Investigating spelling in English and Greek native speaking children with and without dyslexia

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Πάνω στο στέμμα μου βρυχάται άγριος λιόντας
κι έιναι του άγνωστου ο πιο μεγάλος τρόμος
το ξέρεις, μάτια μου, πως δεν υπάρχει δρόμος
αφού το δρόμο τον ανοίγεις περπατώντας

[Upon my crown a wild lion roars
The greatest fear is that of the unknown
You know, my love, there exists no path
You forge your path by walking]

From the song «Θέλω να πάρω τη φυλή μου και να φύγω» [I want to take my tribe and leave] by the Greek band "Hainides" (2000, Ο ξυπόλητος πρίγκηπας [The barefoot prince])

Abstract

Background. Mastering spelling skills can be very demanding for pupils of primary education, and might often be problematic for children with literacy learning difficulties. This thesis aimed to examine the spelling abilities of English and Greek native speakers with and without dyslexia attending primary education. The main goal of this study was to identify the problematic areas of spelling in relation to the abilities of the participants and the language in which they were writing.

Method. Typical spelling development was examined with cross-sectional comparisons between the spelling performances of 101 typical spellers in England (7.6-10.7 years) and 112 children in Greece (8.6-11.5 years) attending consecutive grades. The sample of children with dyslexia consisted of 18 children in England (M = 9.5 years) as well as 17 children in Greece (M = 10.1 years). Their spelling difficulties were investigated by comparing their error rates with those of chronological-age, reading and spelling ability-matched controls sourced from the sample of typically developing pupils. Spelling performance was assessed with three experimental tasks employing semantic context in a different manner: single word spelling, passage completion and text composition.

Results. Results in both languages showed an incremental progress in the spelling skills of typical spellers. Higher error rates were produced by dyslexic participants in comparison with their chronological controls but not with their ability-matched controls. A subsequent analysis of errors showed that the patterns, which depended on orthographic and morphological knowledge, were more frequently misspelled by all children of this age in comparison to phonological errors. The effect of semantic and syntactic context on different error types depended on the language, the spelling task and the abilities of the children.

Conclusions. The results are viewed in the light of universal theories of spelling development and theories of dyslexia. Implications for future research, for the diagnosis of spelling difficulties and for spelling practice in the classroom are discussed.

Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Anna Tsakalaki

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Studying at a Ph.D. level has been one of the most challenging and rewarding experiences in my life so far. My progress in discovering the fascinating world of research very often resembled the adventures of Lewis Carroll's famous heroine: "In another moment down went Alice after it, never once considering how in the world she was to get out again".

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Chapter 1

General Introduction

Learning to read and write is the main goal of the first years of formal education worldwide. Reading and writing skills constitute the foundation for the communication of ideas among the members of all literate societies. Furthermore, the development of reading and writing is linked with that of other language skills, such as the awareness of how individual phonemes map on graphemes (Goswami & Bryant, 1990) to form words that convey a certain meaning. Because of their crucial role, literacy skills consistently attract a strong interest of educational, cognitive and neuropsychological research.

Research studies have investigated the beginning of learning to read and write with the aim to describe the difficulties that young children confront at their early contact with written language and the ways that these are overcome through practice (e.g., Read, 1986; Treiman, 1993). Differences in the developmental trajectories of literacy skills are used to distinguish between children developing in a typical and atypical manner. Regularly a slow pace of acquisition of literacy skills is linked with a specific deficit in reading and writing, developmental dyslexia, which occurs despite normal intelligence, adequate learning opportunities, and no serious emotional or personality disorders. There is proportionally far more research on reading skills than there is for spelling skills both for children with or without dyslexia worldwide. However, mastering spelling skills is more challenging than learning to read, especially for languages where correspondences between phonemes and graphemes are not highly predictable. This is supported by studies in various alphabetic languages showing that individuals with dyslexia face persistent spelling difficulties even in adulthood regardless of their reading abilities (Alegria & Mousty, 1996; Bruck & Treiman, 1990; Bruck & Waters, 1988; Frith, 1980; Landerl, Wimmer, & Frith, 1997).

The importance of phonological awareness for the development of spelling ability is well established by research in various languages (e.g., English: Wagner & Torgesen, 1987; Wagner, Torgesen, Laughan, Simmons, & Rashotte, 1993; Czech: Caravolas, 2006; German: Landerl & Wimmer, 2008; Norwegian and Swedish: Furnes & Samuelsson, 2011; Greek: Aidinis & Nunes, 2001; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006;

Porpodas, 1989). Furthermore, the significant contribution of orthographic, grammatical and semantic knowledge has been highlighted (Bryant, Nunes, & Aidinis, 1999; Ehri, 1997). In particular, children appear to employ a variety of strategies to spell including retrieving the visual form of the word from memory (i.e., orthographic knowledge), recognising the morphological structure of words and following graphotactic rules of the conventional writing system (Nunes, Bryant, & Bindman, 1997; Treiman, Cassar, & Zukowski, 1994; Treiman, 1997). Spelling development has been suggested to involve progressing through sequential stages characterised by a dominant spelling strategy or through phases in which different spelling strategies are used to various degrees at different times (e.g., Ellis, 1994; Gentry, 1982; Goswami & Bryant, 1990; Goswami, 1999; Treiman, 1993). The latter concept is based on findings showing that there is no absolute homogeneity in the pace that each type of knowledge is acquired depending on the orthographic feature, the properties of the language (Caravolas, 2006; Seymour, Aro, & Erskine, 2003) and the literacy abilities of the children (i.e., typical and atypical development). Hence, it is important to ask what type of knowledge children acquire and when, as well as to examine both typically and atypically developing children to inform the theoretical frameworks aiming to describe spelling development and spelling instruction in formal education.

Research has demonstrated certain commonalities in the manifestation of dyslexia across different languages, such as a phonological deficit, slow and serial grapheme-to-phoneme decoding, weak spelling-to-sound associations and acquisition of verbal vocabulary (Gathercole & Baddeley, 1993; Ramus et al., 2003; Snowling, 1995; Stanovich & Siegel, 1994; Wimmer, Mayringer, & Landerl, 2000; Ziegler, Perry, & Coltheart, 2003), which postulate similar causes and consequences of dyslexia across orthographies. However, it appears that the level of consistency of the correspondence between phonemes and graphemes in a language impacts significantly on the extent to which learners with dyslexia manage to compensate for their phonological processing weaknesses when spelling. To date, mixed evidence is provided from studies across languages regarding the effect of phonological processing weaknesses on spelling performance. Overall, children with dyslexia are often found to make significantly more errors than same-age typically developing peers but there is a lack of consensus as to whether they perform at the same level as younger reading and spelling ability-matched typical learners (e.g., Alegria &

Mousty, 1996; Caravolas & Volín, 2001; Landerl & Wimmer, 2000). Similar discrepancies characterise the findings of studies in different languages examining morphological and orthographic weaknesses in spelling (e.g., Diamanti, Goulandris, Stuart, & Campbell, 2013; Egan & Tainturier, 2011; Nikolopoulos, Goulandris, & Snowling, 2003; Protopapas et al., 2013; Treiman, 1997; Tsesmeli & Seymour, 2006). Hence, there is an ongoing discussion about whether dyslexia may be associated with a delayed or a deviant spelling profile. Examination of systematic errors may be very informative in revealing the underlying mechanisms impacting on spelling processes.

To date, the number of studies comparing different types of spelling errors of children with and without dyslexia is limited and mainly conducted in English. The goal of the present thesis was to extend research findings by examining the spelling errors of English and Greek native speaking children of primary school age in quest of information related to the universal and unique characteristics of typical and atypical spelling development. Comparing spelling in English and in Greek can be very insightful of the role of language in the development of different spelling skills as well as the manifestation of dyslexia in two languages with different levels of consistency. Unlike English, which is considered to be an opaque orthography for both reading and spelling, Greek is fairly transparent for reading but not for spelling. On the other hand, both languages have a morphophonemic structure, since they retain the written form that satisfies adequate representation of morphemes, thus using alternative graphemes to represent specific phonemes. They, therefore, provide an excellent opportunity for a cross-linguistic investigation of spelling development in relation to different types of knowledge and different levels of ability.

1.1 Structure of the present thesis

In chapter 2 the literature related to spelling development in typical learners and learners with dyslexia is reviewed. An overview of the classification of writing systems as well as a description of the properties of the English and the Greek language are provided. This is followed by a critical overview of the central theories of spelling in relation to the acquisition of different spelling skills. Subsequently, the theories of dyslexia and cognitive factors influencing spelling skills are critically discussed. Finally, previous research investigating the development of spelling skills of children with and without dyslexia is evaluated accompanied by research exploring spelling processes within text writing.

Chapter 3 presents an outline of the rationale and the research goals of the present study. Chapter 4 thoroughly discusses the methodological considerations which led to the research design, the scoring of the data and the method of analysis. This is then followed by three empirical chapters presenting the findings of this cross-linguistic, cross-sectional study. The study presented in chapter 5 examines the development of phonological, morphological and orthographic spelling skills of typically developing children attending the four last grades of primary education in England and Greece. Chapter 6 investigates the spelling performance of one group of children with dyslexia in England and one in Greece attending the three last grades of primary school in comparison with three control groups of typically developing children, one matched in age, one matched in reading ability and one in spelling ability. Chapter 7 explores the extent to which semantic and syntactic context may influence the spelling performance of English and Greek children with and without dyslexia in relation to the application of different types of knowledge. Finally, in chapter 8 a summary of the goals and the results of the study is provided. This is followed by a general discussion interpreting the findings of the three empirical chapters in relation to the theories of spelling development, the theories of dyslexia. The chapter ends with a discussion of the theoretical and practical implications of the overall findings, the limitations of the present study as well as future research directions.

Chapter 2

Literature Review

2.1 Introduction

This chapter reviews research regarding literacy development with a focus on spelling ability. Research across different languages with pupils of various ages has shown that the development of literacy skills is subject to the characteristics of each language, which also define the predictors of reading and spelling development and the cognitive profile associated with literacy disorders, such as dyslexia.

2.2 Orthographic systems: transparency, regularity and consistency

One of the most salient features which distinguishes between different alphabetic orthographic systems is the transparency of the script. By the term "transparency" researchers refer to the systematicity of the relationships between written symbols and language sounds. A transparent script has a simple one-to-one relationship between the letter(s) and the sound, whereas less transparent scripts may contain sounds (phonemes) that correspond to more than one letter or letter string (graphemes), or letter(s)/graphemes that correspond to more than one sound/phoneme. By that definition, Finnish and English stand at two opposite ends of a continuum of transparency. The former is a highly transparent orthographic system where every phoneme corresponds to one grapheme (Aro et al., 1999) and the latter an opaque system with complex relationships between phonemes and graphemes (Venezky, 1970). Transparency of a written system may refer to the feed-forward direction (i.e., grapheme-to-phoneme) for reading or the feed-back direction (i.e., phoneme-to-grapheme) for spelling. Orthographic systems may be less transparent in the latter than in the former direction, as is for instance the Greek system (Protopapas & Vlahou, 2009).

Regularity and consistency are two main indices of orthographic transparency. Regularity refers to the degree to which the mappings between graphemes and phonemes conform to rules regulating the conventional system. As such, the pronunciation or spelling of regular words are fully predictable by the grapheme–to-phoneme correspondence (GPC) or graphotactic rules (e.g., the grapheme <ck> can only occur at the end of a word in English). In contrast, irregular or exception words have alternative pronunciations or spellings that do not conform to the GPC rules, as for example the word <yacht> in English. Deviation from GPC rules reflects the historical evolution of the language which results in retaining the spelling of morphemes despite changes in their phonological identity over time (Venezky, 1999). Consistency and inconsistency relate to the variability in the correspondences between the phonological and orthographic units, i.e., phoneme-grapheme, body and rime, whole word (Lete, Peereman, & Fayol, 2008; Treiman, Mullennix, et al., 1995). Body and rime are the written and spoken form representing a vowel and any following consonants in monosyllabic words (Wimmer & Mayringer, 2002) (e.g., <at> and /at/ respectively in CAT). In more opaque orthographies, smaller units, such as graphemes-phonemes are less consistent than larger units, such as bodies and rimes (Treiman, Mullennix, et al., 1995). This effect is indicative of the interaction between grain-size and transparency as suggested by the granularity and transparency hypothesis (Wydell, 2003). Granularity relates to the size of the linguistic unit represented in writing, as for instance graphemes, syllables, words using a fine-grain to large-grain classification. Therefore, as the level of opacity rises both small-unit and large-unit recoding strategies are required for proficient reading and spelling. Conversely, learners of more transparent orthographies may achieve accurate performance focusing on finer grain sizes (Ziegler & Goswami, 2005).

It follows that in order to read and write accurately one must be familiar with the rules that determine grapheme-to-phoneme correspondences in their conventional orthographic system, as well as with other meta-linguistic information (e.g., graphotactics, grammar, vocabulary, semantic context), which would explain any phonological inconsistencies. This familiarity does not have to be explicit. In general, translating letters to sounds (reading) and converting sounds to letters (spelling) employ the same types of information and, according to the theories of reading and spelling, involve similar processing. Nonetheless, major differences between them are also acknowledged (Ehri, 1997). More specifically, a satisfactory level of reading accuracy can be achieved based on at least some knowledge of grapheme-to-phoneme correspondence rules (phonetic-cue reading in Ehri, 1997). Conversely, exact awareness of the sounds and precise information about grammatical and orthographic properties of the conventional linguistic system is required to spell accurately (Perfetti, 1997).

2.3 The English orthographic system

The English language may be regarded as a morphophonemic writing system, because its written form combines both phonemic and morphological features. “Thus many words are phoneme-based correlatives of the actual sounds in the word” (Katzir, Shaul, Breznitz, & Wolf, 2004, p. 746), as for instance in DOG = /dog/. Many different types of syllables, most of which have a complex closed structure, compose the spoken form of the English language (e.g., CVC, CVCC, CCVC, where C: consonant and V: vowel). This increases the difficulties in phonological segmentation of spoken English, which consists of over 44 phonemes represented by the 26 letters of the English alphabet. In the feed-forward direction, the grapheme-phoneme correspondences are often inconsistent for vowels, as for example the 6 vowel graphemes (a, e, i, o, u, y) vary in their mappings to phonemes (e.g., compare the pronunciation of <a> in CAT, CALL, and WANT). There are also vowel digraphs and trigraphs (ae, ai/ay, au/aw, ea, eau, ee, ei/ey, eo, eu/ew, ie, oa, oe, oi/oy, oo, ou/ow, ue, ui, uy), many of which have alternate pronunciations depending on the lexical context or their position. For instance, Venezky (1999) estimated that when <ea> spellings do not occur before /r/, 63% are pronounced /i/ (e.g., MEAT) and 27% are pronounced /e/ (e.g., BREAD), while before /r/ they are pronounced /ɪər/ (e.g., EAR), /ʌr/ (e.g., EARLY) or /ɛər/ (e.g., BEAR). Consonant letters and digraphs are more consistent in their representation of phonemes (ck, d, dg, f, gn, h, j, k, kh, l, m, n, p, ph, q, r, rh, sh, v, w, x, y, z). However, there are exceptions, such as the <b>, <c>, <ch>, <g>, <gh>, <s>, <t>, <th>, <q> and <wh>, which alternate pronunciations according to the letters that follow (Venezky, 1970). For example <c> corresponds to /s/ before <e>, <i> and <y> (e.g., CITY) or /k/ elsewhere (e.g., CAT) and <gh> may remain silent (e.g., FLIGHT) or correspond to /f/ (e.g., TOUGH).

In the feed-back direction, phonemes can be represented by more than one grapheme, since according to Treiman, “…… /k/ may be spelled with c, as in cat, k, as in kite, or ck, as in back, among other possibilities. The spellings of /i/ include e, as in he, i, as in pizza, y, as in happy, ie as in chief, and others” (1993; p. 23). This is because the words retain their original etymological root or morpheme, as for example the silent <c> in <muscle> which is morphologically driven, because it is derived from the original Latin <musculas> (Katzir et al., 2004, p. 746). English orthography is determined not only by phoneme-based rules, but also by morphological and orthographic principles. Treiman provides a coherent example: "generally, / ɔ i / is spelled as oy at the ends of morphemes (e.g., toy, boyfriend) and before vowels (e.g., royal). It is spelled as oi elsewhere (e.g., oil, coin)" (1993, p. 23). However, there are exceptions to these rules which make spelling of certain words unpredictable, unless one has specific word-knowledge, as for instance with the word OYSTER. According to Treiman, "a person who knew the rule governing the alternation of oy and oi could generally spell / ɔ i/ correctly. However, this person would misspell the irregular word OYSTER as <oister>". Morphological rules that influence spelling are associated with inflection of words, such as the verbs "helped and cleaned. In English, inflections are added to the ends of words to mark such things as tense and number. The past tense suffix -D is one inflectional ending" (Treiman, 1993, p. 23) and is spelled as <ed> consistently, despite various pronunciations (e.g., HELPED actually ends with /t/, CLEANED ends with /nd/).

These examples serve to illustrate that English can be classified as an opaque orthography with spelling inconsistencies, many of which are due to morphophonemic structure. Nevertheless, English has a higher degree of orthographic consistency at the rime level. Treiman, Mullennix, and colleagues (1995) estimated that rimes were 77% spelling-to-sound consistent over different words, while the pronunciation of written vowels over the same words was only 51% consistent. The beneficial role of phonological segmentation into onset-rime units and the use of orthographic rime analogies has been highlighted in studies of learning to read monomorphemic words in English (Goswami, Gombert, & de Barrera, 1998; Goswami, 1999; Treiman, Mullennix, et al., 1995).

2.3.1 Instruction in English

Most children in England have pre-reading exposure in semi-formal settings at 3 or 4 years of age (Ellis et al., 2004). In nursery school the shapes of most letters of the alphabet are taught and books are read to the children as part of a daily routine. Repetition and rhyming are introduced at this stage. In reception year there is dedicated reading time daily and teachers use word-building, pattern recognition, and odd-one-out games to familiarise children with script. In year 1 strategies for whole-word recognition are cultivated further.

Emphasis is given in building a sight vocabulary, including families of word patterns sharing phonological or orthographic properties at onset or rime (e.g., CAT, HAT, and MAT) and in forming simple sentences. At this stage there is a requirement that all children are taught through systematic, structured phonics programmes as the first approach to word reading. Overall, developing reading and writing skills is a main target of the national curriculum from the start until the end of English primary education (4-11 years old).

2.4 The Greek orthographic system

Contemporary examination of the linguistic characteristics of Modern Greek has shown that, concerning reading practice, there is a high regularity in grapheme-to-phoneme mappings (Aidinis & Nunes, 2001). Thus, Greek is considered to have a highly transparent orthography. A Greek reader always pronounces each graphemic unit in each written word e.g. <θρανίο> = /θ-ρ-α-ν-ί-ο/ (/th-r-a-n-i-o/ = desk). Additionally, while the majority of Greek words are polysyllabic, according to Nikolopoulos (1999), Greek syllables are simple in structure following the open consonant-motif (e.g., V, CV, VC, CCV, CCCV). Therefore, phonological segmentation of the Greek spoken language is not as challenging for children as the English language. Spoken Greek consists of 32 phonemes that are represented by the 24 letters of the alphabet. There are 5 vowels that sound the same whether stressed or unstressed (a, e, i, o, u) (Harris & Giannouli, 1999) and 15 consonants (p, t, k, f, θ, x, v, δ, γ, s, z, l, r, m, n) (Holton, Mackridge, & Philippaki-Warburton, 2002). Graphemes correspond to single phonemes relatively consistently in different contexts (Chitiri & Willows, 1994).

Nevertheless, there is asymmetry in transparency, especially as concerns spelling. Most researchers agree that the main reason for the inconsistencies is the preservation of ancient Greek graphemes in Modern Greek language ("historic orthography" according to Loizidou-Ieridou, Masterson, & Hanley, 2009; Nikolopoulos, 1999; Treiman, 1993). As a result, the written system has a morphophonemic nature that reflects the etymology of words (Porpodas, 1999), which may lead to differences in the spelling of phonemes within a word. As such, certain sounds in Greek can be represented by more than one letter (Mavrommati & Miles, 2002) including homophone vowels, as well as vowel and consonant clusters (diphthongs and dipsipha). For example the phoneme /i/ can be written with the letters <ι>, <η>, <υ>, <ει>, or <οι> e.g. <φιλήσυχοι> (/fil΄isiçi/ = peaceful). Similarly, the phonemes /o/, /e/, and /s/ are written with different letters depending on the letters that follow, their position in the word or sometimes unpredictably. For example the letter <υ> can be pronounced in three ways; as an /i/ e.g., <χύνω> (/ç΄ino = I pour), as an /f/ e.g., <ευτυχώς> (eftix΄os = fortunately), as a /v/ e.g., <αυγό> (/avg΄o = egg) or may remain silent e.g. <εύφορος> (/΄eforos/ = fertile).

As concerns the structure of the words, the standard form of a word in Greek consists of two parts: a stem, which represents the meaning of the word, and a suffix, which defines whether it is a noun or a verb, and conveys other grammatical information. For more complex words prefixes can be combined with the stem before suffixes are added e.g., ΦΙΛΑΝΘΡΩΠΙΚΟ = philanthropic : <φιλ> (/fil/ = caring), <ανθρωπ> (/anthrop/ = people), <ικό> (/ikó/ = adjective, singular, and neuter). In addition, a word may inflect according to case (e.g., possible singular masculine endings; <–ος>, <-ης>, <-ας>, <-ες>, <-ους>), and depending on the lexical context e.g., <βάζω> (/v΄azo/ = I put: verb) versus its homophone <βάζο> (/v΄azo/ = flowerpot: noun).

The spelling of Greek suffixes in particular is dictated by morphological rules relating the structure of nouns, adjectives and verbs with morpho-syntactic information. In the Greek rich inflectional system this information is conveyed by nine features, each of which has at least two values (Ralli, 1998;Table 2.1, p. 29). Feature is the term used by Ralli (1998; 2000) to signify the properties of a word that may have a role in morphology and syntax. The values relate to specific spelling options determining correct representation of the morpho-syntactic information by the suffix. Specifically, in the case of nominal inflectional classes, different classification systems have been proposed, as for instance based on the number of syllables (i.e., parisyllabic and imparisyllabic; Tsopanakis, 1948), on syncretism, i.e., how much overlap occurs between different cases (Clairis & Babiniotis, 1996), on allomorphic variation of the stem (i.e., different forms in singular and plural) and the form of inflectional endings (Ralli, 2003) (see Appendix C1 for a classification of inflectional affixes of Greek nouns and adjectives). As concerns the inflectional suffixes of verbs, these indicate the person, number, tense, voice, aspect and mood. Similarly to English, aspect refers to the way an action is viewed by the speaker. The imperfective aspect indicates a single but continuous action or a habitually repeated action. Perfective aspect represents a single and completed action. Perfect aspect relates a completed action of the past to the present time. The tense of the verb refers to the time when the action occurs. The voice indicates whether the subject of the verb acts (active) or undergoes (passive) the action. Mood signifies the attitude of the speaker toward the action expressed by the verb (e.g., a statement, a desire, a command). Finally, Greek verbs may be classified as regular or irregular depending on whether their perfective stems fit into the recognisable "regular" patterns.

Table 2.1

Values of Morpho-syntactic Features of Nominal[a] and Verbal Inflection in Greek (adapted from Ralli, 1998, p. 53)

Feature	Values
Case[b]	nominative, accusative, genitive, vocative
Number[d]	singular, plural
Gender[c]	masculine, feminine, neuter
Nominal inflectional class[b]	eight classes (1-8)[e]
Verbal inflectional class[c]	two classes (1-2)
Person[d]	first, second, third
Tense[c]	present, past, future
Aspect[c]	imperfective, perfective, perfect
Mood[c]	indicative, subjunctive, optative, imperative
Voice[c]	active, passive

Note. [a] Nominal = nouns and adjectives. [b] Relates to nouns and adjectives. [c] Relates to verbs. [d] Relates to nouns, adjectives and verbs. [e] The number of classes varies depending on the classification system adopted.

An additional feature of the Greek orthographic system is the prosodic stress symbol (΄). Stress can occur on any of the final three syllables of a word depending on a variety of morphological and phonological factors, and indicates semantic/lexical information. It must be properly interpreted for successful reading because there are homophone words that are differentiated only by stress e.g., <γέρος> (/ʝ΄eros/ = old) versus <γερός> (/ʝer΄os/ = robust; Nikolopoulos, 1999). Especially for verbs, the position of the stress in the first person singular of the active voice distinguishes between paroxytone and oxytone verbs and defines their conjugation (see Appendix C2 for a table with the conjugation of the main types of Greek verbs).

2.4.1 Instruction in Greek

In Greece reading instruction usually starts at 5.5 to 6 years old. Initially, letter shapes and letter-to-sound correspondences are introduced, although most of the children have some knowledge of at least letter shapes since nursery school. Children practise synthetic phonics and rhyming for phonological recoding of simple CV syllables forming simple words. Letter names are taught once letter–sound correspondences are established, the use of phonics is extended to syllables with a more complex structure and children start building an augmenting sight vocabulary. In addition, the stress is introduced and children are encouraged to use it regularly in their writing. The basic reading process is typically well established by the end of the first grade (Harris & Giannouli, 1999) forming the basis for the development of children's spelling skills.

2.5 Theories of spelling

The processes by which readers/spellers manipulate script in their conventional orthographic system, as well as the development of reading and spelling skills are summarised in Ehri's (1997) framework (Table 2.2, p. 31 and Table 2.3, p. 33). This framework provides a coherent infrastructure for the first part of this chapter giving an overview of relevant theories. The focus is mainly on spelling processes and development, in order to address the central interest of the present study.

