place un projet sur le langage oral et l'orthographe chez des enfants français et anglais.

Si nous en savons plus sur le langage et l'orthographe, nous pourrons mieux aider leur développement, dans les deux pays.

Le projet se déroulera dans l'école de votre enfant en mars 2017.

Votre enfant peut nous aider en faisant avec moi quelques exercices de langage et d'orthographe.

Qu'est-ce que je fais ? Je m'intéresse au développement du langage et de l'orthographe en Français et en Anglais, et aux stratégies qui aident les enfants à apprendre.

Qu'est-ce que votre enfant va faire ? Je demanderai à votre enfant de faire des exercices simples comme écrire un court texte, écrire des vrais mots ou des mots inventés, m'expliquer comment il/elle a fait pour écrire certains mots, ou répéter des phrases ou des mots inventés. Les enfants aiment généralement faire ces exercices. Votre enfant recevra un certificat pour le remercier de sa participation.

Combien de temps ça dure ? En tout, votre enfant passera 45 minutes avec moi en groupe, puis éventuellement, 1h à 1h15 en individuel, par la suite, pour faire ces exercices, en prenant des pauses si besoin.

Est-ce que le nom de mon enfant apparaitra dans l'étude ? Non. Votre enfant aura un code, et ses réponses ne pourront pas être identifiées.

Est-ce que votre enfant voudrait participer ? Si vous et votre enfant souhaitez participer, merci de remplir le formulaire ci-dessous.

Et si vous changez d'avis ? Vous pouvez décider de ne pas participer à n'importe quel moment, en me contactant.

Et si vous voulez en savoir plus ? Merci de me contacter, Nelly Joye, à ce numéro ou par mail :

Autorisation parentale

Je donne mon consentement pour que mon fils/ma fille participe au projet de recherche sur le langage et l'orthographe.

- Le nom de votre enfant : ……
- Sa date de naissance : ……
- Sa classe : ……

Votre enfant présente-t-il un diagnostic pouvant affecter son langage/orthographe ? (surdité, dyslexie, trouble du langage, trouble de l'attention, autisme, autres)

……

Votre enfant parle-t-il une autre langue que le Français a la maison ?

……

Date ……

Signature :

Coupon-réponse à renvoyer avant le

Accord de l'enfant

Est-ce que tu souhaites participer ?

Oui, je voudrais participer

Merci d'écrire ton nom ici :

Merci pour votre réponse!

Coupon-réponse à renvoyer avant le