Table 2.2

Processes That Speakers of English Use to Read and Spell Words, to Recognise Misspellings of Familiar and Unfamiliar Words (adapted from Ehri, 1997, p.241)

	Familiar Words	Unfamiliar Words		
	By Memory	By Decoding	By Invention	By Analogy
Reading Processes	Access representation in lexical memory on seeing written form; retrieve pronunciation-meaning amalgam	Generate plausible pronunciation by sounding out and blending (assembling) units		
Knowledge sources possibly used		Phonological awareness (blending), grapheme-phoneme units, letter patterns, consolidated units, morphographs (roots, affixes)		
Spelling Processes	Access representation in lexical memory on hearing word; retrieve sequence of letters		Generate plausible spelling by stretching out pronunciation and segmenting it into units	Access familiar word with analogous pronunciation in lexical memory; retrieve relevant letters; generate remaining letters
Knowledge sources possibly used			Phonological awareness (segmentation), phoneme-grapheme units, letter patterns, consolidated units, morphographs (roots, affixes), partial memory for correct letters	
Misspelling Recognition Processes	Verify match or detect mismatch between spelling in view and representation of target word held in lexical memory	Apply knowledge of the alphabetic system to verify match or detect mismatch between letters in spelling and sounds in pronunciation of target word		Verify match or detect mismatch between spelling of word in view and representation of analogous word held in lexical memory

2.5.1 Stage models of spelling development

Stage models of spelling have been proposed by a number of researchers (Ehri, 1986; Frith, 1980; 1986; Gentry, 1982; Marsh, Friedman, Welch, & Desberg, 1980) based on analyses of spelling errors. One of the similarities among these models is that they all describe spelling development as a gradual process from primitive writing, through a phase of phonetic transcription, to mastery of morphemic-orthographic knowledge for correct spelling (Snowling, 1994).

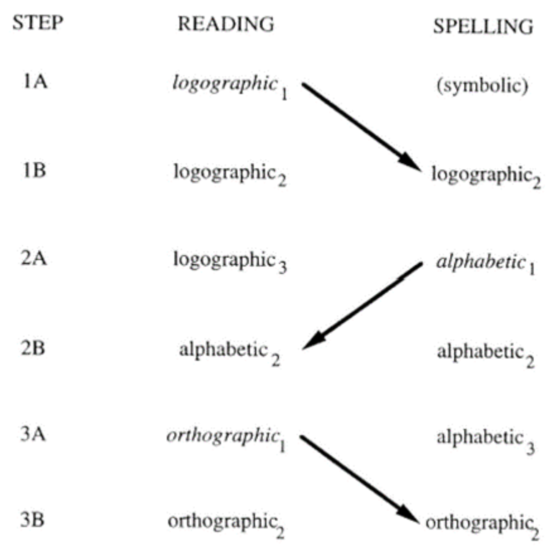


Figure 2.1
Frith's (1985) Model of Spelling Development (from Frith, 1985, p. 311)

More specifically, Frith (1980, 1985) suggested a model of spelling development with three stages (Figure 2.1, above): a) the logographic stage, at which children demonstrate no sound-to-letter knowledge and are only able to spell a few memorised words, b) the alphabetic stage, where sound-to-letter encoding is employed and c) the orthographic stage, at which phoneme-to-grapheme conversion is replaced by application of orthographic knowledge to analyse words into orthographic units without relying on previous phonological analysis. Frith's model is dynamic in that it also depicts the parallel development of reading ability, which interacts with spelling towards mastery of both. Furthermore, as the reader becomes proficient in the dominant reading strategy of one stage, his/her acquisition of that strategy in spelling is also enhanced, and vice versa (depicted with arrows in Figure 2.1, p. 32) (Ellis, 1994).

Table 2.3

Developmental Levels of Reading and Spelling (adapted from Ehri, 1997, p.241)

Developmental Levels	
Reading Words	Spelling Words
1. Pre-alphabetic, logographic	1. Pre-communicative
2. Partial alphabetic	2. Semi-phonetic, letter-name
3. Full alphabetic	3. Phonetic, phonemic
4. Consolidated alphabetic, orthographic	4. Morphemic, within word pattern

Similar to her model of reading development, Ehri (1997) proposed four phases of spelling development: the pre-communicative, the semi-phonetic, the phonetic, and the morphemic (Table 2.3, p. 33). In the pre-communicative phase children employ visual cues to represent arbitrary letters in a word (scribbles), which do not correspond to the actual sounds. Moving to the semi-phonetic phase, they have some knowledge of letters' names and sounds and have difficulty with detecting phonemes or segmenting words into phonemes. Studies of children's early spellings have demonstrated that learning to spell vowels is particularly difficult (e.g., Stage & Wagner, 1992; Treiman, 1993), and that they often omit vowels when spelling. The use of consonants only when spelling a word, is an indication that children's spelling represents the more salient sounds of the word, which often contain the sound of the vowel in the consonant letter's name, for instance <frmmr> for FARMER (Bourassa & Treiman, 2001). In the phonetic or full alphabetic phase children become capable of converting sounds to letters, and may also include extra letters in their attempt to convert adequately all sounds in a word. At the final, morphemic or consolidated alphabetic phase, children can recognise familiar spelling patterns in smaller (e.g., <ck> in BACK) and larger units in words, such as suffixes. Children become proficient in pattern recognition via reading and writing practice (exposure to print).

In Gentry's (2000) view there is an additional transitional level in children's spelling development between the phonetic stage and the final stage, which is called correct stage. This is when the child learns about exception words, and moves from phonological to morphological and visual spelling (e.g., <eightee> for EIGHTY). Reversal of letters within graphemes (e.g., <huose> for HOUSE) may occur often, because the visual strategy is not yet fully mastered by the child. Also, the words already learned (i.e., correctly spelled words) are used more frequently in children's written composition. In Gentry's (2000) final (*correct*) stage, spellers establish their knowledge of the rules of the conventional system. Specifically, they become able to spell prefixes and suffixes, can differentiate between homophones by employing semantic knowledge and can detect misspelled words via visual identification. Inspection of misspellings in various orthographic systems has shown that children's mastery and application of morphological and orthographic knowledge to spelling is still in development during the final grades of primary school (e.g., Bryant, Nunes, & Aidinis, 1999; Diamanti, Goulandris, Stuart, & Campbell, 2013; Loizidou-Ieridou et al., 2010; Protopapas, Fakou, Drakopoulou, Skaloumbakas, & Mouzaki, 2013; Treiman, 1993).

Developmental theories have informed the teaching of spelling as well as the assessment of spelling performance through the analysis of spelling errors. However, the notion that children's skills progress in stages has been criticised as lacking empirical support. More specifically, studies have found that the spelling errors of a child at a given time may reveal processing that corresponds to different developmental stages (e.g., Rittle-Johnson & Siegler, 1999; Sprenger-Charolles, Siegel, Béchennec, & Serniclaes, 2003; Varnhagen, McCallum, & Burstow, 1997). For example, indications for some basic use of both phonetic and orthographic strategies from an early age are provided by several studies (Goswami & Bryant, 1990; Nation & Hulme, 1998; Treiman & Cassar, 1997; Treiman, 1993). More specifically, Treiman (1993) observed that first graders appreciate the orthographic rule that <ck> does not occur in an initial position in English words. Goswami and Bryant (1990) and Nation and Hulme, (1998) detected the use of analogy to spell novel words based on familiar words in children as young as 6-7 years old.

Furthermore, there is no sufficient evidence to support that children progress from the use of the characteristic strategy of one stage to that of the next one. For instance Sprenger-Charolles and colleagues (2003) showed that children continued relying on phonetic strategies when they had already started using orthographic strategies.

Other approaches describing and explaining spelling processes are Share's self-teaching hypothesis (1995), Treiman's naturalistic approach, and the overlapping waves model (Rittle-Johnson & Siegler, 1999). According to Share's self-teaching hypothesis (1995), children initially employ phonological rules to read. They use phonological recoding as a self-teaching tool to develop word orthographic representations for skilled reading and spelling (Caravolas, Hulme, & Snowling, 2001). However, since studies have shown that there are children with good phonological awareness who still struggle with reading, researchers have concluded that additional cognitive factors might interfere in forming and using orthographic representations (Barker, Torgesen, & Wagner, 1992; Cunningham & Stanovich, 1993; Stanovich & West, 1989).

In a series of studies Treiman (1985, 1992, 1993, 1994) has examined the development of spelling as depicted in children's free writing. Based on the findings, she suggests that children's spellings do not necessarily progress in stages and that children appreciate the contribution of different types of knowledge in the conventional orthographic system from the start of writing practice, although their proficiency in applying them in spelling varies. A more illustrative depiction of the use of spelling strategies is provided by the more general framework of the overlapping waves model of cognitive development. "Abundant variability", "adaptive choice" and "gradual change" are the main principles supporting development (Rittle-Johnson & Siegler, 1999, p. 332). The researchers observed and interviewed first graders focusing on the spelling strategies they were employing. The children were retested in grade 2. The findings from both testing phases revealed a parallel use of six spelling strategies, supporting the notion that children may possess and apply selectively different strategies from the beginning. The fact that accuracy and speed increased from one testing point to the other was attributed to the continuous reinforcement of the various strategies over time, which lead to better and faster application of different types of knowledge (phonological, morphological and orthographic) at the second phase of the study. In contrast with the more static stage theories, Treiman's naturalistic approach and the overlapping waves model provide a more flexible framework describing spelling development. Testing the latter model over larger developmental periods and in more naturalistic writing conditions (e.g., text writing) would prove further its viability to describe spelling processes. Recently, Ehri (2014) revised her description of orthographic learning to integrate aspects pointed out by the aforementioned approaches. Her phase theory is combined with these approaches to suggest that grapheme-phoneme units and morphemic spelling units (e.g., roots-affixes) accumulate in memory as children acquire deeper knowledge about them. She also suggests that different units can be learnt at different paces within the same phase of development. Evidence from studies in languages with different levels of transparency and with participants of various ages provide further support for these more flexible approaches to spelling development and will be discussed in the following sections.

2.5.2 Models of skilled spelling

In line with models of skilled reading, models of skilled spelling describe spelling processes with regards to the strategies employed to spell correctly. As such, the dual-route account describes two mechanisms that spellers use in order to produce the spelling of a word (Barry, 1994). One route is called the *assembled* route (sometimes also known as the *non-lexical* or *sub-lexical* route) and the other is called the *lexical* route (Figure 2.2, below).

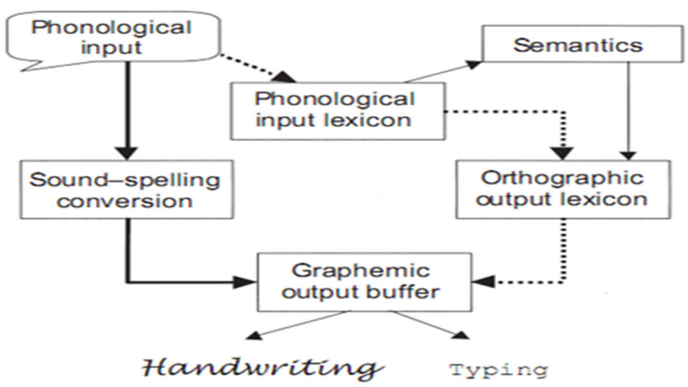


Figure 2.2

The Dual-Route Model for Spelling (Houghton & Zorzi, 2003, p. 117)

Note. Doted arrows show the lexical route, bold arrows the assembled route. A direct input from semantics is also shown.

In spelling to dictation tasks, the sound of the word is auditorily input and would initially be held in the phonological buffer of the model. Then either sound-to-letter conversion or retrieval of the word-specific information, as stored in the speller's memory, occurs. The two routes are activated simultaneously. The *assembled* route is the path whereby phoneme-to-grapheme correspondences (PGC) are applied to produce the visual form of the word, while the *lexical* path activates the words' orthographic representation using any phonological or semantic information stored in the lexicon (Barry, 1994). In that manner, regular words and non-words, such as /vot/, as well as irregular words, like YACHT, can be spelled correctly with the application of phonological rules and retrieval of word specific knowledge from the lexicon.

Different dual-route models have been proposed, which vary regarding the processing mode (serial versus parallel), possible interactions between the two routes and the control over when each path is used (Houghton & Zorzi, 2003, for further discussion on variability see Barry, 1994; Coltheart & Rastle, 1994; Zorzi, 2000). The dual-route architecture is adopted by many researchers, since it was regarded as an appropriate framework to explain spelling processes in studies with typical and impaired individuals (e.g., phonological dysgraphia and surface dysgraphia, see Barry, 1994; Houghton & Zorzi, 2003).

More specifically, Campbell (1983) suggested that spellings of non-words can be produced by lexical analogy with already familiar words. In her study participants were presented orally with lists of words (e.g. /brain/ and /crane/) and non-words (e.g. /prein/) and they were asked to write down only the non-words. Campbell observed that non-words' spellings were affected by the oral words' spelling (e.g. /prein/ spelled as <prain> or <prane>) depending on the oral word given each time. Barry and Seymour (1988) extended Campbell's study to adult participants and introduced the *sound-to-spelling contingency* effect, which refers to the frequency with which spelling patterns represent vowels (e.g. /i:/ corresponds more frequently to <ea> and <ee> than to <ie>). According to their findings, sound-to-spelling contingency did not influence non-word spelling. However, for less frequent vowel patterns participants were found to use the regular spelling of the vowel more frequently as opposed to the irregular (e.g. /i:/ spelled as <ee> more frequently than as <ey>). Based on their findings, they proposed an interactive dual route framework for non-word spelling: vowel phonemes can be spelled through the assembled route taking into account the probabilistic sound-to-spelling correspondences stored in the lexicon. Tainturier and Rapp (2004) and Tainturier and colleagues (2013) further support the proposal for interaction between the two routes. The former study provides evidence from participants with acquired dysgraphia suggesting that representations of words and pseudo-words may be activated at the graphemic level via the lexical route, the sub-lexical route or both. The representations are maintained active until a letter string is selected for output under the combined influence of lexical and sub-lexical processes. The results of the latter study with normal adult participants showed a strong effect of lexical neighbouring (words) on the spelling of pseudo-words, which increased for higher frequency words and when larger phonological overlap between the word and the pseudo-word under examination occurred. This effect was attributed to the parallel activation of the component graphemes of orthographic forms in the lexicon (lexical route) and a set of candidate graphemes (sub-lexical route), which results in selecting an integrated spelling output.

The movement towards a single-process architecture of computational connectionist models to simulate human reading performance (e.g., Plaut, McClelland, Seidenberg, & Patterson, 1996; Seidenberg & McClelland, 1989) resulted in the designing of the Dual Route cascaded model for reading aloud (Coltheart, Curtis, Atkins, & Haller, 1993). This model combined the computational architecture and the dual paths for reading, both of which would be activated by any written output (Bates et al., 2007). Soon single-route multilayer connectionist networks trained with a back propagation algorithm were applied to simulate spelling processes in humans (Figure 2.3, p. 39, left). The advantage of connectionist models over traditional dual-route models was that they included hidden units between the input and output units. Hidden units enabled the model to produce distributed representations at this intermediate layer, which allowed it to generalise statistical regularities to novel stimuli (pseudo-words) (for an overview see Houghton & Zorzi, 2003).

In line with the movement towards computational models, Houghton and Zorzi (2003) designed a connectionist dual-route multilayer model of spelling (Figure 2.3, p. 39, right). According to Houghton and Zorzi, the hidden units introduced between the input units (phonemes) and the output units (graphemes) of the lexical route would permit the item-by-item “rote” learning of exception stimuli. At the same time, the assembled (sub-lexical) route of classic dual-models was retained, so as to enable training in “linear regularities” (i.e., regular PGC), while freeing the lexical route from the need to generalise to novel stimuli. That way the two routes were allowed to learn simultaneously.

Figure 2.3
Single-Route Multilayer Model (left) and Dual-Route Multilayer Model (right) (Houghton & Zorzi, 2003, p. 121)

After training in a representative sample of English monosyllabic words the network employed both routes interactively. According to Houghton and Zorzi, the results from different simulation experiments showed that the interaction of the assembled and lexical route produced an effect of frequency and regularity. Specifically, it was found that the most frequent spelling patterns were spelled significantly faster than less frequent ones (e.g., /are/, /done/ versus e.g. /flood/, /lose/), which results in a greater influence of the assembled route on low-frequency words’ spelling. Also, regular words were spelled faster than irregular words (e.g., /best/, /big/ versus e.g., /bush/, /doll/) indicating an effect of interaction between lexical and assembled route when spelling familiar words. When the assembled route was tested in isolation, no effect of lexical information was found on the spelling outputs. On the contrary, it operated as a purely phonological path by applying phoneme-to-grapheme correspondence rules and by regularising the phonologically inconsistent patterns.

Dual-route connectionist models have the advantage of retaining the direct connections between input and output units, which enables the division of knowledge in two routes. This allows for separate investigation of the behaviour of each route to simulate not only typical but also impaired human spelling by examining each route in isolation. For instance, weakening the lexical route permits a more detailed simulation of surface dysgraphia (see Houghton & Zorzi, 2003). Furthermore, the multilayer architecture provides the asset of hidden units, which enable the extraction of statistical relationships between input and output simulating human implicit learning of spelling. Despite the limitations of the described connectionist dual route model (e.g., training only in monosyllabic units, absence of lexical mediation for the sub-lexical route; for a discussion see Houghton & Zorzi, 2003), researchers continue applying the dual-route architecture to connectionist models simulating spelling process in various languages (e.g., Bates et al., 2007; Katidioti, Simpson, & Protopapas, 2009). The capacity of the dual-route computational architecture to produce spelling outputs in systems of various orthographic depths resulted in the frequent employment of such models of spelling in different languages. This ability might be attributable to two main advantages of this architecture. First, connectionist networks are sensitive to statistical regularities between input and output, which allows them to capture the advantage of reading and spelling in more regular orthographic systems over less regular orthographies (Hutzler, Ziegler, Perry, Wimmer, & Zorzi, 2004). Second, the dual-route architecture permits better simulation of spelling processes in orthographies with different levels of transparency. In more transparent orthographic systems (e.g., Spanish) spelling outputs would be mainly the product of the assembled route, since the majority of the words can be spelled by applying regular sound-to-spelling correspondence rules, although there is evidence for the use of the lexical route (e.g., in French: Alegria & Mousty, 1996; Sprenger-Charolles et al., 2003; in Spanish: Cuetos, 1993; in German: Wimmer & Hummer, 1990). On the other hand, in more opaque orthographies (e.g., English) with many inconsistent spelling patterns, the lexical route would be the medium to correct spelling of exception words by retrieval of word-specific knowledge from the lexicon. This is supported by the findings of Seymour, Aro, and Erskine (2003) suggesting an advantage in reading real words over reading pseudo-words in more opaque orthographies as contrasted to more transparent orthographies.

Hutzler and colleagues (2004) argued in favour of introducing constraints simulating the teaching instructions implemented in the educational systems, where the languages are taught, to capture the language effect on the rate with which children master reading skills. In other words, taking into account the teaching regime would enable the model to replicate findings of empirical studies suggesting that children writing in more transparent orthographies develop their literacy skills earlier than children learning more opaque orthographies but that this advantage decreases when GPC rules become established (e.g., Frith, Wimmer, & Landerl, 1998). This is a plausible solution to address the limitation of connectionist models even when tested in a single orthographic system, namely the reliance on implicit inference of statistical properties. The critique on connectionist models also highlights the fact that children may apply spelling rules that are explicitly taught in combination with knowledge that they extract from orthographic exposure (Berninger et al., 2000). This is different from the processes followed by these models, which rely on inferring knowledge implicitly and extending it to novel stimuli. Another limitation of these models relates to the differences between models and children learning in real life conditions in the number of words they learn and repeated exposures to these words for successful learning. Specifically, Houghton and Zorzi (2003) recognised that their model was trained in far fewer exposures than children would experience in a formal learning environment as well as that the model was exposed to the whole set of monosyllabic English words, which would be impossible for children. Finally, the fact that the corpora used to test models of skilled spelling are limited to monosyllabic words restricts their capacity for simulating the learning of polymorphemic words that constitute a large part of the vocabulary of many alphabetic languages. Nevertheless, the advantages of connectionist models to simulate the processes involved in skilled word spelling as well as the learning process towards skilled spelling in orthographic systems of various orthographic depths establish them as useful tools in the conceptualisation of spelling mechanisms applicable to different linguistic systems. Besides, research on reading processes have shown that adequate modifications to the models may provide a very close approximation of human learning and can offer insights into key elements of children's reading development (Powell, Plaut, & Funnell, 2006).

Beyond the dual route and connectionist models of skilled spelling, the interaction of different information for accurate spelling is also conceptualised in the lexical quality hypothesis (Perfetti & Hart, 2002). According to this hypothesis, phonological, orthographic, semantic, morphological and syntactic information are stored in the speller's mental lexicon for each word. High quality of a lexical representation means exact knowledge of the above mentioned components. Thus, spellers with higher lexical quality spell more accurately than spellers with lower lexical quality. Lexical quality is subject to engagement with written language via reading and spelling practice. In this framework, regular and simpler words are easier to spell because their representations in the lexicon are stronger. The components of the representation are interconnected in a way that when one component is activated, it activates all the others. Repetitive activation of any of the word's stored information (e.g., semantic) by reading or spelling practice leads to strengthening their interconnections and results in higher lexical quality and hence more accurate spelling. This hypothesis has the main advantage of providing a flexible framework, which can be implemented in research examining various populations, including younger and older children, adults, typically and atypically developing participants. There is also the benefit that it emphasises the contribution of various factors in spelling processes and the multidirectional relationships among them, which constitutes it an appropriate framework to be used in cross-linguistic research and studies investigating spelling processes in different writing conditions. Due to this flexibility this framework is compatible with many other models of spelling providing the opportunity to be used either as a core or a supplementary model to explain research findings.

2.6 Derivational and inflectional morphology

A morpheme is defined as the smallest unit of meaning in a word (Quirk & Greenbaum, 1973; Quirk, Greenbaum, Leech, & Svartvik, 1985). One of the common linguistic characteristics of English and Greek is that a large proportion of words consist of more than one morpheme. Morphemes include stems and affixes, which may precede (prefixes) or follow (suffixes) the stems of polymorphemic words. Stems convey meaning but do not have a syntactic function, whereas suffixes may convey meaning and have a syntactic function, as for example the inflectional <-ed> suffix that marks the past tense of regular verbs and the derivational <-hood> suffix that generates abstract nouns in English (e.g., CHILD-CHILDHOOD, NEIGHBOUR-NEIGHBOURHOOD; Bryant et al., 1999). Therefore, morphology "involves both syntax and meaning expressed in a particular form" (Bryant et al., 1999, p. 113). Inflection is close to derivation but the distinctive characteristic between them is that the first provides forms of words, while derivation provides new words (Ralli, 2000).

As concerns the processing of words and their component morphemes, psycholinguistic models of lexical representation have suggested different ways of processing. Firstly, there are models that propose that lexical access proceeds through decomposition, which assumes the computation of individual morphemes (e.g., Taft & Forster, 1975). Alternatively, other models propose that simple and derived words are stored as whole units in the lexicon (e.g., Butterworth, 1983). There are also the intermediate models which suggest that the lexicon contains both whole words and individual morphemes (e.g., Caramazza, Miceli, Silveri, & Laudanna, 1985). Bryant and colleagues (1999) reviewed a series of studies about the acquisition of morphological strategies by English and Greek children and their application in spelling. Based on the findings, they suggest that children master the phonological aspects of spelling first, which results in accurate spelling of the phonologically consistent morphemes earlier than the phonologically inconsistent ones, e.g., <-ing> versus <-ed> in English. When children start using morphemes as spelling units, they do not appear to possess full appreciation of their function, which leads to over-generalisation of the morphemes, as for example by adding the <-ed> suffix to irregular verbs, e.g., writing <heared> for <heard>. Finally, they develop an understanding of the function of morphemes, which is signified by restricting the use of a specific suffix to the appropriate types of word and using all examined alternative spelling patterns correctly. Using word analogy and sentence analogy tasks, the researchers provide evidence to support that at this stage there is a strong relationship between children's morpho-syntactic awareness and their ability to adopt morphemes as spelling units. They conclude that the acquisition of morphological strategies is accomplished over time through reading and writing and that children writing in different morpho-phonemic orthographic systems seem to progress in a similar manner.

2.7 Dyslexia and cognitive factors influencing literacy skills

Mastering reading and writing skills is a demanding task for all young learners. It is completed gradually during primary school, and the pace of progress depends largely on the particular properties of the orthographic system and the cognitive abilities of the learner. Research in the acquisition of literacy skills in various languages has well documented the specific difficulties and slow progress of a number of children within the schooling population (Goswami, 2002). These difficulties are very often the behavioural signs of "dyslexia", which attracts the interest of researchers, educationalists and teachers.

A number of definitions of dyslexia have been suggested, identifying either its causes or its behavioural features, depending on the scope of each definition. There is however an agreement that “developmental dyslexia” is a disorder existing in impaired readers/spellers, whose difficulties with written language are not a product of inadequate learning opportunities, sensory or emotional disorders, brain damage or intellectual deprivation (Treiman, 1997; Vellutino, Fletcher, Snowling, & Scanlon, 2004). According to Rose, dyslexia “[…] affects the skills involved in accurate and fluent word reading and spelling”. It “[…] occurs across the range of intellectual abilities”, and is characterised by “[…] difficulties in phonological awareness, verbal memory and verbal processing speed” (Rose, 2009, p. 10). Particularly spelling is considered to be a more difficult task than reading, since precise knowledge of the word’s properties is required (Frith, 1980). Research in several languages provides evidence that pupils with dyslexia tend to underachieve in spelling tasks compared to typically developing spellers, even after having compensated for their reading difficulties (Caravolas, 2003; Frith, 1980; Snowling, 2000; Treiman, 1997).

As with all disorders of biological origin, the interest of research is attracted by the causal links from brain to mind to behavioural signs of dyslexia (Snowling, 2000). Morton and Frith’s (1995) three-level model of developmental disorders was originally designed to explain autism, but was effectively employed to demonstrate causal links in dyslexia too (Figure 2.4, p. 44). A significant advantage of this framework is that it incorporates a fourth external factor, the environment. Environment is postulated to influence the cognitive level lying between the biological and the behavioural level (Frith, 1999). This design is eminently suitable for the scope of the present study, because it allows for a better understanding of the effects of the orthographic script on literacy difficulties.

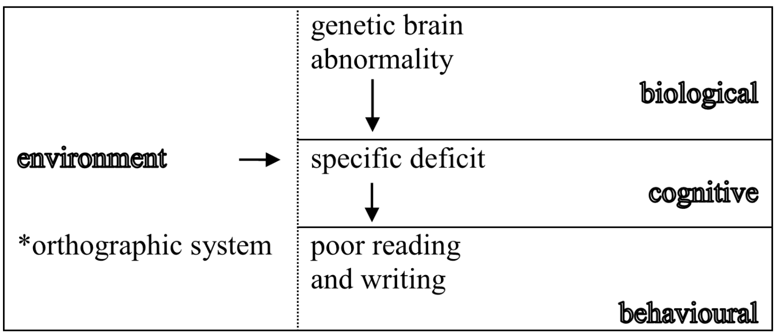


Figure 2.4

The Three-Level Framework (adapted from Frith, 1999)

Neuroimaging studies have investigated the biological basis of dyslexia in various alphabetic systems (e.g., Paulesu et al., 2001; Siok, Perfetti, Jin, & Tan, 2004). These studies have detected brain regions with atypical function e.g., magnocellular visual processing system (for an overview see Stuart, McAnally, McKay, Johnston, & Castles, 2006), temporo-parietal areas (see Vellutino et al., 2004), and temporo-occipital gyrus (Brown et al., 2001). A more detailed investigation of the biological origins of dyslexia is not relevant to the aims of the present study. It is nevertheless meaningful to note that in the examination of cerebral activity across languages one must take into account any variability due to different orthographies. More specifically, possible differences in neural circuits might occur, since print might be linked differently to oral language in different orthographic systems (Goswami, 2002).

Following the design of the three-level framework (Morton & Frith, 1995), the cognitive factors that are postulated to relate to literacy skills, are to be explored in this thesis. Evidence from research in typically developing children and pupils with dyslexia across languages will be presented, so as to investigate the interaction of the two levels (cognitive and behavioural) with a focus on spelling. Three main observations are evident from an inspection of research in different languages: a) studies in the English language are a lot more numerous than in any other system (Smythe & Everatt, 2004), b) a lot less research is conducted in spelling and writing than in reading, and c) phonological awareness is the most documented cognitive skill that has been investigated in relation with reading and spelling achievement.

Consequently, when examining different studies across languages, it is important to take their features into account. For instance, the selection criteria of participants with dyslexia might affect the outcome of comparisons. Thus, if they are recruited from different environments (e.g., special versus mainstream schools) or identified with different measures, comparisons between the findings of these studies should be treated with caution. Additionally, although all linguistic systems are based on the same principles, their prints may differ at the level of phonological or morphological properties (e.g., different uses of inflection, syllabic versus phonemic structure of the words). Thus, tasks adequately assessing a skill in one language might not detect the same ability in another system as efficiently.

For the purposes of the present study, research in alphabetic systems of different orthographic consistency was inspected. As outlined in section 2.2., consistency is the most profound linguistic feature that could produce differences when processing script in different orthographies. In order to draw comparisons regarding literacy skills across languages, orthographic systems can be located relative to each other depending on the level of grapho-phonemic consistency. For instance, Finnish is considered to have highly consistent grapheme-to-phoneme correspondences (GPC), even at the level of single letters (Lyytinen, Aro, & Holopainen, 2004). In contrast, grapheme-to-phoneme mappings are inconsistent in the English orthography, and knowledge of the GPC rules alone is not sufficient for correct reading and spelling. Readers/spellers need different levels of knowledge and proficiency in manipulating linguistic features depending on the transparency of the system. Skilled reading and spelling in a more opaque orthography would require mastery of a larger and more complicated set of rules about regularities and exceptions than in a more shallow system. Furthermore, differences related to the morphological rules regulating the structure of each linguistic system (e.g., monomorphemic versus polymorphemic words, inflectional and derivational rules) should be taken into account when examining literacy skills across languages.

Nevertheless, all alphabetic systems have some similarities in the structure, since for example written words consist of similar components, e.g., graphemes, syllables, stems, affixes. There are also commonalities in the operation of all orthographic systems. For instance, words relate to each other following specific grammatical and syntactical rules to communicate meanings in a text. These commonalities can form the ground on which to compare the influence of cognitive skills on reading and spelling across different languages. The cross-linguistic framework designed by Smythe and Everatt (2000) encapsulates five "key" cognitive areas related to causal theories of literacy difficulties in a coherent manner (Figure 2.5, p. 47). In detail, phonological segmentation and assembly skills include the manipulation of phonemes, syllables, rimes, onsets and words, which are related to correct reading and spelling. In addition, deficits in the auditory system would lead to difficulties in auditory discrimination or perception of sounds, as well as in storage and retrieval of this information from short-term memory. Deficits in the visual system would result in impaired visual discrimination or perception of symbols and their storage and retrieval from visual memory. Moreover, low speed of verbal processing, as indicated by naming speed tasks, has also been found to correlate with weak literacy skills. Finally, impairment in the lexical system would lead to difficulties with storage and retrieval of semantic, morphological and orthographic information from the mental lexicon, which affects reading and spelling. Variation in each factor (e.g., between children performing in different languages or between sub-types of dyslexia in a single orthographic community) "[…] may increase the level of explanation of variability in literacy ability" (Smythe, Everatt, & Salter, 2004, p. 20). Therefore, since this is an effective model to account for individual differences among readers/spellers, it is an excellent framework to support a cross-linguistic examination of literacy skills of children with and without dyslexia.

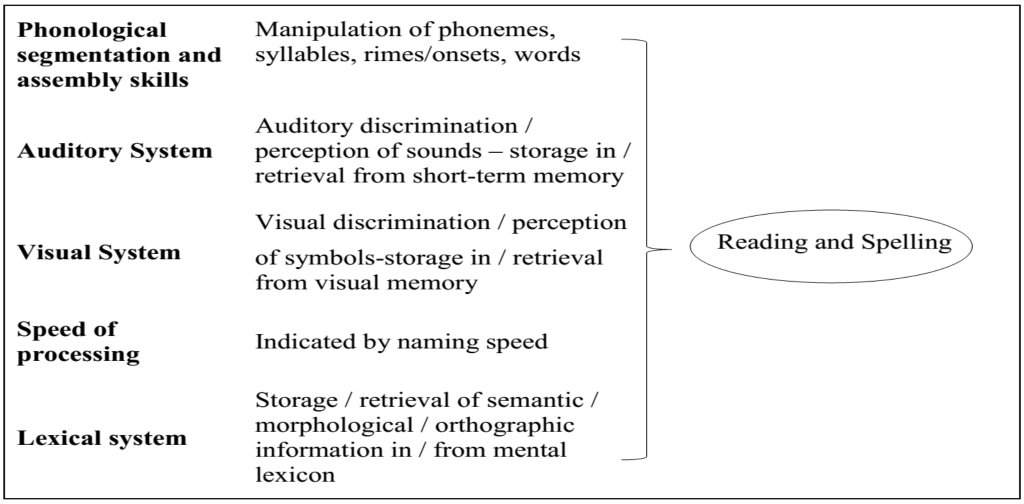


Figure 2.5

The Cross-Linguistic Framework (adapted from Smythe & Everatt, 2000, p. 20)

To comprehend the impact of phonological awareness on dyslexia, researchers' interest was firstly directed towards identifying the connection between this skill and proficient reading. Phonological awareness refers to children's ability to perceive, process, and manipulate the sub-lexical components of spoken words such as phonemes, syllables, onsets and rimes (Elbeheri & Everatt, 2007). The importance of phonological awareness for reading and spelling performance is very well documented in English and many other languages (Goswami, 2000; Snowling, Stackhouse, & Rack, 1986). It has been argued that literacy skills develop with the gradual establishment of connections between the spoken words and their visual forms (Vellutino et al., 2004). Phonological skills, such as the ability to segment words in units, have been found to relate to acquisition of word reading (e.g., Apel, Wilson-Fowler, Brimo, & Perrin, 2011; Castles & Coltheart, 2004; Stage & Wagner, 1992; Stainthorp, 2003). On the other hand, investigation of phonological awareness in relation to reading difficulties resulted in proposing the phonological deficit as a dominant cause of dyslexia (Snowling, 2000; Stanovich, 1988). Difficulties in acquiring phonological awareness and grapheme-to-phoneme coding skill are suggested to be the central cause of specific reading disabilities (Stanovich, 1988).

The influence of phonological skills on reading drew researchers' attention to possible similar connections with spelling ability. Caravolas, Hulme and Snowling (2001) examined the spelling ability of pupils in English following them during the first three years of primary education. In line with the findings of studies in reading, they found that phoneme segmentation skill and knowledge of grapheme-to-phoneme correspondences were significantly correlated with spelling ability at this age. Caravolas, Volín, and Hulme (2005) extended this research to Czech and English pupils. The sample included children with dyslexia between 6 and 12 years old, one group of chronological controls and one group of spelling age controls for each language. The results verified the strong correlation between phoneme awareness (phoneme deletion and spoonerisms) and spelling to dictation (sentences).

Evidence from the Greek language with typically developing children has so far verified the strong links between phonological awareness and spelling skill. Nikolopoulos, Goulandris, Hulme and Snowling (2006) conducted a one year longitudinal study on 131 pupils of the second and fourth grades of primary education, which included tasks of phonemic deletion, spoonerisms, speech rate, and spelling and highlighted the importance of phoneme awareness for spelling. Diamanti's (2005) findings have also underlined the role of phonological awareness in predicting orthographic ability. The data were obtained from a sample of 28 Greek speaking pupils of 8 to 10 years old assessed in phonemic deletion and spoonerisms (phonological awareness) and spelling choice tasks (orthographic ability). These results are in agreement with previous studies in English, Greek and in more transparent languages (in Greek: Aidinis & Nunes, 2001; Porpodas, 1999, in Czech: Caravolas et al., 2005, in Turkish: Babayiğit & Stainthorp, 2011; Oney & Durgunoglou, 1997; in German and English: Wimmer & Goswami, 1994).

Evidence supporting the phonological deficit hypothesis is also sourced from studies investigating the nature of spelling errors produced by children with dyslexia. For instance, Bruck and Waters' s (1988) study included children who were good readers and good spellers (Type A) and children that were good readers but poor spellers (Type B). Participants were assessed in reading and spelling tasks. Type B pupils appeared to have mastered basic phoneme-to-grapheme correspondence rules, but they failed to manipulate higher-level rules (e.g., the use of the silent marker <-e> in a monosyllabic word). Based on these findings, the researchers argued that Type B students' poor spelling resulted from an interruption of the typical developmental sequence in the alphabetic stage, associating these participants with classical developmental dyslexia.

In line with the above results, Snowling, Chiat and Hulme (1991) found that children with dyslexia employed poor phonological spelling strategies in comparison to younger normal readers when assessed on a spelling task with thirty real words of one, two, and three syllables. They classified misspellings in "phonetic" and "dysphonetic" categories. Phonologically plausible errors (e.g., <coler> for COLLAR) and phonologically implausible errors (e.g., <tert> for TENT) were audited. Although children with dyslexia and younger reading controls spelled the same amount of words correctly, the first made significantly more dysphonetic errors compared to the typical readers. Hence, spellers with a phonological deficit, referred to as phonological dyslexics (Hatcher & Snowling, 2002), were suggested to show an impairment in the ability to establish mappings between letter strings and phonology, thus making more "dysphonetic" errors (Bruck & Treiman, 1990; Caravolas, Hulme, & Snowling, 2001; Diamanti, 2005).

Finally, there are a number of studies claiming that phonological difficulties are not evident early in primary school in more transparent languages (e.g., in German: Wimmer, Mayringer, & Raberger, 1999; in French: Alegria & Mousty, 1996). On the other hand, there are also studies, which showed that the specific phonological difficulties of dyslexic pupils persist at least between 9 and 13 years old and affect spelling performance, as for example in Czech (Caravolas & Volín, 2001) and in Greek (Diamanti, 2005; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006). The discrepancies in the findings might be due to the different research design, since in other studies only a reading age control group was included (e.g., Diamanti, 2005) and in others only a spelling age controls' performance was assessed (e.g., Caravolas & Volín, 2001). Therefore, further research with better matching in reading and spelling levels would be more promising as a strategy for addressing this question.

However helpful phonological skills are, and despite the extensive research supporting the phonological deficit hypothesis, there is a lack of consensus regarding which components are responsible for poor reading. For example, the ability to convert graphemes to phonemes, but also to store and manipulate larger phonological units (e.g., rimes) indicates different levels of phonological processing (e.g., Smythe et al., 2008). In addition, the skill of storing and producing verbal labels is postulated to include phonological processing, although the speed of access as indicated by Rapid Automatised Naming (RAN) tasks (i.e., naming aloud as fast as possible sets of objects, pictures, colours, letters or digits) has also been associated with automatisation deficits (Wagner & Torgesen, 1987). There is a lack of consensus regarding the level of phonological processing children employ to progress in reading and spelling across languages (e.g., onset-rime, syllable or phoneme analysis), which partly depends on the properties of each orthographic system (for a discussion see Hulme, Muter, & Snowling, 1998). Hence, further research in different languages is required for the specification of the phonological processing associated with dyslexia.

Studies in various languages suggest that difficulties with retaining sounds in short-term memory are indicative of weak spelling-to-sound associations and acquisition of verbal vocabulary (Gathercole & Baddeley, 1993; Gathercole, Willis, Emslie, & Baddeley, 1992; Wimmer, Mayringe, & Landerl, 1998). Furthermore, a strong association between reading difficulties and poor short-term memory has also been suggested (Hulme & Roodenrys, 1995). Regarding the role of memory, Singleton (2002) distinguishes two main ways of interference of memory in the performance of readers/spellers with dyslexia. First, their auditory short-term memory is less efficient in maintaining information required for correct spelling or second, impaired representations of phonological information restrict the amount of orthographic information that can be stored in short-term memory (effect of a phonological deficit on memory).

Dyslexia has also been associated with auditory and visual difficulties. Since the aims of the present study are not relevant to an investigation of auditory and visual skills in relation to spelling, only a brief reference to research in these areas is included. More specifically, although auditory problems are connected with language and hence can produce phonological deficits (e.g., Tallal, Miller, Jenkins, & Merzenich, 1997), it has been argued that the ability of letter-to-sound conversion can be impaired even in the absence of auditory difficulties (Snowling, 2000). Additionally, deficits in visual memory might restrict older children's acquisition of a sight vocabulary resulting in difficulties in spelling exception words and homophones (e.g., Goulandris & Snowling, 1991; Seymour, 1986; Singleton, 2002). Further examining these areas, Stein (2001) has proposed a combination of auditory and rapid changing visual temporal processing deficits leading to visual and phonological processing difficulties. This view has common grounds with Nicolson, Fawcett, and Dean's (2001) perspective suggesting that cerebellum deficits result in automaticity problems.

Another hypothesis associated with automaticity of storing and recalling information is the double-deficit hypothesis by Wolf and Bowers (1999). It was initiated by observations connecting low speed at Rapid Automatised Naming (RAN) tasks and poor reading skills. It was proposed that dyslexia could be caused by a phonological deficit, a deficit in RAN, or both. Individuals who have both impairments show the most severe reading difficulties (Smythe & Everatt, 2004). Wagner and Torgesen (1987) suggested that RAN is a measure of the rate of access to and retrieval of stored phonological information in long-term memory (see also Vellutino et al., 2004). Other links between RAN and reading beyond phonology have been proposed, as for example speed of processing, visual processing, serial processing and impairment in orthographic knowledge (e.g., Bowers & Wolf, 1993; Georgiou, Torppa, Manolitsis, Lyytinen, & Parrila, 2010; Kail, Hall, & Caskey, 1999; Powell et al., 2013; Stainthorp, Powell, Stuart, Quinlan, & Garwood, 2010). There is a long discussion about what exactly RAN measures and the mechanisms underlying the link between RAN and reading are not yet fully specified. Studies in different languages examining these links have provided mixed findings (e.g., de Jong & van der Leij, 2002; Georgiou, Parrila, & Papadopoulos, 2008; Powell, Stainthorp, Stuart, Garwood, & Quinlan, 2007; van den Bos, 1988; Wimmer, Mayringer, & Landerl, 2000). In practice RAN has been found to be a strong predictor of reading ability and occasionally of both reading and spelling in orthographies of different levels of phonological consistency, thus providing supportive evidence for the double-deficit hypothesis (e.g., see Powell, Stainthorp, Stuart, Garwood, & Quinlan, 2007).

While phonological skills and speed of processing have been found to be directly connected with reading and spelling, storing and employing specific orthographic and morphological knowledge are also essential, particularly to spell less consistent patterns (e.g., Juel, Griffith, & Gough, 1986; Tunmer & Nesdale, 1985). This information is contained in the mental lexicon of the reader/speller. Connectionist models have suggested that the lexicon contains phonological, orthographic and semantic information (Coltheart et al., 1993; Plaut et al., 1996; Seidenberg & McClelland, 1989), and researchers in different languages have examined the role of orthographic and semantic awareness in literacy acquisition and difficulties.

Aiming to investigate differences in the accuracy of orthographic representations between adults with dyslexia and younger controls, Pennington and colleagues (1986) found that the first group produced more orthographically accurate spellings than the younger spelling-matched group. In line with these findings, the children with dyslexia who participated in the study by Siegel, Share, and Geva (1995) were significantly better than younger typically developing readers in recognising the orthographically legal unit from a pair of two pronounceable pseudowords (e.g., MOKE and MOJE, FILV and FILK). This finding was interpreted by the researchers as signifying that children with dyslexia may rely heavily on visual recognition strategies to read, due to a lack of sufficient phonological skills, in agreement with the phonological-core deficit hypothesis (Stanovich, 1988). Another plausible explanation might be related to the role of print exposure in older participants' visual decision processes. The ability of participants with dyslexia to select the orthographically legal non-words, is in agreement with the notion that more years of experience with print is linked to better orthographic skills (e.g., see Cunningham & Stanovich, 1993). There is evidence from spelling in Greek to support the suggestion that the spelling of inconsistent words depends significantly on the quality of orthographic representations. In detail, Nikolopoulos, Goulandris, and Snowling (2003) found that children with poor reading skills had particular difficulties in spelling stems requiring word specific knowledge and in spelling the endings of words. Similar results were found by Diamanti (2005). Nikolopoulos and colleagues (2003) suggested that the results were indicative of the over-reliance of participants on consistent phonological correspondences, due to their reading experience in a highly regular language.

In addition to phonological and orthographic information, semantic knowledge is also considered to facilitate reading and spelling ability (Houghton & Zorzi, 2003; Perfetti & Hart, 2002; Seidenberg & McClelland, 1989). Semantic awareness is the knowledge of how the meanings of the words are organised and function in a language (Nagy & Gentner, 1990). This knowledge helps the reader/speller to deduce effectively the meaning of unfamiliar words. The role of oral vocabulary in reading development, both for word reading and reading comprehension skills, is well documented in English (e.g., see Nation & Snowling, 2004; Ouellette, 2006; Ricketts, Nation, & Bishop, 2007). Investigating specifically orthographic learning, Share (1995) assessed the influence of context on orthographic accuracy. It was found that Hebrew native speaking pupils of second and third grade benefited in terms of spelling accuracy from learning the meaning of non-words embedded in a story context. Subsequent research in English verified the relation between contextual information and orthographic learning. Semantic knowledge was suggested to have facilitated orthographic learning, according to the findings of Ouellette and Fraser's studies (Ouellette & Fraser, 2009; Ouellette, 2010). In the first study, 35 English native speaking fourth graders and in the second study 36 second graders in Canada were exposed to non-words, half of which were accompanied by semantic information and half were presented in isolation. Post-tests assessing the pupils in word recognition and in spelling accuracy, were conducted one and seven days later using the same target items as the training session. The results showed a small, though significant, effect of semantic information and spelling practice on both tasks. Therefore, Ouellette concludes that "semantics are proposed as a relevant factor in learning to spell, supporting the view that orthographic learning involves the integration of phonological, orthographic, and semantic representations" (Ouellette, 2010, p. 50).

Different causal theories of dyslexia, co-morbidity with other disorders (e.g., ADHD, SLI) and variability in the findings of studies examining cognitive skills in relation with reading and spelling performance in different languages resulted in the multiple deficit hypothesis (Pennington, 2006). Pennington argues against single path explanations of literacy deficits and proposes that it is rather a combination of factors affecting dyslexia. In addition to the underlying factors, the levels of orthographic transparency are expected to influence the role of different cognitive factors in different systems (Smythe & Everatt, 2004). Aiming to strengthen theories accounting for ability to read and write, researchers developed a growing interest in cross-linguistic studies. Recently, Caravolas et al. (2012), have studied literacy performance in four languages with different levels of transparency (English, Spanish, Slovak, and Czech) implementing a 10-month longitudinal design. According to their findings, later assessed reading and spelling skills were predicted from a combination of earlier measures, namely of phoneme awareness, letter knowledge, RAN, verbal memory span, vocabulary, and nonverbal ability.

The longitudinal predictors of literacy performance in Finnish, Greek and English, were examined by Georgiou, Torppa, Manolitsis, Lyytinen, and Parrila (2010) with pupils in the first three years of education. The researchers found RAN to be the strongest predictor for spelling in English and Greek, but not in Finnish. They attributed this difference to the shallow Finnish orthography, hypothesising that if RAN measures the quality of orthographic representations of the participants it must be a stronger predictor for less consistent orthographies. The fact that Greek, although being phonologically transparent for grapheme-to-phoneme conversions in the reading process, is less consistent in the feed-backward direction (i.e., for spelling) with more than one potential grapheme corresponding to a single phoneme allows for comparisons with the inconsistencies of the English orthographic system, and would provide some ground for Georgiou and colleagues to link RAN with levels of orthographic transparency.

Similarly, Elbeheri and Everatt (2007) have found similarities in the role of phonological awareness to predict reading and spelling performance of participants with dyslexia in Arabic and English. In a later study Smythe and colleagues (2008) investigated the links between phonological awareness, reading and spelling in Arabic, Chinese, English, Hungarian and Portuguese. They found that different levels of phonological awareness (phoneme, rime) predicted reading in all five languages, but predicted spelling only in Arabic and English. The researchers attributed this finding to the variance in levels of orthographic transparency among the five languages, which require different levels of phonological awareness to be acquired in different pace (e.g., rhyme awareness is important for English but not necessarily for the more shallow Portuguese).

2.8 Spelling development: evidence from children with and without dyslexia

In a series of studies, Treiman investigated children's naturalistic spelling development (Treiman, Zukowski, & Richmond-Wely, 1995; Treiman, 1985, 1992, 1997). Based on the findings, she specified some characteristics of typical spelling development (Treiman, 1994). Children initially perceive correspondence between speech and writing at syllable level and represent the sound of the syllable with one letter. One of the findings supporting this notion is the representation of whole phonemic units with single letters e.g., <r> for CAR (Snowling, 1994; Treiman, Zukowski, et al., 1995; Treiman, 1993).

As spelling development continues, children shift to an intermediate level of awareness between syllables and phonemes e.g., <cr> for CAR. Findings reporting omission of consonants within consonant clusters at the beginning or at the end of the word (e.g., <l> in BLOWS) may reflect this transitional level of spelling (Bourassa & Treiman, 2001; Fowler, Treiman, & Gross, 1993; Treiman, 1985, 1992). Specifically examining misspellings in final consonant clusters, Snowling (2000) observed that nasal consonants are more frequently omitted before a final unvoiced consonant (BENT as <bet>), than when the final consonant is voiced (as in BEND). In line with the above findings, other studies (Bruck & Treiman, 1990; Bruck & Waters, 1988) have shown that children with reading difficulties had a particular difficulty in spelling consonant clusters. Thus, according to Treiman (1997), sound-to-letter mapping becomes more precise as children learn more about conventional orthography. While having this knowledge, they can still make substitution or omission errors that reflect phonological structures, e.g., spelling TRAP as <chrap> because <t> and <ch> sound similar. But they can differentiate between COT and GOT, because there is a profound difference between /k/ and /g/ sounds (Bourassa & Treiman, 2001).

As concerns children with dyslexia, their difficulties with spelling have been found to be prominent and persistent over time. Research in English has highlighted their phonological weaknesses influencing literacy skills (e.g., Bruck & Treiman, 1990; Bruck & Waters, 1988; Snowling, 1994). Studies in languages with more consistent orthography have shown that pupils with dyslexia tend to master phonological skills early in primary school. As a result they are more likely to overcome any difficulties with phonological spelling relatively early, whereas difficulties with more inconsistent spellings requiring specific word (orthographic) knowledge or morphological awareness persist to the end of primary education (e.g., in German: Landerl & Wimmer, 2000; in French: Alegria & Mousty, 1996). More specifically, Nikolopoulos, Goulandris and Snowling (2003) investigated the spelling performance of 28 pupils with dyslexia in grades 2 and 4. Their performance was compared to that of a group of typically developing children of similar age. Spelling performance was assessed with a single word spelling task. Results showed that the pupils with dyslexia performed significantly lower than their chronological controls. The majority of pupils with dyslexia (70%) produced orthographically inaccurate spellings. However, none of the misspellings was phonological, in the sense of altering the pronunciation of the word. Based on these findings, the researchers concluded that children with dyslexia appear to face no difficulties in spelling phonologically consistent patterns due to the transparency of the Greek orthographic system.

Similarly, results from the study of Fakou and colleagues (2010) showed that phonological misspellings were rarely produced by pupils with and without dyslexia. Their sample consisted of children with dyslexia attending grades 2, 4, 6, 7 and 8 and two control groups, chronological-age and reading-matched typically developing pupils. The findings of both these Greek studies are in agreement with research in other relatively transparent languages (e.g., in German: Landerl & Wimmer, 2000; in French: Alegria & Mousty, 1996). More specifically, Landerl and Wimmer (2000) detected a small amount of phonological errors made by their German and English participants with poor reading skills, as well as by the reading-age controls. Alegria and Mousty (1996) also investigated the spelling errors of children with reading difficulties and younger reading-age controls in French focusing on ambiguous consonant sounds embedded in words and non-words. The performance of children with reading difficulties was interpreted as employing phonological strategies to spell in contrast to their control group, who took both phonological and graphotactic rules of the French system into account. All of these studies postulate that children with literacy difficulties show analogous mastery of spelling strategies when compared with their reading age controls. However, results of studies in spelling, which lack an additional group of spelling age controls, should be treated with caution. This is because there is a concern that sole reading performance matching would not account for possible discrepancies between the spelling performance of participants with dyslexia and the control group (Egan & Tainturier, 2011).

In contrast with these findings are the results from a study in Czech, which is considered to be a transparent orthography as most word spellings can be derived by one-to-one phoneme-to-grapheme correspondences (Caravolas & Volín, 2001). Caravolas and Volín assessed the spelling performance of 43 pupils with dyslexia at the age of 9-12 years. Their performance was compared to that of a group of typically developing children of similar age and to the performance of younger pupils who performed at similar spelling levels as the dyslexic group. The experimental spelling task included 10 sentences which were dictated to the participants for spelling. The researchers examined whether children's misspellings altered the phonological identity of the words. In total, 62 words were dictated and one point was given to each phonologically misspelled word. The score for each participant was converted in a percentage. The results showed that pupils with dyslexia continued making phonological errors even at grade 5 with rates comparable to typically developing second graders, whereas pupils without dyslexia reached a plateau of this type of errors by grade 4. This result was interpreted as implying a delay in the development of phonological spelling strategies for Czech pupils with dyslexia, since phonological misspellings appear to occur for a longer period of time than for typically developing children.

In agreement with these findings, the study of Diamanti and colleagues (2005) in Greek has found that older children with dyslexia continued making phonological errors. The group of pupils with dyslexia consisted of children with a mean age of 12 years, who were matched with a group of typically developing children of the same age and a group of pupils of the same reading level, but with a mean age of 9.5 years old. The children were assessed in spelling with a spelling task consisting of a list of 57 words of increasing difficulty. Participants' spellings received one score for phonological accuracy and one score for orthographic accuracy of each word spelled. The results showed that children with dyslexia continued making phonological misspellings even at this age. Their performance was similar to the younger reading control group but significantly lower than that of typically developing pupils of the same age. Moreover, their performance in orthographic spelling (i.e., requiring unit specific or morphological knowledge) was significantly lower than that of both control groups. This finding supports the notion that orthographic spelling is more challenging than phonological spelling for Greek native speaking pupils with dyslexia.

Eventually, according to Treiman (1993), children also acquire knowledge of orthographically plausible patterns (e.g., spelling CAKE as <kack> but not as <ckak>), demonstrating awareness of the orthographic constraints of the English system, even without previous explicit instruction on graphotactic rules. Spelling by analogy is regarded as a strategy indicating children's orthographic awareness. For instance, Nation (1997) found that spelling of monosyllabic words is influenced by the number of their word friends, i.e., words that share the rime unit and orthographic pattern with the target word. It was found that the target words with more friends (e.g., SPILL that shares the <-ill> unit with twenty seven friends) were spelled more accurately in comparison to the words with less friends (e.g., DISK, which has only two word friends). Additionally, Cassar, Treiman, Moats, Pollo and Kessler's (2005) findings indicate that children with literacy difficulties also demonstrate similar levels of graphotactic knowledge with spelling matched typical first graders.

Moreover, children soon come to realise that morphemes are spelled in a consistent manner within one orthographic system. An indicative example is the finding that children demonstrate their knowledge of past tense formation, by adding the past tense suffix <-ed>, regardless of its pronunciation (e.g., <rained>, <jumped>, <painted>; Bourassa and Treiman, 2001). Furthermore, children at an early stage may also generalise this knowledge by applying the regular past tense suffix to irregular verbs e.g., spelling SLEPT as <sleped> (Nunes, Bryant, & Bindman, 1997). Such findings were regarded as evidence supporting that the development of morphological knowledge is a gradual understanding of regularities and exceptions of the conventional system.

In their study investigating spelling development, Varnhagen, McCallum and Burstow (1997) examined free writing samples from 272 native English speaking children attending first to sixth grade, and analysed the spelling of long vowels followed by the silent <-e> marker and the <-ed> ending of past tenses in 35 stories from each grade. The results showed that children's spelling of silent <-e>, long vowels, and different types of <-ed> past tense suffix did not follow a strict developmental sequence through distinct stages, but appeared to progress from the phonetic stage directly to the correct spelling. Furthermore, while most misspellings fell into the phonetic stage category, they nevertheless varied indicating different levels of phonological knowledge. The researchers interpreted these findings as supporting the naturalistic approach adopted by Treiman (1993, 1994), and argued in favour of its adequacy in describing spelling development as opposed to the stage theories.

Bourassa and Treiman (2003) further researched spelling development specifically investigating potential distinguishable misspellings among children with reading and spelling difficulties in comparison with younger spelling-age matched controls. The participants were asked to spell ten given words and ten non-words. The researchers examined the application of phonological and morphological knowledge in spelling by focusing on the use of letter name to spell vowels or consonants, the spelling of intervocalic flaps, /t/ and /d/ representations before /i/ (e.g., DRIP), spelling of initial and final letter clusters, use of <t> to represent past tense endings, use of final <-e> and of double consonants. The results showed that the participants with literacy weaknesses faced significantly more difficulties than the control group only in applying the final <-e>, and in spelling double consonants. These results provided further support for the suggestion that spelling develops similarly in children with literacy difficulties and younger spelling matched children. In a later study, Bourassa, Treiman and Kessler (2006) reinforced their argument with the finding that neither children with literacy difficulties nor younger controls made use of morphological knowledge when spelling pre-final consonants in inflected verbs (e.g. <n> in EARNED) and single morphemic words (e.g. HAND). A later study by Bourassa and Treiman (2008) provided similar findings showing no significant difference between the target group's and the control group's use of morphology to spell the stem of derived words (e.g., EXPLAIN - <explaination> rather than the correct spelling: <explanation>).

The spelling of derivational suffixes was found to be difficult for English native speaking children with dyslexia (13-15 years old), for a group of children of the same age and for younger reading-age matched typically developing students (Tsesmeli & Seymour, 2006). Tsesmeli and Seymour (2006) assessed their sample with a spelling task consisting of pairs of words, with the second word deriving from the first (e.g., HONEST-HONESTY). The word-pairs included high and low level frequency items. The group with dyslexia made significantly more errors in the derivational suffixes (6% correct spellings) and the stems (23% correct spellings) of the words in comparison to both control groups. However, the within dyslexic group difference between error rates in stem and derivational suffixes was at the same level as that of younger reading-age matched controls (6% correct suffix spellings - 34% correct stem spellings). According to the researchers, this finding supports the notion that derivational spellings remain as challenging for adolescents with dyslexia as for younger typically developing children.

Similarly, difficulties with spelling orthographically inconsistent patterns have been reported in studies in more transparent languages, such as Greek. In the aforementioned study by Nikolopoulos, Goulandris, & Snowling (2003) the misspellings in Greek inflectional suffixes were also examined. The inflectional units consisted of noun suffixes with one or two letters (e.g. <-ος> /os/ singular masculine) and noun or verb suffixes with more than one letter (e.g. <-αίνω> /eno/ 1st person, singular, present tense). Pupils with dyslexia performed at the same levels as their chronological controls when spelling inflectional suffixes with up to two letters. They were significantly worse than pupils of the same age at spelling longer suffixes. However, the researchers did not differentiate in scoring the different components of longer suffixes (e.g., <-αίνω> /εno/= <αιν> /en/ the derivational component and <ω> /o/ the inflectional component). Moreover, there was no reference to results of any comparisons between the spellings of pupils with dyslexia and younger reading controls, despite the employment of this group for comparisons in reading performance. It is, therefore, impossible to detect the challenging component, which produced this discrepancy in error rates between pupils with dyslexia and their chronological controls, and to draw any conclusions regarding potential differences with the performance of younger pupils. It is, nevertheless, an important finding directing research attention to the persisting difficulty of pupils with dyslexia in spelling suffixes which contain a derivational component.

Aiming to further explore this area, Diamanti et al. (2005) extended their aforementioned study by adding a spelling-age matched control group to investigate the spelling performance of their sample in stems and suffixes (Diamanti, Goulandris, Stuart, & Campbell, 2013). Experimental spelling tasks included a list of 28 pairs consisting of an adjective and a noun (e.g., <ο τελευταίος αυτοκράτορας> = the last emperor) and 18 sentences including a verb and a noun (e.g., <το γυμναστήριο έκλεισε> = the gym is closed down). The misspellings were scored with regards to their position in the word. Children with dyslexia achieved lower scores than their chronological-age controls. However, their spelling performance resembled that of younger spelling-age controls. It was found that the derivational component of the suffixes, especially of adjectives (e.g., <αι> in <-αίος> /es/ of <τελευτ<u>αί</u>ος> /telefteos/ = last), was most frequently misspelled by children with and without dyslexia. More specifically, correct spelling was substituted by the most common phonologically accurate grapheme. This is an interesting finding possibly implying that lower word frequency (i.e., adjectives) as well as lower unit frequency (i.e., derivational component of the suffix) impacts on the spelling performance of Greek native speakers.

A very detailed study by Protopapas and colleagues (2013) systematically investigated the spelling errors made by students with dyslexia in Greek. The sample consisted of 44 children with dyslexia attending grades 3, 4 and 7 and a control group of typically developing children of the same age. Students with dyslexia in grade 7 were also matched with younger pupils (grades 3-4) performing at the same reading level, as assessed with word and pseudo-word reading tasks, and phonological level, as assessed with a phoneme deletion task. The experimental spelling tasks consisted of a list of 22 words and an age appropriate passage of 33 words for the younger children and 49 words for the older students. The words were analysed in graphemes and all spelling errors occurring in each word were classified in major and minor categories of errors (e.g., major: phonological, morphological, and orthographic). Relative proportions for errors were calculated by taking into account the opportunities for errors to occur in each category. The results showed that error rates were higher for children with dyslexia than their chronological-age controls and younger reading-matched children. However, the aforementioned concerns regarding the absence of a spelling-age control group affecting the validity of results of the above studies should be taken into account. In addition, there was no feature that would distinguish the spelling performance of students with dyslexia from that of their controls. On the contrary, all pupils found primarily derivational, but also inflectional components of the suffixes more challenging to spell. Stem vowels, dependent on word specific knowledge, were another area of difficulty for all participants. The researchers suggest that difficulties in derivational and inflectional spellings might be revealing of students' weakness in apprehending the systematicity of the Greek orthography (e.g., morphological rules), while mistakes in word roots could be connected with poor lexical representations of the specific units.

It is worth noting that in the study of Protopapas and colleagues (2013) the proportion of phonological misspellings made by the group with dyslexia was negligible when compared to their orthographic and morphological mistakes. Despite the fact that they made significantly more phonological errors than typically developing children, within dyslexic group comparisons showed that the rate of phonological errors versus orthographic and morphological errors was not so high as to support a phonological impairment of the dyslexic cohort. This is in agreement with earlier findings (in Italian: Angelelli et al., 2004; in Greek: Nikolopoulos et al., 2003) postulating that, in transparent orthographies, children with dyslexia manage to develop an alphabetic strategy earlier than orthographic and morphological strategies for spelling. They are, therefore, able to produce phonologically plausible spellings despite of inaccuracies in the orthographic representation of the patterns spelled. Overall, there was no indication of a specific spelling profile for the students with dyslexia when compared to pupils of the same age and younger reading-age controls. With regard to this result, inclusion of an additional spelling-age control group might have been more informative in detecting potential discrepancies which was not allowed by a reading-match only design. Nonetheless, Protopapas and colleagues (2013) provided a very systematic and detailed study of the errors made by students with dyslexia, as well as by a large sample of typically developing children, stimulating further investigation in the field of spelling difficulties.

In contrast to the above studies, Carlisle (1987) in an examination of morphological misspellings of 14-15 year old children with dyslexia showed that they were as able as younger spelling-age controls to spell stems e.g., MAGIC, but found it more difficult to connect them with derived words' spelling, for example producing <magishian> or <magition> for MAGICIAN. Egan and Tainturier (2011) suggested an abnormal use of morphological strategies by children with dyslexia, based on their finding that 9-year-old children with literacy difficulties were significantly poorer than younger reading and spelling-age matched children at spelling consistently stems presented in isolation versus within inflected verbs (e.g., <chun> – <chewnd>). However, there was no difference in spelling <-ed> suffixes phonetically (e.g., <kisst> for KISSED), apart from seven poor reading and spelling children, who were significantly worse than younger reading and spelling controls. These pupils used <-ed> suffixes less frequently, did not generalise <-ed> to monomorphemic words as frequently as ability-matched controls and made more phonetic misspellings in word endings. Their spelling errors were perceived as representing the "phonetic" stage of spelling development and were associated with an over-reliance on the sub-lexical spelling route due to weak orthographic representations. This is in agreement with the interpretation of the misspellings produced in the French study by Alegria and Mousty (1996).

2.9 Spelling in text writing context

Spelling when writing a text may differ from spelling-to-dictation (Pattison & Collier, 1992), since the purpose of communicating a meaning is much more pronounced in a text composition task than in a spelling-to-dictation task. Writing is a more overarching skill involving different processes taking place simultaneously. There is a growing body of research investigating the quality of writing in typical and atypical populations as well as the improvement in writing skills over time and with practice. Evaluating the quality of writing is beyond the scope of the current research. However, the very influential model of Berninger and Swanson (1994) is outlined in this section, because it comprises a comprehensive framework to conceptualise the position of spelling processes within writing conditions. For this purpose, the description of the model mainly focuses on highlighting the contribution and constraints that spelling may pose to writing processes.

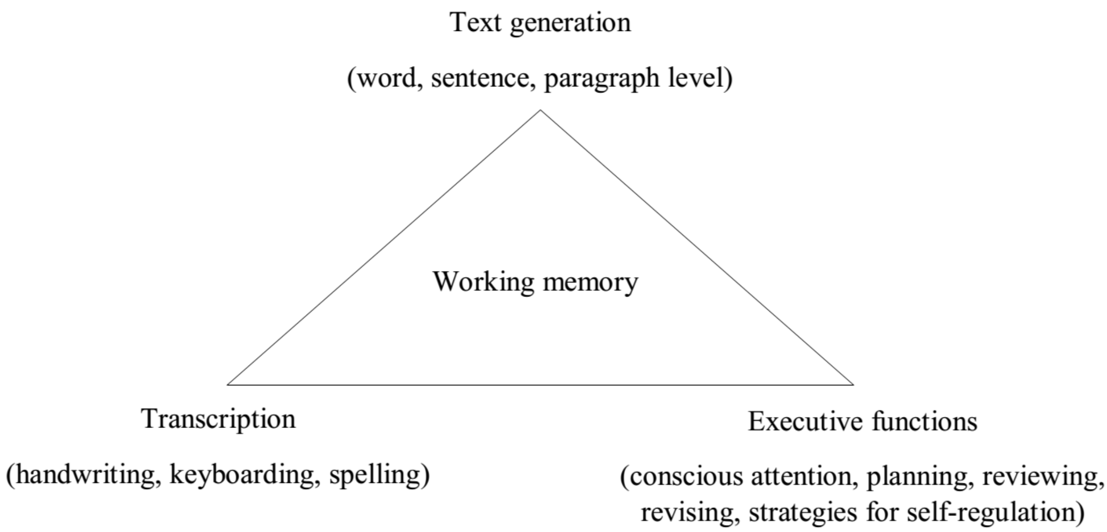


Figure 2.6
A Simple View of Writing (adapted from Berninger & Amtmann, 2003)

The “simple view” model (Figure 2.6, above) is a modification of the earlier Hayes & Flower (1980) model. It is based on the research findings of Berninger and colleagues investigating the developmental changes in the writing skills of English speaking children aged 6-15 years old (Berninger et al., 1992; Berninger, Mizokawa, Bragg, Cartwright, & Yates, 1994; Swanson & Berninger, 1994). Text generation and transcription are depicted as two separate more technical components of the action of expressing ideas in written form (lower-level processes). Executive functions are higher-level processes crucial for monitoring the content of the written text and evaluating its quality. The three components are coordinated by working memory, which activates long-term memory when composing the text and short-term memory when reviewing the written product. The higher-level processes of planning and reviewing are self-activated, when required throughout the course of writing, and feed back on the lower-level processes. Inclusion of lower-level processes emphasises the importance of more technical skills for the quality of the written output. According to Berninger and Swanson (1994), the first constraints for beginning writers are posed by the transcription skills (i.e., spelling, handwriting, keyboarding). As these improve with practice, children shift their efforts to text generation, which includes language skills at the word, sentence and paragraph level.

As discussed in the previous sections, spelling is an effortful process for both typically and atypically developing learners. Beyond spelling, handwriting may also be demanding for beginning writers, since it is a motor skill which requires coordination of fine movements (Van Galen, 1991), which children begin to learn as soon as they join formal education. Spelling and handwriting speed are closely related, as shown by the study of Puranik and Alotaiba (2011), which measured the time that beginning writers of 5-7 years old needed to write the alphabet and their general spelling ability in a writing composition task. When transcription skills are still effortful, the resources of working memory are exploited in spelling and handwriting. As lower-level skills improve, these resources are freed to engage with the executive functions of older typically developing children (12-15 years old). Cognitive skills involved in actions such as concentrating their attention to the content and structure of the text, planning and reviewing the writing product, play a more important role than handwriting, which by now should be automatized, and spelling, where they are expected to have developed a relatively broad repertoire (Berninger & Swanson, 1994).

Berninger, Fuller, and Whitaker (1996) suggest that the skills comprising each of the three components of writing process develop at their own rate. Therefore, they argue that skilled adult writing differs from the writing of beginners or developing writers, since their executive functions are not yet in full operation. The same could be hypothesised for dyslexic writers on the basis that often children with dyslexia lag behind their chronological age-matched peers in spelling accuracy and handwriting speed (British Dyslexia Association, n.d.). In the framework of this model, it would be reasonable to assume that as long as transcription skills remain problematic, writers with dyslexia will not be able to progress to more proficient writing skills. Alternatively, it is possible that the additional demands posed on their working memory shift their attention away from transcription skills, which might result in higher error rates. In addition, text generation involves language skills, which translate into selection of appropriate vocabulary that in turn prompts spelling and handwriting. However, this relationship might be bidirectional resulting in less confident spellers restricting their vocabulary choices to the words they know how to spell. Slow handwriting might be another barrier to spelling achievement and vice versa, especially in written composition where the resources of working memory are distributed in more than one component. The "simple view" model is a general model that does not describe the development of each of the three components in detail nor specifies the interaction among them. Nevertheless, because of its inclusive nature, it constitutes an illustrative framework to compare the spelling performance of children with dyslexia and typically developing children in written composition tasks in order to explore the aforementioned hypotheses.

Previous research in spelling development has not used written composition as much as spelling-to-dictation tasks. Aside from Treiman's detailed studies (e.g., 1993, 1994) on writing samples of beginner spellers, there are few examples of studies employing text writing to investigate spelling development in English. In a study with pupils in grades 3-6 (Puranik, Lombardino, & Altmann, 2008), 120 story retelling texts were collected. Analysis of composite scores showed a significant effect of grade on spelling performance, with older children making fewer mistakes than younger children. The researchers observed considerable variability in the spelling performance of pupils attending the same grade, which they attributed to the vocabulary constraints of the task. In their study, Green and colleagues (2003) focused on morphological spelling in picture prompted texts produced by pupils in grades 3-4, in two testing times, in the fall and spring of the same year. Omissions and use of incorrect graphemes in the suffixes were audited. The results showed that pupils employed inflectional suffixes of verbs to a larger extent, earlier and more accurately than derivational suffixes. The researchers also observed a significant growth in the morphological accuracy of the spellings of both grades over time.

In an earlier study of free writing samples produced by children in grades 1-6, Varnhagen and colleagues (1997) observed a progress in long vowel and past tense <-ed> spelling, although no evidence of distinctive stage development was found. The researchers interpreted their findings as supporting the naturalistic approach of Treiman's studies (1993; 1994) that investigated beginner spellers' written products. Improvement in spelling performance has also been recorded in narrative texts of beginner spellers in England, as in the one-year longitudinal study by Stainthorp and Hughes (1999). Children were asked to compose a written story based on a set of pictures in year 1 and again in year 2. The results showed that the proportion of correct spellings increased significantly over time, that pupils did not seem to restrict the vocabulary only to words they knew how to spell and that they often performed visual checking (orthographic strategy) or sounding-out (phonological strategy) to aid their spelling.

To date, few studies have examined the spelling performance of children with dyslexia in written context. Puranik, Lombardino, and Altmann (2006) assessed a group of English speaking participants with dyslexia ranging from 11 to 20 years old. The participants listened to a text and were asked to reproduce it from memory. Their writing samples were compared to those of a chronological-age control group and a group with language impairment. The researchers observed that only the younger dyslexic participants made significantly more spelling errors than their chronological-age controls, while they did not show any statistically significant difference with the language impairment group. A limitation of this study is the very small sample (13 participants) and its wide age range. Nevertheless, the results related to spelling performance are in agreement with findings of many studies employing spelling-to-dictation tasks.

In a more recent study, Sumner (2013) compared the spelling errors of 31 English native speaking children with dyslexia 8-11 years old with a chronological-age group and a spelling ability-matched group of typical learners. The investigation of spelling errors was part of a larger study on the writing skills of children with dyslexia using a free-text narrative writing task (Wechsler Objective Language Dimensions; Rust, 1996). The spellings were scored for phonological accuracy, orthographic accuracy and morphological accuracy at the whole-word level. Children with dyslexia made significantly more phonological errors than the chronological-age controls but not than the spelling-age controls. In addition, they made significantly more orthographic errors than both control groups. This finding was interpreted as suggesting that poor phonological skills, as indexed by the first group's scores in separate assessments (phoneme segmentation, reading, non-word reading), prevented their progress in orthographic spelling. Finally, a very small amount of morphological errors was observed for all participants. This was attributed to the freedom provided to the children to select the vocabulary they would use in the narratives. When the phonological spelling errors of all groups in the narrative task were compared to those made in a standardised single word spelling task (BAS-II; Elliott, Smith, & McCulloch, 1996), no effect of task was detected. In contrast, when the orthographic errors were compared across tasks, a significantly lower error rate was detected in the narrative than in the spelling-to-dictation task. However, a limitation that might have influenced this result is that there was ample variability in the stimuli examined in the two tasks, since the children were allowed to freely choose the vocabulary used in the narrative, whereas there was a very specific set of single words that they spelled in the spelling-to-dictation task. Future research should attempt to control for this imbalance by devising appropriate spelling tasks to enable unbiased comparisons across spelling conditions.

2.10 Summary

This chapter focused on reviewing the theories of spelling and research examining typical and atypical spelling in languages with different levels of transparency. Orthographic systems may be considered to be transparent in both reading and spelling, such as Finnish (Aro et al., 1999), in neither of the two, such as English (Venezky, 1970), or may be more transparent for reading than for spelling, such as Greek (Protopapas & Vlahou, 2009). Spelling may be a more demanding process than reading, particularly if there is less consistency in the correspondences between phonemes and graphemes. The contribution of phonological, orthographic, semantic, morphological and syntactic information to literacy skills has been highlighted by all the models of spelling development and skilled spelling. However, research has shown that the magnitude of contribution of many of these aspects depends on the specific characteristics of the orthographic system (Seymour et al., 2003). Therefore, in cross-linguistic comparisons researchers must take into account the differences of the scripts in terms of transparency (e.g., rime versus grapheme), structure of the words (e.g., syllabic versus phonemic structure), morphological properties (e.g., different uses of inflection), direction of reading/writing (i.e., from left to right, from right to left, from top to bottom). This is crucial to enhance efficient assessment of the skills under examination, since a task that measures one ability in one language may not be an adequate measure in another language.

Taking into account the properties of the orthographic system also plays an important role when investigating literacy skills in dyslexia. Research in different languages has provided evidence to support the view that the deficits underlying dyslexia might be universal, however, are manifested in different ways depending on the properties of the language. For example, there is evidence that participants with dyslexia have a profound difficulty in phonological skills and their application to spelling (e.g., Bruck & Treiman, 1990; Caravolas, Hulme, & Snowling, 2001; Diamanti, 2005), which supports the phonological deficit hypothesis (Snowling, 2000; Stanovich, 1988). On the other hand, studies in more transparent orthographies claim that children overcome phonological difficulties relatively early, thus suggesting a delay in the development of those skills rather than a deficit (e.g., Alegria & Mousty, 1996; Wimmer, Mayringer, & Raberger, 1999). Additionally, there is evidence to support the notion that difficulties with retaining sounds in short-term memory is a possible cause for the spelling difficulties of participants with dyslexia (Gathercole & Baddeley, 1993; Gathercole, Willis, Emslie, & Baddeley, 1992; Wimmer, Mayringe, & Landerl, 1998). Thirdly, there is some evidence from research using RAN tasks in different languages (e.g., de Jong & van der Leij, 2002; Georgiou, Parrila, & Papadopoulos, 2008; Powell, Stainthorp, Stuart, Garwood, & Quinlan, 2007; van den Bos, 1988; Wimmer, Mayringer, & Landerl, 2000) to support the double-deficit hypothesis (Wolf & Bowers, 1999). However, there is no consensus about the mechanisms underlying RAN. Beyond differences in the linguistic properties, the lack of consensus in research findings across languages might also be due to differences in the research design. Particularly as concerns research on spelling, it is purposeful to include a spelling ability-matched group, because sole inclusion of chronological-age and reading-age controls might overlook the existence of an initial discrepancy between the spelling ability of the dyslexic and the control groups, which might affect the results (Egan & Tainturier, 2011). Certainly further research in more languages is required in order to clarify these points and strengthen knowledge about the underlying causes of dyslexia and their influence on spelling skills. This would inform the theories of spelling and would have important educational implications for policy makers, teachers and practitioners working with children with dyslexia.

Models of spelling development and skilled spelling are useful tools attempting to describe, explain and simulate the processes that typical and atypical learners follow to master spelling skills. They are particularly helpful for educational purposes because they provide a theoretical framework for comprehending the cognitive processes underlying spelling skills to inform teaching practice. They may also be used for evaluating children's performance in comparison with their peers and for identifying and planning next steps for individual progress. Thirdly, the models provide a framework for diagnostic purposes in the case of atypical development and steadily inform the design of standardised spelling tests or experimental spelling tasks for research purposes. Nevertheless, they have been subject to criticisms, not necessarily aiming to reject but rather to improve the models' viability by extending their implementation to more than one orthographic system and to populations of a wider age range and characteristics (i.e., typical-atypical performance). In particular, the developmental theories have been criticised for their static view of spelling acquisition in very discrete stages characterised by certain dominant skills and in successive progress from one stage to another. A number of studies suggest that children possess spelling strategies that correspond to various stages, although at different levels at any given point in time, and employ them according to the demands of the stimulus and the task. For example, indications for some basic use of phonetic and orthographic strategies from an early age is provided by several studies (Goswami & Bryant, 1990; Nation & Hulme, 1998; Treiman & Cassar, 1997; Treiman, 1993). In contrast, Treiman's naturalistic approach (1993, 1994) provides a more flexible framework explaining the processes involved from single letter-sound recoding to employing GPC rules, for which stage theories do not account. Similarly, the overlapping waves model (Rittle-Johnson & Siegler, 1999) provides a better account for research evidence supporting the notion that spelling skills develop in different paces and are employed at various levels depending on the demands of the task and the orthographic system. Ehri's (2014) recent revision of her phase theory to integrate these points is illustrative of this movement towards a more flexible approach to spelling development.

As concerns the models of skilled spelling, these are proved very useful to describe the processes followed by skilled spellers but also to simulate the learning mechanisms employed by typical spellers or being restricted in atypical spellers (Hutzler et al., 2004). Traditional dual route models have been criticised for providing a view limited to mature literacy skills (Coltheart et al., 1993). Connectionist models with single path or dual path multilayer architecture addressed this gap by including hidden units, which enable the extraction of statistical relationships between input and output simulating human implicit learning of spelling. Especially the dual route connectionist models retain the advantage of being able to replicate findings of research on impaired human spelling by examining each route in isolation (Houghton & Zorzi, 2003). In addition, their sensitivity to statistical regularities allows them to capture the advantage of reading and spelling in more regular orthographic systems over less regular orthographies (Hutzler et al., 2004). However, connectionist models have been criticised for their inadequacy in incorporating explicitly taught knowledge for better simulation of human learning processes (Berninger et al., 2000), especially with regard to cross-linguistic research since different educational systems implement various learning strategies (Hutzler et al., 2004). The extensive corpora on which they are trained, the number of exposures and their restriction to monomorphemic words are three more points that differentiate these models from real life learning. Nevertheless, these models are still advantageous over more traditional ones and, for this reason, very influential in the field of literacy research. Their limitations should be addressed by future research for further improvement of their ability to describe and explain spelling processes. Finally, the lexical quality hypothesis (Perfetti & Hart, 2002) provides a suitable framework to describe the multidirectional relationships among phonological, orthographic, semantic, morphological and syntactic information for spelling. For this reason, it is a valuable tool to explain research findings from populations of various ages and abilities, cross-linguistic studies and studies investigating spelling processes in different writing conditions.

The purposes of writing for communication result in differentiating spelling in writing composition and spelling-to-dictation (Pattison & Collier, 1992). The influential model of simple view of writing by Berninger and Swanson (1994) provides the appropriate framework to conceptualise spelling within written semantic and syntactic context. For the purposes of the present study, it is very important that this model emphasises the interaction between lower-level skills, such as spelling, and higher-level skills, such as conscious attention, planning and reviewing, as well as the role of working memory in coordinating all the processes occurring when writing for meaning. Despite the fact that the development of each of the components and the interaction among them are not specified by the model, this is a valuable framework to investigate the challenges posed for individuals with dyslexia when spelling in writing condition. Research in various languages has shown that spelling is an effortful process, especially for children with dyslexia as compared with their peers (e.g., Bourassa and Treiman, 2008; Caravolas & Volín, 2001; Carlisle, 1987; Diamanti, et al., 2013; Egan & Tainturier, 2011; Nikolopoulos et al., 2003; Protopapas et al., 2013; Treiman & Kessler, 2006). Evidence from research in written composition further supports this notion, although the number of studies in this area is still extremely limited (Puranik et al., 2006; Sumner; 2013). In the framework of the simple view of writing it is assumed that spelling influences and is affected by the co-occurring processes, as well as that the resources of working memory are exploited according to the demands of the writer. Many questions arise regarding the impact of all these processes on and the role of self-generated semantic context in the spelling performance of children with dyslexia in comparison with typically developing writers. To date there is no sufficient evidence to address these questions. Although it is established that spelling processes differ depending on the writing condition, further evidence is needed to support the notion that spelling performance is affected by the writing task and to specify the directions of this effect. The current study will attempt to address these questions via examining the spelling performance of children with dyslexia in different writing conditions in two orthographic systems, English and Greek. The research goals of this study are outlined in the following chapter.

Chapter 3

Rationale and Research Goals of the Present Thesis

3.1 The need for universal models of spelling

According to Olson and Caramazza (1994) the adequacy of a literacy theory depends on its ability to explain processes in more than one linguistic system. Having appreciated this need, there is a growing interest to study reading and writing processes in a more inclusive, universal framework. Identifying mutual predictors of literacy skills, common patterns in typical development and shared characteristics of atypical performance have attracted the attention of cross-linguistic research (Caravolas, Bruck, & Genesee, 2003; Caravolas, 2003; Caravolas et al., 2012; Seymour, Aro, & Erskine, 2003; Smythe & Everatt, 2000; Smythe & Everatt, 2004). Focusing particularly on computational models, Frost (2011) defines two main media that humans employ to learn: implicit statistical learning and explicit learning. He emphasises the ability of the human cognitive system to grasp the correlations between information that the orthographic codes convey. Writing systems take the optimal, condensed form required to express phonological and semantic information using minimal orthographic units. Therefore, orthographic processing in any language must be able to grasp all types of information that the graphemes carry.

Despite the commonalities, languages may vary in statistical properties, such as grain size (grapheme, syllable, and word), phoneme-to-grapheme correspondence (consistent-inconsistent), correlations between written form and meaning (homophones) or spoken form and meaning (homographs) etc. Since languages have evolved to convey meaning while at the same time retaining phonological information, a universal literacy model should be able to focus on the invariant characteristics of orthographic processing across writing systems reflecting all those dimensions that dictate orthographic structure (Frost, 2011). Especially with regard to morphological information, Grainger and Ziegler (2011) argue that a viable model should take into account the structure of polymorphemic words by recognising that affixes are attached to base words and differentiating between these two types of morphemes. Aside from computational models (Houghton & Zorzi, 2003), most theories of spelling recognise the contribution of different types of information and of the interactions between them to the accuracy of the spelling output by replicating the processes or observing the strategies that learners employ to achieve better spelling (e.g., orthographic mapping see Ehri, 2014; overlapping waves theory see Rittle-Johnson & Siegler, 1999; self-teaching hypothesis see Share, 1995; naturalistic approach see Treiman, 1985, 1992, 1993, 1994; lexical quality hypothesis see Perfetti & Hart, 2002).

3.3.1 To what extent are trajectories of typical spelling development dependent on the linguistic characteristics of systems with different levels of orthographic consistency (English and Greek)?

This thesis aimed to address this need to enrich the existing empirical evidence about the universal characteristics of orthographic learning by investigating the spelling performance of native speaking children of a wide age range across the English and Greek orthographic system. Overall, Greek is fairly transparent for reading, but is characterised by several irregularities in spelling. Specifically, vowel sounds, which can be represented by different single letters or digraphs, are a common ground for comparison with the English orthography (Figure 3.1, p. 74), where vowel spelling is the major area of inconsistencies (Kessler & Treiman, 2001). Consonant clusters having one sound-to-many graphemes correspondences are another similarity between the two linguistic systems. Thus, in order for these phonologically non-transparent patterns to be spelled correctly, employment of grammatical (number, tense), etymological (root morphemes) and contextual (semantic) information is essential in both languages. This morphophonemic nature of the two languages allows for a parallel investigation of the spelling of words and morphemes in English and Greek.

Analysis of misspellings has shown that orthographic consistency plays a significant role in spelling achievement and the pace with which children progress to mastery of conventional spelling patterns. For instance, children writing in more transparent orthographies are expected to master phonological spelling skills relatively early whereas they still struggle with orthographically dependent patters (e.g., in German: Landerl & Wimmer, 2000; in French: Alegria & Mousty, 1996; in Greek: Nikolopoulos, Goulandris &Snowling, 2003). On the other hand, the findings of Bryant, Nunes and Aidinis (1999) support the notion that children writing in English and children writing in Greek face similar challenges when it comes to spelling morphologically complex words.

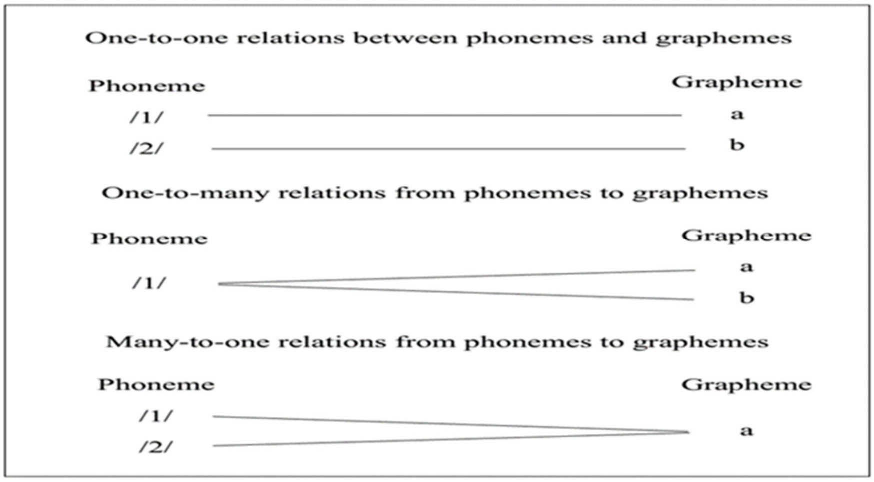


Figure 3.1

Phoneme-to-grapheme Correspondences in English (adapted from Treiman, 1993, p. 22)

The first part of the current study aimed to add to this knowledge by examining error types in two languages of different levels of orthographic consistency but with morphophonemic nature in comparable spelling patterns. Direct cross-linguistic comparisons were drawn to enable forthright conclusions about the role of the orthographic system in the acquisition of spelling skills. It is innovative in that the experimental lists included a number of monomorphemic and polymorphemic words matched as much as possible for frequency, length and grapho-phonemic complexity across the two languages to allow for the universal features of spelling development to emerge. Another asset is that the method of analysis was tailored to examine spelling errors in relation to the full array of types of knowledge required to spell (i.e., phonological, morphological and orthographic), as dictated by contemporary theories of spelling, to enable a more global investigation of developmental trends in spelling. Thirdly, it included cross-sectional comparisons between typically developing children in the last four grades of primary school so as to capture any evident developmental trends within a wider period of time at an age when children are introduced to and get regular practice in spelling the most challenging patterns of their conventional orthographic system. The findings regarding typical spelling development in English and Greek are discussed in chapter 5.

3.1.2 Is there a distinguishable spelling profile of children with dyslexia in comparison to typically developing pupils of the same age, reading or spelling ability?

Research on reading in languages of different levels of orthographic consistency has well established the universality of dyslexia as a cognitive deficit affecting phonological processing, reading speed, naming speed and speed of processing (e.g., Italian and English: Bonifacci & Snowling, 2008; Hebrew and English: Katzir, Shaul, Breznitz, & Wolf, 2004; German and English: Frith, Wimmer, & Landerl, 1998; Ziegler, Perry, Ma-Wyatt, Ladner, & Schulte-Körne, 2003; Chinese: Ziegler, 2006). Studies on spelling are much less numerous as are studies in other languages aside from English (Smythe & Everatt, 2004). To date research has provided mixed findings regarding the manifestation of dyslexia in spelling. Some studies in more transparent languages suggest that children with dyslexia experience a phonological developmental delay in comparison with typical learners even at later grades of primary education (e.g., in Czech: Caravolas & Volín, 2001; in Greek: Diamanti et al., 2005) while other studies postulate that significant phonological difficulties cease to exist relatively early (e.g., in German: Landerl & Wimmer, 2000; in French: Alegria & Mousty, 1996; in Greek: Fakou, Drakopoulou, Skaloumbakas, & Protopapas, 2010; Nikolopoulos, Goulandris & Snowling, 2003). This lack of consensus might be a result of differences in the research design of the studies (i.e., different tests or types of stimuli). In addition, it has been noted that a lack of spelling ability-matched controls might affect the validity of the results, since a potential difference in the general spelling ability between the target group and the control group is not controlled for (Egan & Tainturier, 2011).

3.1.3 What is the role of the orthographic system (English or Greek) in the spelling performance of children with dyslexia writing in two different languages?

Overall findings of studies in different languages consistently support the notion that morphological and orthographic weaknesses are more persistent than phonological difficulties of children with and without dyslexia. In general, statistically significant differences between the target group and their chronological-age controls are interpreted as suggesting a developmental delay in morphological/orthographic spelling skills, while discrepancies with younger reading or spelling ability-matched controls are regarded as postulating a specific morphological/orthographic deficit. However, research evidence is mixed with some studies endorsing a morphological/orthographic delay and others a deficit of pupils with dyslexia (e.g., Alegria & Mousty, 1996; Bourassa & Treiman, 2003;

Carlisle, 1987; Diamanti, Goulandris, Stuart, & Campbell, 2013; Egan & Tainturier, 2011; Nikolopoulos, Goulandris, & Snowling, 2003; Protopapas et al., 2013; Tsesmeli & Seymour, 2006). Similarly to the phonological spelling errors, the discrepancy in the results of these studies with regard to the morphological/orthographic errors might be attributable to the differences in the testing material, the categorisation of errors or the control groups employed.

The second part of the present study aimed to investigate the phonological, morphological and orthographic spelling skills of children with dyslexia. In particular, it aimed to detect any specific spelling profile of those children in comparison with a carefully matched chronological age group, as well as a separate younger reading age and a spelling age control group. Another goal was to investigate any universal aspects of dyslexia's manifestation in spelling, as well as to explore whether the spelling challenges faced by Greek and English children with dyslexia would be alleviated or hindered by the writing system in which they were writing. Any similarities or profound differences were explored by matching the target words as much as possible across the two languages and drawing direct cross-linguistic comparisons between the two groups of children with dyslexia. This study is expected to contribute with further evidence to the theories of spelling by investigating the spelling skills of children with dyslexia in two languages with different levels of orthographic consistency in the feed-forward direction, which, however, show several inconsistencies in the feed-back direction (Protopapas & Vlahou, 2009; Venezky, 1970). The results concerning the spelling abilities of children with dyslexia are discussed in chapter 6.

3.2 The need to assess spelling in text writing condition

Writing is often a more "intractable problem than reading for most dyslexics. Such children typically are less engaged in writing tasks and less attentive to written words, but also are at risk of becoming writing avoidant" (Singleton, 2009, p. 49). Despite this fact, the majority of exploratory research and intervention studies with dyslexic children direct their attention to reading while relatively few studies have focused on writing. Moreover, the dictation of single real words and non-words isolated from a contextual environment is regarded as incompatible with the natural process of writing and, hence, spelling in writing condition may differ from spelling-to-dictation (Pattison & Collier, 1992) even when the target words are embedded in a sentence.

3.2.1 What is the role of oral and written context in facilitating or restricting spelling achievement of children in primary school? Does semantic and syntactic context affect the application of different types of knowledge?

The simple view of writing model (Berninger & Swanson, 1994) briefly specifies three components of the writing process. Great capacity is provided by the framework for further research exploring these components and the interactions between them. For instance, research has shown that application of different types of knowledge (i.e., phonological, morphological and orthographic) is required to spell accurately and that this knowledge increases accumulatively through practice in reading and writing (e.g., Nunes, Bryant, & Bindman, 1997; Treiman, 1993; Varnhagen, Mccallum, & Burstow, 1997). Furthermore, text generation skills involve selecting an appropriate vocabulary to express ideas. Research has shown that there is a strong relationship between spelling and vocabulary. For example spelling skills might restrict or facilitate vocabulary choices in a free writing task (Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008). To date the role of semantics with regard to spelling performance in writing tasks is not thoroughly explored. Studies on learning spelling have shown that semantic context facilitates the acquisition of novel words (Ouellette & Fraser, 2009; Ouellette, 2010; Share, 1995). If the relationship between semantics and spelling is bidirectional, then it would be reasonable to hypothesise that semantic context would affect spelling performance. However, there is still not sufficient research evidence to specify the extent and direction of this effect.

3.2.2 Is the spelling performance of children with dyslexia affected in the same manner as that of their typically developing peers?

With regard to spelling development, studies employing writing tasks have detected a gradual decrease in children's spelling errors, which signifies the progressive application of phonological, morphological and orthographic knowledge (Green et al., 2003; Puranik, Lombardino, & Altmann, 2008; Stainthorp & Hughes, 1999; Varnhagen et al., 1997) in accord with the theories of spelling and findings of studies using solely dictation tasks. Especially as concerns children with dyslexia, the few studies employing text composition have demonstrated that the phonological weaknesses linked with dyslexia are reflected in their spelling errors and that orthographic misspellings are also very prevalent (Sumner, 2013). One of the demands of text composition tasks is that of creating a semantic and a syntactic written context by employing appropriate vocabulary and structuring meaningful sentences and paragraphs. On the other hand, in text composition tasks there is no acoustic input of the words. According to the simple view model, the third component of writing, executive functions, serve to communicate ideas in a meaningful way. Working memory coordinates all three components and employs its resources according to the needs of the writer and the task. Research has linked dyslexia with slow handwriting and memory weaknesses (Berninger et al., 2008; Rose, 2009; Singleton, 2002). If retrieving spelling information from memory is effortful, it could be argued that, as the demands of the task increase, memory resources of children with dyslexia are exploited differently. This could result in focusing on or, conversely, distracting those children from spelling, which could lead to detectable differences in their error rates when text writing and spelling-to-dictation are compared.

If different error types reflect the application of different types of knowledge in spelling, then the aforementioned specific characteristics of the text composition task would be expected to have distinguishable effects on the writer's error rates. To date the extent to which the rate of different error types might be influenced by these properties in texts created by children with dyslexia is not adequately explored in research. Furthermore, the limited number of studies using text writing to compare the spelling performance of children with dyslexia and typically developing controls do not provide consistent results linking dyslexia with a developmental delay or deficit, thus replicating the lack of consensus in studies employing spelling-to-dictation tasks. One potential reason to explain this inconsistency might be that in previous studies of written composition error rates were not often assigned to different error categories. This does not facilitate the detection of prevalent deficits in phonological, morphological or orthographic spelling. Another reason might be the employment of different control groups across studies using text writing and/or spelling-to-dictation, which impedes drawing viable comparisons between them.

3.2.3 Do linguistic properties of the orthographic system (English or Greek) affect the magnitude of the impact of semantic and syntactic context on spelling performance of pupils with dyslexia and their typically developing peers?

Language might also play a significant role in the manipulation of written context, which might impact on the prevalence of specific error types or on the discrepancies between the performance of children with and without dyslexia. Writing in more transparent languages has been found to enhance overcoming of phonological spelling difficulties of children with dyslexia relatively early (e.g., Alegria & Mousty, 1996; Landerl & Wimmer, 2000; Nikolopoulos et al., 2003). On the other hand, studies on reading have shown that children writing in more opaque orthographies may be more accurate in orthographic processing because they substitute grapheme-to-phoneme strategies with whole word strategies (Goswami, Ziegler, Dalton, & Schneider, 2003; Wimmer & Goswami, 1994; Ziegler, Perry, Jacobs, & Braun, 2001). Based on this evidence, it might be reasonable to expect a detectable difference in the manner that Greek and English children with dyslexia make use of written context to facilitate application of different types of knowledge in spelling.

The third part of the current study aimed to address this need for a combined examination of dictation tasks and text composition tasks for a more inclusive assessment of spelling performance of children with and without dyslexia. More specifically, a first goal was to further the investigation of a specific spelling profile of children with dyslexia in comparison with age and ability matched control groups in a more naturalistic spelling task (i.e., text composition). A second aim was to examine the extent to which children with dyslexia might benefit from surrounding semantic and syntactic information to enhance application of different types of knowledge when spelling. It is innovative in that different error categories (i.e., phonological, morphological, orthographic) were examined for a direct investigation of a possible impact of semantic and syntactic context on different aspects of spelling. Incorporating the concept of direct interactions between semantics, morphology and spelling performance is one of the assets of this study, because it provided a more holistic framework to investigate spelling processes. To allow for viable comparisons between spelling tasks the same target words were used and compared across spelling conditions.

The study also aimed to explore further the universal aspects of dyslexia's manifestation in spelling and how language-specific characteristics might impact on the effect of context on spelling difficulties linked to dyslexia. The spelling performance of children with and without dyslexia writing in two languages with different levels of orthographic consistency was thoroughly examined in writing tasks where semantic and syntactic context was employed in a different manner (i.e., oral versus written). For this purpose the properties of the target words were matched across languages as much as possible and the spelling profiles of English and Greek children with dyslexia and their typically developing controls were examined in parallel. To date cross-linguistic studies incorporating these aspects of writing are very limited. Hence, this study is also expected to contribute with further evidence to the universal theories of spelling and writing. Finally, the results are anticipated to have significant practical implications adding to the way that writing tasks are employed by practitioners working with children with dyslexia to diagnose their spelling difficulties and by teachers willing to enhance the development of their pupils' spelling skills in formal education. The findings are discussed in chapter 7.

Chapter 4

Methodology

4.1 Introduction

In this chapter the research design is outlined. General considerations about the design, the conduct of this cross-sectional study and the analysis of the data are reviewed. The study comprised a first phase of pre-test selection measures followed by one experimental phase where the spelling performance of participants was assessed. The selection measures and experimental spelling tasks are discussed in the following sections.

4.2 Outline of research design

This study compared the spelling performance of primary school pupils as assessed with specially devised spelling tasks. Cross-linguistic comparisons were drawn by recruiting English or Greek native speaking participants from schools in the two countries respectively. Furthermore, performances of typically developing participants belonging in different year groups of the same language sample (i.e., English or Greek) were compared. One group of children showing a dyslexic profile was also recruited in each country. The performances of these two groups were compared with those of three matched control groups writing in the same language, who were selected from the two larger samples of typically developing pupils. A repeated measures design was used to compare the performances of the participants in different spelling error categories and across three different spelling tasks. This design, where comparisons are drawn between groups of participants, is referred to as “cross-sectional” (Coolican, 2014). It was utilised in the present study to examine the cumulative acquisition of spelling skills of typically developing children, to explore potential signs of atypical development of pupils with a dyslexic profile and to investigate possible effects of the orthographic system (English, Greek) on children’s spelling performance. To draw comparisons between groups, quantitative analyses were performed.

4.2.1 Cross-sectional design

Cross-sectional and longitudinal studies aim to investigate changes in the performance of groups within a population. Often both designs are used to detect developmental trends within a population. For this purpose cross-sectional studies compare the performance of participants belonging to different age groups at the same point of time, while longitudinal studies compare the performance of the same group over time. Both designs have advantages and limitations (Coolican, 2014). In a cross-sectional study, assessment of participants takes place at a specific point of time and is completed within a relatively short period. This ensures economy of time and resources, while participant attrition can be more easily controlled. Because of these characteristics, cross-sectional studies may include more participants than longitudinal studies, which are more prone to participant attrition, and can observe developmental trends by comparing groups of a wide age range faster than longitudinal studies, which require following the same participants over longer periods of time. Finally, often in cross-sectional studies measurement effects can be avoided, i.e., familiarity of participants with the task due to repeated testing.

On the other hand, one limitation of cross-sectional design is that, because different groups of participants are compared, the possibility that different sample characteristics may influence the results cannot be ruled out (Coolican, 2014). More specifically, when exploring developmental trends, the researcher cannot be certain that the observed abilities or weaknesses of a younger group were present in older participants at an earlier stage of their development. The difficulty in detecting developmental trends may augment if there is a large discrepancy in the age of the compared groups. In that sense, a longitudinal design would be preferable since it allows for comparisons between the performances of the same individuals over time. However, even in longitudinal studies other uncontrolled external and internal factors such as the school and family environment, the emotional or physical state of the participant may influence their performance in different points of time. Finally, even if diminished, the problem of participant attrition cannot be ruled out for cross-sectional studies, especially if the sample is required to have specific characteristics, e.g., pupils with dyslexia. Therefore, in order to achieve successful completion of the study the researcher must ensure that larger samples are assessed, positive relationships with the participants and their environment are maintained, and testing is well timetabled and complies with the pupils' daily routine as much as possible.

4.2.2 Cross-linguistic design

The cross-linguistic design is a type of "cross-cultural" designs. Cross-cultural designs (Coolican, 2014) are employed to examine reliable effects beyond one specific culture to extend the study's population validity, i.e., the extent to which the findings may be generalised across different populations. If the trends are found in more than one culture, universal characteristics can be extracted to reinforce the theory under examination (Coolican, 2014). For this purpose a cross-linguistic design is often used to study the development of literacy skills in typical learners and the effects of dyslexia on the performance of individuals reading and writing in different orthographies. The advantages of a cross-cultural design are that it provides data that no other method can provide, it can enhance application of the theory under examination by separating between universal and cultural-specific characteristics, it offers understanding of different cultural systems and practices, but can also provide evidence that an effect is limited to one culture or system (Coolican, 2014), e.g., educational and orthographic constraints. Specifically as concerns theories of orthographic processing, Frost (2011) suggests examining the type of information provided by the orthographic structure of different languages, which extends beyond describing letter combinations or letter location. The orthographic structure of a language reflects the "phonological space" and the way it conveys meaning through morphological structure (Frost, 2011). In that sense, the cognitive system captures the statistical regularities to relate phonology, morphology and orthography in an optimal way for the linguistic system in which an individual reads and writes. Frost suggests that, since different computations may be found across languages and even within one language, a universal literacy theory should concentrate on analogous characteristics of orthographic processing across writing systems. The common grounds between English and Greek on which the present study based any cross-linguistic comparisons are that both languages have a morpho-phonemic structure (Frost, 2011) and that often mapping a phoneme to a grapheme for spelling is not as consistent as mapping a grapheme to a phoneme for reading (Davies & Weekes, 2005; Porpodas, 2006; Protopapas & Vlahou, 2009; Stone, Vanhoy, & Orden, 1997).

However, cross-cultural studies are not without limitations. They can be costly and time-demanding, variables may not be culturally analogous or findings may be exploited to support concealed ethnocentric assumptions (Coolican, 2014). In the case of cross-linguistic studies, one of the main challenges is finding analogous experimental task stimuli across languages. Studies of reading have used different methods to match target words in different languages depending on their aims. Such methods include transforming real words in non-words (e.g., Wimmer & Goswami, 1994), translating words from one language in another language (e.g., Landerl, Wimmer, & Frith, 1997; Spencer & Hanley, 2003), using parallel word lists of high-frequency words sourced from children's books (e.g., Goswami, Gombert, & de Barrera, 1998; Seymour, Aro, & Erskine, 2003) or using parallel word lists with stimuli corresponding to several frequency levels from the most frequent to the least frequent words in each language (e.g., Ellis et al., 2004). Ellis et al. (2004) support the last method as being advantageous in comparison to the rest because it can distinguish between learners at different stages of proficiency. According to these researchers, matching the stimuli in more factors related to language, such as length, morphological complexity, phoneme-to-grapheme consistency, is too restrictive. Their argument is based on input-driven perspectives of language acquisition that learning is dependent on the amount of experience a learner has with a word or similar words. Thus, native speaking participants of two languages with similar experience should show comparable efficiency in reading word lists solely matched in frequency levels, if the two languages are equally difficult to acquire.

Nevertheless, cross-linguistic studies do not always investigate languages of equal difficulty, sometimes including languages that do not correspond to an alphabetic system (e.g., Japanese: Ellis et al., 2004; Chinese: Smythe et al., 2008). Moreover, many languages may seem very different at the level of word for reading and writing but may be comparable at a more refined grain-size e.g., rime, phoneme-to-grapheme, morpheme levels. Especially for studies of writing that focus on spelling accuracy rather than speed, validity may be enhanced by controlling for other factors which may affect learning (e.g., word length, phono-graphemic complexity, morphemic structure), to the extent that the different linguistic systems permit. Caravolas, Bruck and Genesee (2003) discuss the issue of differences in the transparency of two compared written languages postulating that some are easier to learn than others, at least at the level of word spelling (e.g., of studies employing word-level analysis: Caravolas & Bruck, 1993; Wimmer & Goswami, 1994). Beyond the word-level, studies often employ smaller unit sizes to explore spelling-to-sound correspondences in relation to reading and spelling. Smaller units include the onset (i.e., the initial sequence of consonants) and the rime (i.e., the vowel and the graphemes following it) of monosyllabic words (e.g., <str> is the onset and <eet> is the rime in <street>; see Stone, Vanhoy, & Orden, 1997). A study on phoneme awareness by Goswami and colleagues (2005) provides evidence to support the notion that children reading and writing in languages of different transparency levels may differ in developing reading processes at a finer grain-level. This study showed that over the same period of time German children improved dramatically in a rime and a vowel task in comparison to their English peers, who reached ceiling only in the rime task. Goswami et al. (2005) suggest that this is an effect of spelling-to-sound consistency, with German being more consistent at the level of grapheme-to-phoneme correspondences than English, which resulted in English children lagging behind their German counterparts in manipulating small units (i.e., vowels).

Indeed, research in English often focuses on the rime grain-size to examine feedforward (reading) and feedback (writing) processes (Stone et al., 1997). One of the reasons why larger grain-sizes are employed in research is that they often reduce the ambiguity of some phoneme-to-grapheme correspondences, e.g., the pronunciation of <–eap>, as in <heap>, is more consistent than the pronunciation of <ea>, as in <heap> versus <ready> (e.g., of studies using rime-level analysis: Kessler & Treiman, 2001; Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995), However, the critical role of finer grain-sizes, i.e., grapheme-phoneme, in reading and writing is also acknowledged by researchers (see Van Orden & Goldinger, 1994, for the role of coarse-, intermediate- and fine-grain self-consistency in the perception of printed words). In line with this argument, Kessler and Treiman (2001) statistically analysed the spelling-to-sound relations in feedforward and feedback direction in English monosyllabic words of consonant-vowel-consonant (CVC) structure. Their analysis showed that rimes are not processed as whole units. They found that items were read and spelled using a basic phoneme-grapheme process, which took into account the preceding and following phonemes-graphemes (i.e., the phono-graphemic context). Moreover, Protopapas and Vlahou (2009) suggest that using a rime-level analysis to reduce inconsistencies might not be justified for more transparent languages, where grapheme-phoneme mappings might be more consistent across the vocabulary. They also raise the issue of cross-linguistic studies examining only monosyllabic monomorphemic words, as the proportions of monosyllables may vary across orthographic systems. In addition, the level of application of other skills beyond phoneme-to-grapheme mapping may differ when processing monomorphemic and polymorphemic words affecting the representativeness and, hence, the validity of the study. According to these researchers, employing different grain sizes might be more appropriate to examine reading and spelling processes in systems other than English and in cross-linguistic approaches. Van Orden and Goldinger (1994) also discuss the methodological issues of inappropriate grain-sizes employed in cross-linguistic studies. They highlight the importance of "maintaining the narrative function of subsymbols (i.e. grain size)" to avoid the "frustrating experience […] to have a theory "falsified" by refutation of its specific representations" (1994, p. 1274). To address these issues, the experimental stimuli of the present study comprised a range of age-appropriate monosyllabic and pollysyllabic words, matched in frequency levels across the English and Greek system, and analyses were performed at various grain-levels, including whole-word, stem/affix and phoneme-to-grapheme level.

Another factor that may play a role in the development of literacy skills, according to Goulandris (2003), is the age at which children start formal education. This might raise an issue in studies examining literacy skills in different countries. For instance, children in England begin formal schooling at the age of 5, while in other European countries formal schooling starts at 6 or 7, when children are expected to be more advanced in oral language and cognitive skills (i.e., school readiness). To account for this discrepancy, researchers often match children in chronological age to draw cross-linguistic comparisons (e.g., in Czech and English: Caravolas, Volín, & Hulme, 2005; in French and English: Caravolas et al., 2003; in English, Greek, Japanese and Albanian: Ellis et al., 2004; in English, French, Spanish and Greek: Goswami, 1999).

On the other hand, research has shown that the effect of schooling significantly influences the development of skills, such as reading and spelling, sometimes above and beyond effects of age of acquisition (e.g., Cunningham & Carroll, 2011). Cunningham and Carroll studied literacy skills in the first year of formal education with English children starting school at different ages (Steiner versus standard schools). They found the effect of quantity and quality of instruction to be stronger than age effects on reading and spelling, as well as skills related to literacy, such as phonological skills. Zevin and Seidenberg (2002) employed a connectionist model to examine reading processes with a corpus of English monosyllabic words. They observed an effect of age of acquisition only when the orthographic and phonological properties of early and late learned words did not overlap (i.e., unrelated base words). Increasing knowledge about the writing system in combination with the development of phonological skills has been suggested to improve the phonological accuracy of children's spellings, while orthographic accuracy seems to improve as children extract knowledge about the orthography through reading (Caravolas, Hulme, & Snowling, 2001). In addition, experience with reading is suggested to enhance word-specific knowledge through memorisation (Ehri & Wilce, 1987). To account for the effect of schooling on literacy skills cross-linguistic studies have often examined the performance of children attending the same grade across different countries regardless of age discrepancies between language samples (e.g., in English, Greek, Portuguese; Bryant, Nunes, & Aidinis, 1999; in English, Spanish, Czech and Slovak; Caravolas et al., 2012; in 13 countries; Seymour et al., 2003). In the present study possible effects of age of starting formal education and of years of schooling are taken into account when drawing cross-linguistic comparisons by running separate analyses for English and Greek children matched in a) years of schooling and b) chronological age.

4.3 Participants and assessment materials

4.3.1 Participants

The participants of the present study comprised two major language samples, a) the English native speaking and b) the Greek native speaking sample. Each language sample contained two main sub-groups, a) the typically developing pupils and b) the dyslexic-profile pupils. Written consent of the Headteachers of the participating schools and the parents was a pre-requirement for the participation of the children in the study (see Appendix D). Children had the purpose and procedure of the study explained and participation was voluntary. Children were selected randomly to ensure good representation of their year group. Recruitment was expanded to as many schools as needed to fulfil the selection criteria.

All participating schools were selected from urban catchment areas of similar socio-economic status to ensure that all participants in both countries were exposed to a comparable socio-economic environment, since literacy skills have been reported to be affected by socio-economic factors (e.g., Snow, Barnes, Chandler, Goodman, & Hemphill, 1991). For the English sample, 155 children attending years 3, 4, 5 and 6 (7.6-10.7 years old at the time of the study) were recruited from five State mainstream primary schools in a middle-to-high socio-economic area of Berkshire, England. With regards to ethnic background, according to the most recent Census (2011), 8% of the area's population was classified in "other white" (i.e., non-British) and 25% in "non-white" ethnic groups. The most recent Ofsted reports for the participating schools noted that children who spoke English as an additional language were "fewer than average" in most of the schools. In one school "almost all pupils" spoke English as their home language and in one school children speaking English as an additional language were "more than average". Regarding the proportions of pupils with special educational needs, according to the Ofsted reports, in four schools a "below average" proportion of pupils was supported at school action (i.e., extra support provided during school hours and co-ordinated by the Special Educational Needs Co-ordinator of the school), one school had an "average" proportion of pupils supported at school action and an "above average" proportion of pupils at school action plus (i.e., extra support provided by external support services), while no information was available for the fifth school.

As concerns the Greek sample, 170 children attending grades 3, 4, 5 and 6 (8.6-11.5 years old at the time of the study) were recruited from eleven State mainstream primary schools in a middle-to-high socio-economic area of Athens, Greece. According to the most recent Strategic Plans (2012) conducted by the Councils in which the participating schools belonged, the population of non-Greek ethnic background was 6% of the total population. Since official reports are not available for public use, the Headteachers of the schools were asked about the proportions of students with Greek as an additional language and of pupils with special educational needs in their schools. According to their answers, the proportion of children with Greek as an additional language ranged from "very few" to 10% of the total population of the school. With regards to pupils with special educational needs being supported at "inclusive classes" (*τμήματα ένταξης*, i.e., special classes run by specialist teachers within the working hours of the school, providing additional support in literacy and numeracy skills), ranged from “few” to “below average”, according to the Headteachers’ answers.

The final pool of typically developing participants in both language samples had no diagnosis of any emotional, social, psychiatric or neurological difficulties and had at least one English/Greek native speaking parent in their home background. Pupils who did not fulfil the selection criteria, missed at least one experimental session or withdrew at any point of the study were excluded from the final samples. Descriptive statistics of the number and age of participants by year group per language are presented in Table 4.1, p. 89.

Table 4.1

Absolute Numbers and Percentages per Gender of Typically Developing Participants per Language and Year Group

	English				Greek			
	Y3	Y4	Y5	Y6	G3	G4	G5	G6
N Total	25	24	29	23	31	24	35	22
N Boys	12	11	16	11	14	11	11	11
Boys Percentage	48%	45.8%	55.2%	47.8%	45.2%	45.8%	31.4%	50%
N Girls	13	13	13	12	17	13	24	11
Girls Percentage	52%	54.2%	44.8%	52.2%	54.8%	54.2%	68.6%	50%

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6; N = Number.

4.3.2 Baseline measures

4.3.2.1 Selection of typically developing children

Prior research indicates that reading and spelling skills might be affected by age, verbal abilities, non-verbal abilities and socio-economic status (e.g., Dufva, Niemi, & Voeten, 2001; Hecht, Burgess, Torgesen, Wagner, & Rashotte, 2000; Kemp, 2006; Lonigan, Burgress, & Anthony, 2000). Since experience with the written form of a language is considered to affect orthographic accuracy (e.g., Caravolas et al., 2001; Ehri & Wilce, 1987), the first criterion to select the participants of the present study was their schooling years. Children were recruited from years 3 to 6 in England and grades 3 to 6 in Greece. Because the study aimed to investigate the development of the spelling ability in primary school, it was essential to include typically developing children that would had experienced some years of practicing their literacy skills and would had encountered a variety of inconsistent orthographic features in daily practice at school. For this reason the pupils attending the first two years of primary education were excluded in both countries. Selection of older year groups also relates to the anticipation that this would be a stage where daily learning activities would be more directly focused on explicitly teaching spelling with the aim to set solid foundations and develop spelling skills to prepare children for secondary education. Studying this group of children was expected to identify signs of this progress in the children's writing samples. Finally, it was important to recruit participants that would have the confidence and skills to complete the whole set of tasks included in the study with an as low probability of attrition as possible. Thus, younger less experienced learners were excluded from the sample. The chronological age of the participants was recorded and coded in months.

A set of cognitive assessments was administered to select the participants comprising the groups of this study using the following criteria: a) showing a non-verbal ability of at least normal range, as assessed with the Raven's Coloured Progressive Matrices (CPM; Raven, 1938; Raven, Raven, & Court, 2004) and b) having verbal abilities of at least normal range, as assessed in English with the Vocabulary subtest of the Wechsler Intelligence Scale, 3rd ed. (WISC-III by Wechsler, 1991), and in Greek with the Greek version of the WISC-III (Georgas, Paraskevopoulos, Mpezevengis, & Giannitsas, 1997). To obtain a credible estimation of their reading and spelling ability prior to assessing them in the experimental spelling conditions, pupils were assessed with c) a single word reading test in English: Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) and in Greek: a reading efficiency task devised by Georgiou, Papadopoulos, Fella, and Parrila (2012), along similar lines with the English TOWRE as well as d) a single word spelling measure in English: British Ability Scales, 2nd ed. (BAS-II by Elliott, Smith & McCullouch, 1996) and in Greek: a single word spelling test devised by Mouzaki, Sideridis, Protopapas, and Simos (2007).

Non-verbal ability. A total number of 325 children were assessed for non-verbal ability with the Raven's Coloured Progressive Matrices (CPM; Raven, 1938; Raven, Raven, & Court, 2004). The CPM is designed for children between 5-12 years old and consists of three sets of 12 coloured items in each set. Each item has a different design with a part missing. Reasoning skills are required to select the best match for the missing part from six options, which are presented beneath each item (see Appendix A1). The difficulty of the task increases as the participant proceeds from one set to the next. The total raw score for each participant was the number of correct answers in all three sets. The maximum possible score was 36. A high Chronbach's α internal reliability coefficient (α = .90) is reported in the manual of the English (UK) version of the test. For the English sample, the published normative scores were employed to select all children scoring no lower than 1 *SD* below the mean. Due to a lack of normative scores for Raven's CPM in Greece, raw scores obtained by the total number of 170 Greek speaking participants were transformed into z-scores separately for each year group. Raw scores corresponding to 1 *SD* below the mean were calculated for each year group. These scores provided the threshold indicating average ability for children belonging to each year group (i.e. Mean of year group +/- 1 *SD*). Participants in both language samples were selected on the basis of obtaining a raw score corresponding to at least average non-verbal ability.

Verbal ability. The verbal ability of all participants was assessed with the Vocabulary subtest of the English and Greek version of the Wechsler Intelligence Scale (WISC-III; in English by Wechsler, 1991 and in Greek by Georgas et al., 1997) for children of 6-17 years old. This is an expressive vocabulary task consisting of 30 word-items of increasing difficulty. The items are presented orally by the researcher and the participant is asked to define each term, e.g., "What is a clock?" (see Appendices A2 and A3). A score of 2, 1 or

0 points is awarded for each item depending on the accuracy of the definition provided by the participant. The personal score for each child was the total number of points awarded. The maximum possible score was 60. Raw scores were converted into scaled scores as published for each language version of the WISC-III to ensure that all participants had an at least normal verbal ability.

Reading efficiency. English native speaking children were assessed in reading efficiency with the Test of Word Reading Efficiency (TOWRE by Torgesen, Wagner, & Rashotte, 1999). The test consists of two tasks. The sight word reading efficiency task is a list of 104 words divided into four columns. The phonemic decoding efficiency task is a list of 63 pseudo-words listed in three columns (see Appendix A4). The lists of stimuli were presented on an A4 card in a Times New Roman 14 font. The children are required to read the words on both tasks as fast as possible within a time limit of 45 seconds. A practice form with five words is given to the children before each task. The total raw score of each participant is the number of correct words read on both lists. Hence, the maximum possible score is 104 for sight word reading efficiency and 63 for phonemic decoding efficiency. High internal reliability coefficients are reported (α = .83 to .96) in the manual. Due to the lack of a standardised timed measure of reading efficiency in Greek, all participants were screened with a word reading fluency test devised by Georgiou, Papadopoulos, Fella and Parrila (2012) based on the TOWRE (Torgesen, Wagner, & Rashotte, 1999; see Appendix A5). Test–retest reliability coefficients (Pearson's r) for word reading efficiency are reported (Georgiou et al., 2012) to be r = .92 for years 2 and 4, and r = .93 for year 6 children. Test–retest reliability coefficients for phonemic decoding efficiency were r = .86 in year 2, and r = .89 in years 4 and 6. In the present study a total raw score for each participant was calculated.

Spelling ability. For the assessment of the spelling ability of all English native-speaking participants, the spelling subtest of the BAS-II (Elliott et al., 1996) was used. BAS-II is a psychometric test designed for educational applications. The spelling subtest consists of a list of words which are dictated to the participants. The starting point on the list is determined by the age and spelling level of the children. Dictation stops when the children misspell eight or more words in a block of ten words. In the present study, the maximum possible number of dictated words was 60 (see Appendix A6). The participants wrote their answers with a pencil on the answer sheet provided. The raw score was the total number of correctly spelled words. Internal reliability of the subtest for children of this age is reported to range from α = .84 to .93. The spelling performance of the Greek native-speaking participants was assessed with a single word spelling measure devised by Mouzaki, Sideridis, Protopapas and Simos (2007). The task consists of 60 real target words with wide representation of frequent spelling patterns as well as exception words appropriate for children attending years 2-6 of primary school. The task contains verbs, nouns, adjectives, adverbs, conjunctions, prepositions and participles sourced from school textbooks appropriate for children of this age (see Appendix A7). The items are presented orally to the participants and the difficulty of the task increases gradually. The authors report a high internal reliability coefficient (α = .95) and a high test–retest reliability coefficient (r =.91) for children of this age (Mouzaki et al., 2007). The raw score for each participant is the total number of words spelled correctly. The maximum possible score is 60. Descriptive statistics of the performances of typically developing participants in the pre-test measures by year group are presented in Table 4.2 – Table 4.5, pp. 94-98.

4.3.2.2 Characteristics of different year groups

In order to estimate the comparative cognitive abilities of English children, their raw scores were transformed in standardised scores. Standardised scores show the ability of a child in comparison to his/her peers in age bands of three to five months depending on the standardisation procedure employed for each test. Standard scores in Raven's CPM and TOWRE have a mean of 100 and a standard deviation of 15. For the Vocabulary subtest of WISC-III scaled scores for each age group were used. For each age group there is a mean of 10 and a standard deviation of 3. For the BAS-II the spelling percentiles were used. Average performance corresponds to the 50th percentile. An inspection of the data (Table 4.2 – Table 4.5, pp. 94-98) showed that English speaking pupils in all year groups achieved non-verbal (Raven's CPM) and verbal (WISC-III, Vocabulary) scores within 1 *SD* above the mean of pupils for their age, reading (TOWRE) scores of $1/3$ to 1 *SD* above the expected mean for their age and spelling (BAS-II) scores above the 50th percentile.

Table 4.2

Number of Items, Means and Standard Deviations of Raw and Standard Scores in Non-verbal Ability Measures per Language and Year Group of Typically Developing Children

		English								Greek							
		Y3		Y4		Y5		Y6		G3		G4		G5		G6	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Age in Months		91.2	(3.1)	104.1	(3.6)	114.9	(4.4)	128.4	(4.1)	103.3	(3.3)	117.4	(5.5)	127.2	(6.4)	140.6	(3.8)
Raven's CPM (Raw scores)	36	28.0	(4.2)	31.6	(2.2)	31.6	(3.1)	33.9	(1.0)	27.8	(5.1)	30.5	(2.3)	31.3	(3.3)	33.0	(1.9)
Raven's CPM (Standard Scores)		107.0	(14.3)	117.5	(11.7)	108.9	(12.9)	113.0	(8.0)	NA	NA	NA	NA	NA	NA	NA	NA

Note. Y3 = Year 3; Y4 = Year 4, Y5 = Year 5; Y6 = Year 6; G3 = Grade 3; G4 = Grade 4; G5 = Grade 5; G6 = Grade 6; Raven's CPM = Raven's Coloured Progressive Matrices; NA = Non-Applicable.

Table 4.3

Number of Items, Means and Standard Deviations of Raw and Standard Scores in Vocabulary Measures per Language and per Year Group of Typically Developing Children

		English								Greek							
		Y3		Y4		Y5		Y6		G3		G4		G5		G6	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
WISC-III: Vocabulary (Raw scores)	60	21.5	(6.8)	28.6	(6.7)	28.5	(5.8)	35.2	(5.6)	26.6	(6.6)	27.7	(4.7)	30.3	(6.0)	34.5	(6.3)
WISC-III: Vocabulary (Scaled Scores)		11.5	(4.1)	13.8	(3.4)	11.5	(2.9)	12.4	(2.4)	13.9	(3.2)	12.0	(2.4)	11.6	(2.8)	11.5	(2.6)

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6; WISC-III = Wechsler Intelligence Scale, 3rd ed.

Table 4.4

Number of Items, Means and Standard Deviations of Raw and Standard Scores in Reading Measures per Language and per Year Group of Typically Developing Children

		English								Greek							
		Y3		Y4		Y5		Y6		G3		G4		G5		G6	
	Maximum Number of Items	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
TOWRE Reading Test (Raw Scores)	167[a]	80.9	(22.5)	101.2	(16.8)	102.6	(13.2)	117.9	(15.1)	93.8	(20.7)	109.9	(12.8)	115.2	(22.1)	124.1	(18.2)
Word Reading (Raw Scores)	104	52.4	(13.7)	65.7	(9.0)	65.5	(6.43)	72.6	(7.2)	58.1	(13.7)	67.9	(8.4)	71.8	(14.2)	77.4	(10.6)
Non-word Reading (Raw Scores)	63	28.4	(10.2)	35.4	(9.7)	37.0	(8.6)	45.3	(8.4)	35.7	(8.1)	42.0	(6.6)	43.4	(8.8)	46.7	(8.9)
TOWRE Reading Test (Standard Scores)		113.6	(12.2)	116.1	(11.4)	108.3	(11.1)	111.9	(12.5)	NA	NA	NA	NA	NA	NA	NA	NA

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6; TOWRE = Test of Word Reading Efficiency in English and adaptation by Georgiou et al. (2012) in Greek; NA = Non-Applicable.

[a] Sum of word and non-word reading score.

Table 4.5

Number of Items, Means and Standard Deviations of Raw and Standard Scores in Spelling Measures per Language and per Year Group of Typically Developing Children

		English								Greek							
		Y3		Y4		Y5		Y6		G3		G4		G5		G6	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Single Word Spelling Test (Raw Scores)	60[c]	30.9	(9.7)	31.0	(11.1)	20.3	(5.5)	25.7	(6.3)	36.7	(9.8)	44.5	(6.5)	43.3	(9.7)	48.5	(6.8)
Single Word Spelling Percentiles		91.2	(3.1)	71.9	(26.8)	77.3	(22.2)	86.1	(14.0)	64.8	(28.8)	67.9	(21.7)	48.4	(25.6)	52.1	(14.3)

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6; Single Word Spelling Test = British Ability Scales in English and Mouzaki et al. (2007) in Greek.
[C] Different number of items dictated according to age and performance.

The means of the standardised scores of each year group were statistically compared to the expected average scores for children of their age (100, 10 or 50 depending on the scale employed for each measure) with one-sample t-tests. Results showed that year 3 pupils scored significantly higher than expected for children of their age in non-verbal ability (Raven's CPM: t (24) =2.43, $p < .05$). The mean of their verbal scores was not significantly different from the average score expected for pupils of their age (WISC-III: t (24) = 1.87, $p = .074$) signifying an average performance. Their reading standard scores and spelling percentiles were significantly higher than expected for their age (TOWRE: t (24) = 5.56, < .001; BAS-II: t (24) = 64.59, < .001).

All means achieved by year 4 pupils in baseline measures were significantly higher than the average score expected for their age (Raven's CPM: $t(23) = 7.32$, $p < .001$; WISC-III: $t(23) = 5.45$, < .001; TOWRE: $t(23) = 6.88$, $p < .001$; BAS-II: $t(23) = 3.98$, $p = .001$). Along similar lines, the means of year 5 and year 6 children in baseline measures were significantly higher than the average score expected for their age (Y5: Raven's CPM: $t(28) = 3.73$, $p = .001$; WISC-III: $t(28) = 2.86$, $p = .008$; TOWRE: $t(28) = 4.04$, $p < .001$; BAS-II: $t(28) = 6.63$, $p < .001$; Y6: Raven's CPM: $t(22) = 7.74$, $p < .001$; WISC-III: $t(22) = 4.84$, $p < .001$; TOWRE: $t(22) = 4.55$, $p < .001$; BAS-II: $t(22) = 12.34$, $p < .001$). Hence, in the majority of the baseline measures English pupils showed an above average performance for their age. Hatcher et al., (2006) found similar results with 303 typically developing six year-old children tested with the BAS-II Word Reading Subtest. The mean standardised score of their sample was found to be 107.36. The researchers suggest that a possible reason might be the effect of the National Literacy Strategy (first implemented in 1998 in UK schools), which might have raised literacy standards so that norms of testing batteries obtained before that year are considered outdated. Pye (2008) in her doctoral thesis used more subtests of the BAS-II including measures of literacy (Spelling), numeracy (Number Skills), verbal and non-verbal ability (Matrices, Verbal Similarities and Patterns Construction) to test 314 pupils of 6-10 years old. In accordance with Hatcher et al., (2006) she found that children scored higher than the average scores expected for their age not only in the spelling subtest but also in the rest of the measures. The results of the present study confirm the findings of both aforementioned studies and support the claim that factors, such as changes in educational schemes, extensive exposure to new technologies and familiarity with different media requiring flexibility in information processing, raise the demand for more frequent updating of the norms of testing batteries used to measure children's cognitive skills for research purposes.

An estimation of the cognitive abilities of the Greek sample in comparison to other children of their age was more challenging due to absence of standardised scores. Specifically, norms for the Raven's CPM non-verbal ability test, and the reading efficiency test are not available in Greece. Scaled scores for the Vocabulary subtest of the WISC-III battery were available. As shown in Table 4.3, p. 95, the means achieved by all year groups were within 1 *SD* above the expected mean for their age signifying an average to high average performance. One-sample t-test comparisons for grades 3-6 showed that the verbal ability of the pupils was significantly higher than expected for their age (G3: $t(30) = 6.64$, $p < .001$; G4: $t(23) = 4.12$, $p < .001$; G5: $t(34) = 3.42$, $p = .002$; G6: $t(21) = 2.69$, $p = .013$). Word reading efficiency and phonemic decoding efficiency as assessed with the word and non-word subtests of the reading efficiency task devised by Georgiou et al. (2012) could be estimated in comparison to the available raw scores of Greek speaking Cypriot children attending grades 2, 4 and 6, who participated in the study by Georgiou and colleagues. In that study participants attending grade 2 had a mean raw score of 43.65 ($SD = 11.97$) in word reading efficiency and 29.46 ($SD = 9.31$) in phonemic decoding efficiency. In grade 4 the mean of raw scores was 59.48 ($SD = 12.48$) in word reading efficiency and 36.42 ($SD = 8.61$) in phonemic decoding efficiency. In grade 6 there was a mean of 68.99 ($SD = 14.87$) in word reading efficiency and 41.51 ($SD = 8.91$) in phonemic decoding efficiency. The results of the one-sample t-tests showed that grade 4 and grade 6 pupils in the present study (Table 4.4, p. 96) achieved higher scores than the mean of raw scores of the participants of the study by Georgiou and colleagues (G4 word reading: $t(23) = 4.86$, $p < .001$; phonemic decoding: $t(23) = 4.13$, $p < .001$; G6 word reading: $t(21) = 3.69$, $p = .001$; phonemic decoding: $t(21) = 2.77$, $p = .011$). These results indicate that the participants in grades 4 and 6 of the present study were efficient readers for their age. Finally, for the single word spelling test devised by Mouzaki et al. (2007) percentiles per grade are available (Mouzaki et al., 2010). As shown in Table 4.5, p. 98, the means of the spelling scores achieved by grade 3 and 4 participants are above the average mean for children of their age (i.e., above the 50th percentile). This was confirmed with one-sample t-tests (G3: $t(30) = 2.85$, $p = .008$; G4: $t(23) = 4.04$, $p < .001$) indicating above average ability. Grade 5 and 6 participants show an average spelling performance for their age (G5: $t(32) = -0.35$, $p = .726$; G6: $t(21) = .69$, $p = .494$). It is important to note that spelling performance varied widely across the groups as illustrated by the large standard deviations of the mean scores of each year group in both language samples.

Children in England and in Greece start school at a different age, which resulted in significant differences in the age of participants in the two countries. Separate cross-linguistic comparisons were performed taking into account a) the years of schooling and b) the chronological age of the participants at the time of the study. For comparisons between language groups matched on schooling years, raw scores in the Raven's CPM were compared to ensure that the children in the two countries were of a similar non-verbal ability level (Y3=G3: $t(53) = .69$, $p = .491$; Y4=G4: $t(45) = -1.67$, $p = .101$; Y5=G5: $t(60) = -.27$, $p = .786$; Y6=G6: $t(42) = -1.83$, $p = .074$). For comparisons between age-matched groups across languages, it was ensured that English and Greek children did not differ significantly in age (Y4=G3: $t(45) = -.51$, $p = .607$; Y5=G4: $t(48) = 1.26$, $p = .212$; Y6=G5: $t(44) = -1.60$, $p = .116$) and that their Raven's CPM raw scores were not significantly different showing a non-verbal ability of similar level (Y4=G3: $t(45) = -1.16$, $p = .249$; Y5=G4: $t(48) = -1.62$, $p = .111$; Y6=G5: $t(44) = -1.16$, $p = .251$). Children were not directly matched on verbal ability, reading and spelling because concerns have been expressed about matching on variables which depend heavily on linguistic knowledge and might be influenced by language-specific characteristics (Caravolas et al., 2005).

4.3.2.3 Selection of the dyslexic-profile and control groups

The participants comprising the dyslexic-profile groups in England and Greece were selected among the children who responded to a call distributed by the researcher and among children nominated by teachers as having a diagnosis of dyslexia or specific difficulties with reading and writing. This complied with the global definition of "developmental dyslexia" as a disorder resulting in difficulties with written language, which are not a product of intellectual disadvantage, inadequate learning opportunities, brain injury, sensory or emotional disorders (Treiman, 1997; Vellutino et al., 2004). Research has often employed the age discrepancy definition to identify eligible participants (e.g., see Bourassa, Treiman, & Kessler, 2006; Bourassa & Treiman, 2003; Snowling, Goulandris, & Defty, 1996; Vellutino et al., 2004). According to this definition individuals are classified as showing a dyslexic profile if they score within the "normal" range of intellectual ability for their age but significantly underachieve in reading ability tests. An alternative method to identify eligible participants is to use the IQ discrepancy definition, according to which any individual whose reading skills are significantly lower than what expected for their level of intellectual ability may be considered as showing a dyslexic profile (see Vellutino et al., 2004). Narrowing the effects of dyslexia only on written language and using the “intellectual ability” cut-off to define dyslexia (IQ discrepancy definition) have been criticised by some researchers as restricting the diagnosis of individuals who have remedied their reading difficulties or who have lower general ability (e.g., Frith, 1999). The validity of the IQ discrepancy definition has also been questioned as relying on the assumption of a strong relation between intellectual ability and reading skill, which is not always confirmed by research (see Siegel, 2003). On the other hand, the age discrepancy definition may overlook the difficulties of children with a lower than average intellectual ability.

The selection criteria for the present study were identified by its purpose, which was educational rather than diagnostic. The aim was to examine whether children who face specific difficulties in literacy are confronted with significantly different spelling problems than typically developing pupils in tasks resembling the writing activities regularly used in daily school practice. There was an aspiration that the findings would have practical implications for practitioners teaching pupils who face specific difficulties with reading, writing and indeed spelling in the mainstream classroom. Because the population of children who might face such difficulties while showing a very high or very low intellectual ability is much more limited in mainstream schools it was decided that adopting the IQ discrepancy definition could result in issues with grouping the participants and comparing them with typically developing ability-matched students. For this purpose, one main criterion to select children with a dyslexic profile was that they would show an at least average verbal and non-verbal ability as expected from children of their age but would perform significantly lower than expected from children of their age in a standardised measure of reading efficiency, to comply with the most prevalent characteristic included in the definition of developmental dyslexia, i.e., difficulties with reading. Since writing is regularly found to be more problematic than reading (Perfetti, 1997) it was expected that children facing challenges in reading would also confront difficulties in writing, and spelling in particular. This was confirmed by the teachers or parents of the pupils with a dyslexic profile during the recruiting phase. In the selection phase, the spelling ability of these children was found to be significantly lower than expected from pupils of their age as assessed with a standardised measure of spelling.

Another inclusion requirement dictated by the definition of developmental dyslexia was that the participants would have completed enough schooling years so as to ensure that their reading and writing difficulties persisted despite long experience of explicit teaching of literacy skills. Similarly to the typically developing children recruited for the study of typical spelling development, the participants with a dyslexic profile should have had enough experience of manipulating different writing tasks, as required for the study, ensuring the least possible attrition. Children attending the three last years of primary school were considered to be most appropriate to participate in this study for all the above and another reason related to practice, namely the requirement to match them with control children of similar reading and spelling abilities pooled from the sample of typically developing children. To be considered as typical learners, the latter participants, would inevitably be younger than the children with a dyslexic-profile, but should have experienced enough years of schooling to be able to complete the same writing tasks.

The two dyslexic-profile groups were recruited either from the same schools as the typically developing children or individually by responding to a call for participants publicised by the researcher. A total of 50 English and Greek children were nominated by their special teachers on the basis of a diagnosis of a dyslexic profile by an educational psychologist prior to this study. Of them, 45 pupils were offered regular one-to-one and/or group support on literacy and numeracy skills from a special teacher or specialist-teaching assistant. Of the 50 children, the dyslexic-profile groups in England and Greece were formed using three selection criteria, based on the age discrepancy definition of dyslexia: a) showing an at least average level of non-verbal ability for their age, as assessed with the Raven's Coloured Progressive Matrices (Raven et al., 2004; Raven, 1938), b) showing an at least average level of verbal ability, as assessed in English with the Vocabulary subtest of the Wechsler Intelligence Scale, 3rd ed. (WISC-III: Wechsler, 1991), and in Greek with the Vocabulary subtest of the Greek version of the WISC-III (Georgas et al., 1997) and c) having a reading ability of at least 1 *SD* below the mean of typically developing participants of their corresponding year group, as assessed in English using the TOWRE (Torgesen et al., 1999) and in Greek using a reading efficiency task devised by Georgiou et al. (2012) along similar lines with the English TOWRE. Published normative scores were used to select the participants comprising the English speaking dyslexic-profile group. Because standardised scores were not available for all Greek measures, in order to form the Greek speaking dyslexic-profile group, the z-scores of the typical learners of their corresponding year group were employed to obtain a standardised measure of non-verbal ability and reading efficiency. Raw scores corresponding to 1 *SD* below and 1 *SD* above the mean of typical learners attending each year group signified the lower and upper bounds of average ability. The final dyslexic-profile groups comprised pupils satisfying the three selection criteria and attending years 4-6 in England and grades 4-6 in Greece.

A baseline single word spelling measure was also administered in the beginning of the study to estimate the comparable spelling ability of the participants prior to engaging with the experimental spelling tasks. The spelling subtest of the BAS-II battery (Elliott et al., 1996) was used with English speaking children and a single word spelling test devised by Mouzaki et al. (2007) was used with Greek speaking children. A discrepancy between the spelling performance of students with dyslexia and typically developing children of the same age is frequently observed in research (Egan & Tainturier, 2011; Mavrommati & Miles, 2002; Tsesmeli & Seymour, 2006). In the classroom such comparisons may serve to identify specific difficulties of children with dyslexia, which may be used to design literacy support programmes. Analysis of the spelling errors produced by children with and without dyslexia allow researchers to evaluate the extent to which pupils in the first group have acquired phonological, morphological and orthographic skills and their ability to apply relevant strategies to spell as appropriate for their age. The finding that pupils with dyslexia are significantly outperformed by same-age typically developing peers signifies a delay in their spelling development. More importantly, in order to explore specific spelling difficulties, which would indicate a spelling deviance of participants with dyslexia, researchers often compare their misspellings with those produced by younger children matched in reading or spelling ability with the experimental group. If the spellings of the ability-matched and dyslexic groups are indistinguishable, spelling difficulties of the latter are attributed to slower pace of spelling development. However, misspellings that are significantly different from those of the ability-matched controls, are perceived as indications that children with dyslexia approach spelling in a different manner to typically developing children (Bourassa & Treiman, 2001; Kessler & Treiman, 2001). Because dyslexia is primarily linked to reading difficulties, researchers often employ only one younger control group matched in reading ability with the dyslexic group (e.g., Alegria & Mousty, 1996; Caravolas & Volín, 2001; Diamanti, Goulandris, Cambell, & Stuart, 2005; Fakou, Drakopoulou, Skaloumbakas, & Protopapas, 2010; Landerl & Wimmer, 2000; Nikolopoulos, Goulandris, & Snowling, 2003). However, this design might be limiting to the surface of spelling difficulties because despite the usual finding that reading and spelling overlap, the latter is more demanding and may require different skills (Tainturier & Rapp, 2001). Pupils with dyslexia are frequently better readers than spellers, especially in more transparent languages. If matching is only based on reading ability there is a possibility that the control group might be better in spelling than the dyslexic-profile group, which will affect the conclusions of the study (Egan & Tainturier, 2011). Being outperformed by a reading ability-matched group alone would imply no more than that pupils with dyslexia are slower in spelling development than typical children. In order to infer whether spellings produced by pupils with dyslexia deviate from normality, it is meaningful to also include a spelling ability-matched group (e.g., Bourassa et al., 2006; Bourassa & Treiman, 2008; Cassar, Treiman, Moats, Pollo, & Kessler, 2005; Cassar & Treiman, 2006; Egan & Tainturier, 2011; Ellis, 1994).

In the present study students with a dyslexic profile were compared with three carefully matched control groups within their language sample: a chronological age-matched group, a reading ability-matched group and a separate spelling ability-matched group. Reading controls and spelling controls formed separate groups to account for potential differences in experience with reading, which could affect spelling performance. The dyslexic-profile children were also matched on non-verbal and verbal ability with their control groups, to ensure that any differences in their written performance did not stem from discrepancies in these variables. The children comprising the control groups were selected from the wider pool of children attending years 3, 4, 5 and 6 in both countries. Matching was done on a one-to-one basis by age or raw scores obtained on standardised tests, which employed age-appropriate items for the participants. More specifically, the chronological-age control group (CA) consisted of children, who were matched in a) age in months and b) verbal and non-verbal ability raw scores with the participants with a dyslexic-profile. The reading-age control group (RA) consisted of pupils who a) obtained the same raw scores on the single word reading assessment as the dyslexic-profile participants and b) had similar levels of verbal and non-verbal ability. Finally, spelling-age controls (SA) were matched in spelling performance with the dyslexic-profile children as indicated by a) same raw scores on the single word spelling measure and b) similar levels of verbal and non-verbal ability. All participants scoring below 1.5 *SD* on the verbal and non-verbal ability assessments were excluded from the sample. All participants had no diagnosis of any emotional, social, psychiatric or neurological difficulties and had at least one native speaking parent in their home background. Numbers of dyslexic-profile children and controls are presented in Table 4.6, p. 106.

Table 4.6

Absolute Number and Percentages of Participants per Gender for English and Greek Dyslexic-Profile and Control Groups

	English				Greek			
	DP	RA	SA	CA	DP	RA	SA	CA
N Total	18	18	18	21	17	18	17	19
N Boys	7	7	8	12	6	6	10	9
Boys Percentage	38.9%	38.9%	44.4%	57.1%	35.3%	33.3%	58.8%	47.4%
N Girls	11	11	10	9	11	12	7	10
Girls Percentage	61.1%	61.1%	55.6%	42.9%	64.7%	66.7%	41.2%	52.6%

Note. DP= Dyslexic Profile; RA= Reading Age, SA= Spelling Age; CA= Chronological Age; N = Number.

4.3.2.4 Characteristics of the dyslexic-profile and control groups

All dyslexic-profile participants were selected on the basis of the raw scores achieved in the baseline measures of non-verbal ability, verbal ability and reading and were matched on age and baseline measures with three control groups (see previous section). Descriptive statistics are presented in Table 4.7-Table 4.9, pp. 107-109. One sample t-tests were employed to compare the mean standard scores of the English dyslexic-profile group with the expected average score for their age (100 or 10 depending on the scale). Their scores did not differ significantly from average scores in the non-verbal ability measure ($t(17) = 1.42$, $p = .172$), as expected from children of their age, while they were significantly above average in the verbal ability measure ($t(17) = 2.56$, $p < .05$) and below average in

Table 4.7

Means and Standard Deviations in Age and Non-Verbal Ability Measures for English and Greek Dyslexic-Profile and Control Groups

		English								Greek							
		DP		RA		SA		CA		DP		RA		SA		CA	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Age in Months		113.6	(10.0)	94.3	(8.6)	100.4	(11.4)	113.4	(9.7)	121.2	(12.9)	107.7	(12.0)	108.6	(10.6)	126.5	(11.5)
Raven's CPM (Raw Scores)	36	30.2	(2.1)	27.1	(5.6)	29.5	(4.0)	31.0	(2.4)	30.1	(2.7)	26.7	(4.4)	26.5	(5.4)	30.6	(2.6)
Raven's CPM (Standard Scores)		103.8	(11.5)	103.6	(17.8)	107.7	(12.7)	107.6	(10.7)	NA	NA	NA	NA	NA	NA	NA	NA

Note. DP= Dyslexic Profile; RA= Reading Age, SA= Spelling Age; CA= Chronological Age. Raven's CPM = Raven's Coloured Progressive Matrices; NA = Non-Applicable.

Table 4.8

Means and Standard Deviations in Verbal Ability Measures for English and Greek Dyslexic-Profile and Control Groups

		English								Greek							
		DP		RA		SA		CA		DP		RA		SA		CA	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
WISC-III: Vocabulary (Raw Scores	60	27.3	(6.2)	21.8	(5.6)	22.9	(6.2)	27.1	(6.6)	29.0	(4.9)	24.7	(4.8)	24.5	(5.6)	30.6	(2.6)
WISC-III: Vocabulary (Standard Scores)		12.0	(3.3)	11.2	(3.2)	10.6	(2.8)	11.1	(2.9)	11.1	(1.7)	11.8	(3.9)	11.2	(3.9)	10.7	(2.1)

Note. DP= Dyslexic Profile; RA= Reading Age, SA= Spelling Age; CA= Chronological Age. WISC-III = Wechsler Intelligence Scale, 3rd ed.

Table 4.9

Means and Standard Deviations in Reading and Spelling Measures for English and Greek Dyslexic-Profile and Control Groups

		English								Greek							
		DP		RA		SA		CA		DP		RA		SA		CA	
	Maximum Number of Items	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Single Word Reading Test (Raw Scores)	167[a]	64.2	(11.2)	67.4	(12.4)	76.0	(18.5)	101.2	(12.6)	71.0	(13.2)	73.7	(14.7)	82.7	(20.8)	119.7	(18.2)
Reading Test (Standard Scores)		79.2	(5.0)	102.7	(6.6)	101.2	(7.0)	108.9	(12.3)	NA	NA	NA	NA	NA	NA	NA	NA
Single Word Spelling Test (Raw Scores)	60[b]	17.4	(4.2)	23.5	(7.9)	18.7	(8.6)	24.4	(7.4)	28.1	(7.3)	28.6	(7.4)	28.7	(8.8)	46.2	(6.3)
Spelling in Percentiles		23.9	(9.9)	65.9	(24.3)	57.1	(25.9)	74.8	(24.1)	19.4	(14.5)	39.2	(29.0)	38.8	(26.3)	53.0	(25.9)

Note. DP= Dyslexic Profile; RA= Reading Age, SA= Spelling Age; CA= Chronological Age. Single Word Reading Test = Test of Word Reading Efficiency in English and adaptation by Georgiou et al. (2012) in Greek; Single Word Spelling Test = British Ability Scales in English and Mouzaki et al. (2007) in Greek.

[a] Sum of word reading and non-word reading scores. [b] Different number of items dictated according to age and performance.

the reading baseline measure ($t(17) = -17.36$, $p < .001$). To acquire an estimate of the spelling ability of dyslexic-profile and controls before completing the experimental tasks, raw spelling scores obtained from a standardised test were transformed in percentiles. One sample t-tests were performed to compare between the mean percentile for each group and the average expected mean for children of their age (i.e., the 50th percentile). Analyses showed that the English dyslexic-profile children performed significantly lower than expected for their age ($t(17) = -10.47$, $p < .001$). The chronological-age and reading-age control groups showed an above average spelling ability for their age (CA: $t(20) = 4.73$, $p < .001$; RA: $t(17) = 2.78$, $p < .05$). Finally, the spelling-age controls performed as expected from pupils of their age ($t(17) = 1.16$, $p = .261$).

To confirm satisfactory matching of the English groups, Analyses of Variance (ANOVA) were performed. The analysis of age revealed a significant difference in the age of the four groups (F (3, 67) = 15.07, $p < .001$, η_p^2=.40). Sidak corrections were employed to control for the possibility of inflation of Type I errors due to multiple comparisons. Post hoc pairwise comparisons showed that the dyslexic-profile group and the chronological-age controls were well matched on age in months ($p = 1.00$), while as expected both reading (RA) and spelling-age (SA) controls were significantly younger than the dyslexic-profile group (DP > RA, SA, $p < .005$). As concerns the baseline measures, the overall ANOVA showed a significant difference in the non-verbal raw scores of the four groups (F (3, 67) = 3.13, $p < .05$, η_p^2=.12). However, the dyslexic-profile group was well matched with all three control groups on non-verbal ability levels ($p > .05$ in all post hoc pairwise comparisons). A significant difference was also found in the verbal raw scores of the four groups (F (3, 67) = 3.67, $p < .05$, η_p^2=.14). Nevertheless, the dyslexic-profile group was well matched with all three control groups on verbal ability levels ($p > .05$ in all post hoc pairwise comparisons). The four groups also differed significantly in reading raw scores (F (3, 67) = 27.59, $p < .001$, η_p^2=.55), but post hoc pairwise comparisons confirmed satisfactory matching between the dyslexic-profile and reading-age controls ($p > .05$). Finally, there was a significant difference in the spelling raw scores of the four groups (F (3, 67) = 4.07, $p < .05$, η_p^2=.15). Nevertheless, satisfactory matching of the dyslexic-profile group and the spelling-age controls was confirmed by the post hoc pairwise comparisons ($p > .05$).

Due to the lack of norms for most of the Greek baseline measures, the Greek dyslexic-profile group was selected using the z-scores of the larger pool of typically developing children (see section 2.2.2.3). To estimate the spelling ability of dyslexic-profile and controls before completing the experimental spelling tasks, their raw scores were transformed in percentiles and compared with the average expected performance from children of their age (i.e., the 50th percentile). One sample t-tests showed that the Greek dyslexic-profile group performed significantly lower than expected for their age ($t(16) = -8.62$, $p < .001$), while all control groups showed an average spelling ability for pupils of their age (CA: $t(18) = .51$, $p = .615$; RA: $t(17) = -1.57$, $p = .134$; SA: $t(16) = -1.73$, $p = .102$). To confirm satisfactory matching of the groups of Greek children, analyses of variance were performed. The analysis of age revealed a significant difference in the age of children belonging to the four different groups (F (3, 67) = 11.64, $p < .001$, η_p^2=.34). Sidak corrected post hoc pairwise comparisons confirmed satisfactory matching of the dyslexic-profile group and the chronological-age controls in age in months ($p > .05$), while, as expected, reading and spelling-age controls were significantly younger than the dyslexic profile group (DP > RA, SA, $p < .05$). Despite the overall ANOVA showing a significant difference in the non-verbal ability of the four groups (F (3, 67) = 5.28, $p < .005$, η_p^2=.19), satisfactory matching between the dyslexic-profile group and all three control groups was confirmed by post hoc pairwise comparisons ($p > .05$ in all comparisons). The analysis of verbal ability raw scores produced similar results. An overall difference was evident (F (3, 67) = 5.48, $p < .005$, η_p^2=.20), but post hoc comparisons showed that the dyslexic-profile group and the three control groups had similar levels of verbal ability ($p > .05$ in all comparisons). An overall ANOVA on reading raw scores showed that the four groups of children differed significantly (F (3, 67) = 32.32, $p < .001$, η_p^2=.59). Post hoc pairwise comparisons showed that, as expected, the chronological-age controls were significantly better than the dyslexic-profile group in reading ($p < .001$), but there were no significant differences between the latter and their reading or spelling-age controls ($p > .05$ in both comparisons). An ANOVA on spelling raw scores showed an overall difference between the four groups (F (3, 67) = 25.65, $p < .001$, η_p^2=.53). Satisfactory matching on spelling was confirmed by the post hoc pairwise comparisons showing that the dyslexic-profile group did not differ significantly with their spelling or reading-age controls ($p > .05$ in both comparisons). As expected, the chronological-age controls were significantly better that the dyslexic-profile group ($p < .001$).

In order to draw cross-linguistic comparisons between the two dyslexic-profile groups, where possible the same task was used for both language samples (e.g., Ravens CPM). Where this was not possible, the tasks that were used required the same type of processing and response for each language sample. Another issue to be addressed was that children in England and in Greece start school at a different age. Since cognitive development is considered to be dependent upon age (Goulandris, 2003) as well as years of schooling (Cunningham & Carroll, 2011), interpretations of the cross-linguistic comparisons in the present study took into account the year/grade and the age of the participants by matching the English and Greek dyslexic-profile groups in both the above variables and non-verbal ability. Satisfactory matching was confirmed with independent samples t-tests (Age: $t(33) = 1.93$, $p > .05$; Non-verbal ability: $t(33) = -.12$, $p > .05$). Direct cross-linguistic comparisons were not drawn for variables which might be influenced by language-specific characteristics, (see Caravolas et al., 2005), such as verbal ability, reading and spelling.

4.3.3 Experimental spelling tasks and stimuli

4.3.3.1 Spelling tasks

The experimental spelling battery included three spelling conditions: a) the single word spelling task b) the passage completion spelling task and c) the text composition task (see Appendix B). The single word spelling task consisted of a list of 60 target words selected to satisfy the criteria described in the stimuli section (4.2.3.2). The target words were orally dictated to the children by the teacher of the class for the English sample and by the researcher for the Greek sample. Each stimulus was dictated in isolation. Subsequently, a sentence, which included the target word, was orally presented to ensure that all participants were familiar with the meaning of the stimulus. Finally, the word alone was repeated for the children to spell on their answer sheets (see Appendices B3 and B8). For the passage completion spelling task the participants were presented with a printed passage with 19 gaps for the English version and 16 gaps for the Greek version representing equal proportion of missing target words (see Appendices B4 and B9). The passage was printed with Times New Roman font with 14 pixel-size on a white A4 size paper and horizontal lines signposted the missing words. The pupils were asked to read the passage silently first in order to obtain a brief understanding of the meaning of the text. Subsequently, the passage was read aloud by the teacher of the class for the English sample and by the researcher for the Greek sample. The children were required to listen to the passage and use a pencil to fill-in the gaps with the missing stimuli. The complete passage was read for a second time to allow for the children to correct their spellings.

For the text composition task the participants were presented with a collection of pictures depicting on average 20 of the initial 60 target words (see Appendices B5 and B10). The children were asked to use at least 15 of these words to compose an imaginary story of their own. There was an oral presentation of the stimuli at the start of the day to ensure that participants would comprehend the link of each picture with the specific word. The spelling task took place at the end of the day and single stimuli were only repeated to a participant upon request. The children used a pencil to write their narratives on lined A4 pages distributed by the researcher. The purpose of this design was to avoid oral input of the stimuli as much as possible, in order to examine possible differences in the spelling performance of the participants between this and the spelling-to-dictation tasks. The stimuli used in the passage completion (b) and the narrative composition task (c) were sourced from the main list of 60 words comprising the single word spelling (a) task to allow for comparisons across conditions. By comparing the same stimuli across tasks the present study aimed to investigate any effect of oral (task a), printed (task b) and self-generated context (task c) on pupils' spelling performance.

4.3.3.2 Stimuli

Previous research has shown that age of acquisition (AoA) and frequency levels of the experimental stimuli play a significant role in literacy tasks, especially in tasks involving stimuli with inconsistent phoneme-to-grapheme mappings, the correct spelling of which would require a contribution of semantics (for a discussion of results of studies in different languages see Bonin, Barry, & Alain, 2004; Lete, Peereman, & Fayol, 2008; Zevin & Seidenberg, 2002). More specifically, according to Lete et al. (2008), frequency effects can be detected as early as in beginners' spellings and show the extent to which the lexical path is employed, while consistency effects signify the use of a sublexical procedure. Moreover, the researchers found evidence that the frequency effect was strong on French monosyllables for the younger spellers and was increasingly influential on polysyllabic words for older children. They, therefore, suggested that word length modulates the extent to which children at different levels of spelling ability use lexical and sublexical paths, and thus the length of the stimuli should be taken into account when researching spelling. In order to capture the different levels of spelling ability of the participants of the present study, it was ensured that the experimental stimuli were appropriate for participants of the particular age group, were of three levels of frequency (i.e., low-middle-high frequency), and included both orthographically consistent and orthographically inconsistent spelling patterns. The final lists included various parts of speech, verbs, nouns, adjectives, adverbs and participles, and their length extended from 3 letters to 18 letters (see Appendices B1-B2, B6-B7).

To select age appropriate stimuli for the English word list, the Structured Spelling Lists of the Single Word Spelling Test (SWST; Socre & Masterson, 2001) were used. The Structured Spelling Lists are graded in seven levels of increasing difficulty corresponding to the range of words that teachers are expected to teach to children aged 6-14 years old to comply with the suggestions of the National Literacy Strategy (1988). The Lists comprise high and medium frequency words that should be learnt in Key Stages 1 and 2 including regular and irregular "Literacy Hour Words" (Socre & Masterson, 2001, p. 20). In the Lists appear simple regular words i.e., "words […] where single phonemes are represented by one or more letters" (e.g., BEST, /bɛst/), complex regular words i.e., "those involving rules governing the inclusion and position of letters and prefixing and suffixing" (e.g., CHURCHES: nouns ending in CH make the plural form by adding ES) and irregular words, which "…do not conform to phoneme-grapheme rules" (e.g. SAID, /sɛd/, YACHT, /jɒt/; Socre & Masterson, 2001, pp. 16-17). These are mono-syllabic and multi-syllabic words comprising simple and complex consonant-vowel structure e.g., CVC (HAT), CCVC (SHIP), CVVCC (COACH) including "consonant blends (for example, /dr/ =DR; […])", "vowel digraphs (for example, /ei/ =AI; […])", "prefixes and suffixes (for example, agree-disagree; bus-buses)", and orthographic features which conform to "higher order context-sensitive rules (for example C followed by E, […])" (Socre & Masterson, 2001, p.18). Word-candidates for the spelling list used in the present study were selected from these Lists to ensure that children of the specific age range were familiar with these types of words and the phonological, morphological and orthographic rules dictating their spelling. Frequency counts for the stimuli were obtained from the Children's Printed Word Database, a computerised database developed by Stuart, Masterson, Dixon, and Quinlan (1993-1996; available from the University of Essex at http://www.essex.ac.uk/psychology/cpwd/). Because this database contained items sourced from books for children 5-9 years old, word frequencies were also sourced from the word frequency count by Kucera & Francis (1984) obtained from the MRC Psycholinguistic

Database (Wilson, 1988; retrieved from http://www.psych.rl.ac.uk/) to cover the demand for stimuli appropriate for older children. Word frequencies were collected from both sources (see Appendix B1) and were used to classify the word-candidates in five sub-groups: high, high-to-middle, middle, middle-to-low, and low. The final stimuli were selected to represent the high-to-middle, middle and middle-to-low frequency levels to ensure a credible estimation of the participants' spelling skills. A limited number of the stimuli were chosen to fit in the two extreme frequency levels (high and low) to avoid any floor or ceiling effects as much as possible.

For the Greek spelling list age appropriate stimuli were selected from the textbooks used in Greek primary education following the same criteria for length, structure and frequency as for the English spelling list. Word frequencies were obtained from the Children's Textbook Database (Protopapas, 2010) with material sourced from the textbooks used for children in grades 1-6 in Greek primary schools. The same textbooks are used in all the primary schools of the country, thus the database provided a good estimate of the stimuli that the participants would have been familiar with in the six years of schooling. Moreover, in order to avoid the possibility of ceiling effects, especially by older participants, additional frequency counts were sourced from the ILSP PsychoLinguistic Resource (IPLR; Protopapas, Tzakosta, Chalamandaris, & Tsiakoulis, 2012; retrieved from http://hnc.ilsp.gr/), which is based on literature for adults. The final stimuli were selected with the same procedure as the English items.

Beyond frequency and length, the response of participants to stimuli with various phono-graphemic and morphemic combinations was of interest in this study. Based on the pools of words available in the sources for English and Greek stimuli, the final items ranged from one to six syllables and contained simple and complex combinations of consonants and vowels to test the spelling of single graphemes, digraphs and trigraphs. A major aim of the study was to delineate the development of spelling skills in typically developing children of various ages and detect any spelling patterns which might result in different spelling performance of the dyslexic-profile and the control groups. Moreover, due to Greek orthography's relative transparency, a skilled speller is expected to spell correctly a good proportion of orthographic patterns, with application of regular phoneme-to-grapheme correspondence rules. Since the participants of this study belonged to different age groups and to various levels of spelling ability, the stimuli were selected to contain not only spelling patterns with consistent phoneme-to-grapheme correspondences but also patterns with inconsistent phoneme-to-grapheme correspondences. Inclusion of inconsistent patterns, where phoneme-to-grapheme correspondence rules do not adequately dictate correct spelling, was essential to produce a variety of opportunities for spelling errors even for the oldest children of both the English and the Greek sample. Correct spelling of these patterns would require the application of orthographic or morphological knowledge, as is knowledge of the word's root or specific grammatical rules. For example the /e/ sound in Greek has two phonologically plausible spellings, <ε> and <αι>. When the sound is part of the stem of a simple word, as for example in the noun <χέρι> (/χεri/ = hand), correct spelling of /e/ as <ε>, and not as <αι>, requires orthographic knowledge of the specific word. On the other hand, when the phoneme is part of the affix of a word, as in <λέμε> (/leme/= we say), the spelling of the final /e/ sound as <ε> is dictated by morphology, since this is the contemporary spelling for all verbs referring to the 1st person of plural form in the active voice. Therefore, the final list of stimuli contained examples of various cases, simple words, derivatives and inflections, and the ambiguous patterns could be included in stems or affixes, in order to investigate both orthographically and morphologically challenging cases. Inclusion of balanced proportions of stimuli examining all the aforementioned points of interest was achieved as much as possible to allow for an even investigation of various spelling phenomena. Finally, the cross-linguistic nature of the study dictated a relative matching of the stimuli across the two spelling lists as much as possible in frequency level, length, phono-graphemic and morphemic combinations (see Appendices B1-B2 and B6-B7).

4.3.4 Procedure of task administration

There were two testing phases with a one-week to two-week interval for all participants. In the first phase most baseline measuring assessments were administered to each child individually in an empty classroom of the school during lesson times. For Raven's Coloured Progressive Matrices the stimuli were visually presented on a computer screen and through a projector on the classroom's board. Each participant was assessed in five sessions lasting no more than 15 minutes per day and there was an at least two days interval between sessions. In the second phase the experimental spelling tasks were administered to whole classes due to time limit restrictions. There was a two-week interval between administration of each experimental spelling task and the order of administration was semi-counterbalanced with the single word spelling task always being presented first. The pictures stimuli of the experimental text composition task were projected on the classroom's board in addition to being printed out and distributed to the participants. Finally, any missing data due to absence were excluded from the analysis.

4.4 Data analysis

4.4.1 Analysis of spelling errors

Previous studies examining spelling errors in different languages have applied various systems to classify misspellings depending on their research aims. The simplest categorisation distinguishes between correctly and incorrectly spelled words as whole units (e.g., Treiman, 1993). One step further is taken when scoring for a) phonologically misspelled words, i.e., where the phonological identity of the word is not preserved and b) orthographically incorrect words, i.e., where the sound of the word remains intact but the visual form is altered (e.g., Diamanti, 2005; Nikolopoulos, Goulandris, & Snowling, 2003). Treiman (1993, p. 48) also divided the phonological errors in legal (e.g., <pla> for PLAY) and illegal (e.g., <payl> for PLAY). The latter were considered as indications of impaired learning of grapheme-to-phoneme correspondences (GPC). Landerl and Wimmer (2000) evaluated "phoneme distance" in German misspellings to measure the level of phonological deviation from correct spelling. Bruck and Waters (1988) scored misspellings with reference to the extent to which the spelling produced by the speller visually overlapped with the correct spelling.

More recent studies take into account the different types of information conveyed by written language. Theoretical support for a more detailed error analysis is provided in Frost's discussion about a universal model of reading (2011). According to Frost, orthographic processing in any language is determined by the internal structure of a word, which is not always explicitly taught to native speakers. Given the "phonological space" of each language, meaning and morphological structure are optimally represented by the orthographic codes. Frost considers this as a universal property emerging from any linguistic system, which native speakers learn to identify through reading and spelling. Hence, a universal model of orthographic processing ought to account for all the types of linguistic information conveyed by printed language. Along similar lines, an example of a detailed system to categorise spelling errors was used in the study of Caravolas and Volín

(2001) in Czech. They distinguished between phonological, orthographic, morphological, grammatical and lexical categories. In another study by Hoefflin and Franck in French (2005) the errors were classified as lexical root errors (i.e., stemming from lack of knowledge of general or grammatical rules), punctuation and capitalization errors. Finally, Protopapas and colleagues in their recent study in Greek (2013) provided a systematic and very detailed classification by identifying six major categories of errors, namely a) phonological, b) grammatical, c) orthographic, d) stress diacritic, e) punctuation and f) other, each of which contained several sub-groups.

To summarise, error classification has taken different forms to support the aims of each study. For example, a refined categorisation would be more likely to capture differences between populations (e.g., participants with dyslexia versus a typically developing sample). Furthermore, a detailed classification has the potential to reveal the relationship between specific skills (e.g., the ability to manipulate morphemes) and the spelling output i.e., the error, as well as to explore spelling strategies (e.g., application of phoneme-to-grapheme correspondence rules). With this aim a detailed categorisation of errors was employed in the present study to capture multi-layered information about the children's spelling performance, related skills and possible distinguishable characteristics between cohorts.

4.4.2 Categorisation and scoring of errors

In order to investigate spelling errors in a detailed manner each target item used in the spelling tasks of the present study was audited in relation to the phoneme-to-grapheme and the morpheme-to-grapheme correspondence patterns that it represented. The audits related both to simple phoneme-to-grapheme correspondence e.g., CAT, and more complex ones e.g., KNIGHT, where /n/ is represented by the orthographic pattern <kn> and /i/ is represented by the orthographic pattern <igh> or to grapheme-morpheme pattern e.g., the plural affix is represented by <s> as in CATS or <es> as in GLASSES. This classification system was used for the audit of the errors of all participants to a) investigate the spelling development of typical spellers attending consecutive year groups in England and Greece and b) explore the differences in the spelling skills of dyslexic-profile and typical spellers.

Previous studies have shown that when languages are compared at a holistic consistency level (i.e., generally more consistent languages, such as Spanish, versus generally more inconsistent languages, such as English), children writing in more consistent languages make a greater progress in spelling accuracy during the first years of schooling in comparison to children learning to write in more inconsistent languages (Seymour et al., 2003). In the present study the writing systems had different levels of overall consistency. However, relative to Spanish Greek has been found to be more inconsistent in the feedback direction (spelling) than in the feedforward direction (reading) (Protopapas & Vlahou, 2009), thus offering opportunities for comparison with comparable spelling patterns in the opaque English language. Consistency at both the whole-word level and the phoneme-to-grapheme level influences spelling performance, with more errors occurring in the inconsistent parts of the words than in the consistent parts (e.g., see Alegria & Mousty, 1996; Lete et al., 2008 for effects of consistency in French spellings; Weekes, Castles, & Davies, 2006 for effects in English spellings). In addition, cross-linguistic studies have shown that the application of morphological knowledge contributes to the correct spelling of different word parts, i.e., morphemes (e.g., Bryant et al., 1999).

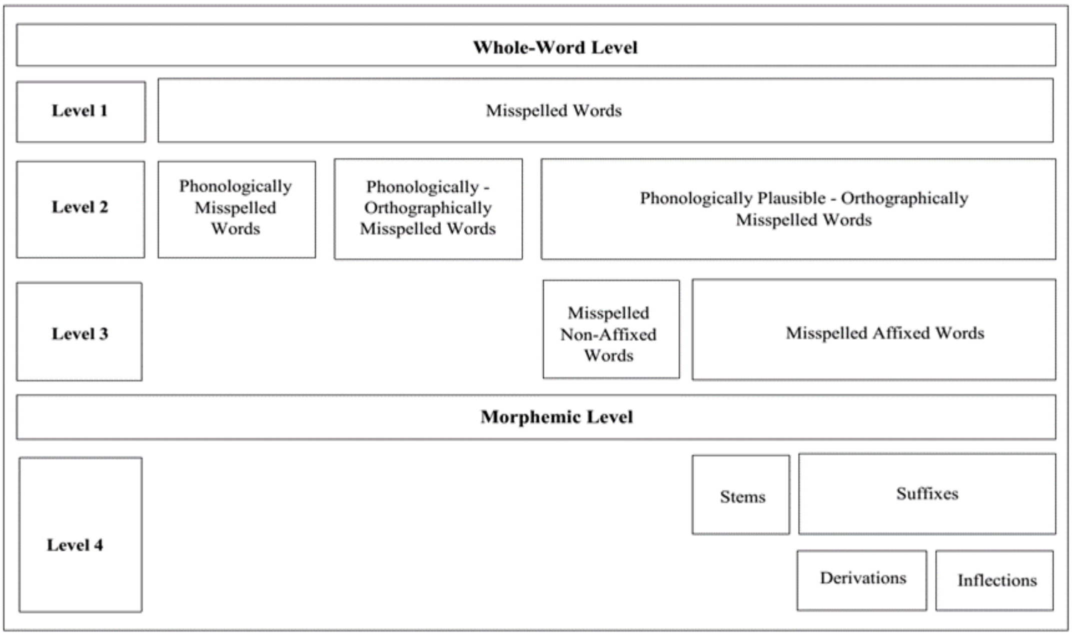


Figure 4.1
Levels of Analysis of Spelling Errors in English and Greek Language Sample

In order to allow for cross-linguistic comparisons, the present study investigated spelling patterns that would share characteristics in the two examined languages. The analysis focused on: a) whole words, and b) misspellings in different morphemes (stems and suffixes) (Figure 4.1, p. 119 and Appendices B2 and B7). A first level of analysis examined potential differences in the total number of misspelled words between groups of children and spelling tasks. At a second level, the examination focused on the component morphemes of affixed words. At both levels the interest was directed to both orthographically consistent patterns, (i.e., phonemes which consistently correspond to only one grapheme) and inconsistent patterns (i.e., phonemes which can be spelled with more than one alternative grapheme), correct spelling of which is not solely dependent on application of phoneme-to-grapheme correspondence rules.

To investigate differences between children writing in two different orthographic systems, the analysis examined the misspelled patterns under the prism of the type of knowledge required for correct spelling, i.e., phonological, morphological and orthographic. When inspecting results of previous studies investigating spelling errors, an inconsistency in findings is evident. This could be partially due to different categorisation systems used to audit the spelling errors. Treiman (1997, p. 205-206) refers to two different classification systems employed by different researchers. More specifically, <tak> for TAKE would be classified as a phonological error by a strict criterion, because the English conventional system calls for a final <-e> to preserve correct pronunciation in this context. By the same criterion <plad> for PLAID would not be considered as phonologically wrong because each phoneme is represented by a letter used to symbolise the specific sounds in conventional English. In contrast, other researchers using a lax criterion would not classify <tak> as a phonological error, because the sound /eɪ/ can be spelt as a single <a> in words such as BACON. In addition, very often a misspelled word can be assigned to more than one error category. With reference to another example provided by Treiman (1997), <jry> for DRY is phonologically wrong because the /d/ sound is never represented by <j> in conventional English, but it could also be considered as an orthographic error, since the combination of <j> and <r> is orthographically unacceptable. This example is illustrative of the fact that there is often an overlap between application of phonological, morphological and orthographic knowledge to achieve correct spelling. To account for this overlap, researchers sometimes assign whole misspelled words to more than one error category. However, such a classification system might result in masking or inflating the impact of each type of knowledge on spelling performance, such as a preponderance of orthographic errors in one's writing. In order to control as much as possible for such an effect, in the present study whole words and whole morphemes were assigned to only one error category in accordance with the strict criterion and the rule of dominance, which was used in the classification system of Protopapas et al. (2013). According to the rule of dominance, primarily one type of knowledge is required to spell each specific spelling pattern correctly. Therefore, a mistake altering the sound of a phoneme in the target word was assigned to the phonological error category, by the criterion that “the link between print and speech is primarily at the level of individual sounds or phonemes” as suggested by Treiman (1997, p. 192) and that “in order to spell a word (at least a word whose conventional spelling is unfamiliar to the child), the child must be able to analyse the spoken form of the word into phonemes so as to represent each phoneme with a grapheme” (Treiman, 1993). Misspellings producing phonological alterations are considered to signify difficulties with manipulating phono-graphemic correspondences independently of orthographic (lexical) word specific knowledge (Protopapas, Fakou, Drakopoulou, Skaloumbakas, & Mouzaki, 2012). For the purposes of the present classification it was assumed that strong phonological representations would be sufficient to dictate phonologically plausible spellings.

More specifically, all misspelled words that contained graphemes altering the pronunciation of the target word, were listed under the major category of phonologically misspelled words (see Level 2, Figure 4.1, p. 119). In particular, the phonologically misspelled words contained phonologically illegal spellings as defined by Treiman (1993):

> “(1) the child represented … one phoneme in the word with a grapheme that was not correct for that phoneme … (2) the child failed to represent one or more phonemes in the word … or (3) the child represented the phonemes in the wrong order” (p. 49).

Examples of such phonological errors from the spelling samples of the present study include (1) in English: <heaviest> spelled as <heeviest>, in Greek: <κολλά>(/kola/=it glues) spelled as <καλλά> (/kala/), (2) in English: <princess> spelled as <priness>, in Greek: <κάηκε> (/kaike/ = it was burnt) spelled as <κάκε> (/kake/) and (3) in English: <burning> spelled as <bunring>, in Greek: <τσαγκάρης> (/tsagaris/= shoemaker), spelled as <τσακγάρης> (/tsakɣaris).

While all words containing phonologically implausible errors were classified under the phonologically misspelled words, all words containing phonologically legal (plausible) transcriptions of at least one phoneme were initially listed under the phonologically plausible-orthographically misspelled words category (Level 2, Figure 4.1, p. 119). At this second level of whole-word audit the phonologically plausible-orthographically misspelled words category did not distinguish between morphological and orthographic errors. In some cases a phonological error in one part of a word was combined with a phonologically plausible orthographic misspelling in another part (e.g., <ritted> for WRITTEN, <heled> for HEATED, <hevest> for HEAVIEST). Hence, a third category, named phonologically-orthographically misspelled (P-OM) words, was created to take into account possible co-occurrence of a phonological and an orthographic misspelling in the same word (Level 2, Figure 4.1, p. 119).

The ability to apply morphological and orthographic information was initially investigated at the level of whole words by recording the number of misspelled non-affixed and affixed words (Level 3, Figure 4.1, p. 119). In order to focus on the application of orthographic and morphological skills when spelling, only the phonologically plausibly misspelled words were subsumed under each error category. The examination of non-affixed versus affixed words was initiated by an interest to investigate the approach that children take to spell polymorphemic (affixed) words as opposed to monomorphemic base words (non-affixed). There is a lack of consensus in the literature regarding whether base and derived or inflected forms are processed in the same way by young learners. In particular, the findings are controversial concerning whether pupils appreciate the morphological complexity of affixed words. An alternative view is that both affixed and non-affixed words are stored as whole units in the lexicon (Carlisle, 1988; Deacon, Whalen, & Kirby, 2011). A significant difference in the error rates attracted by each word category would indicate that children differentiate between monomorphemic and polymorphemic words in spelling. The fourth level of auditing corresponded to the morphemic level of analysis and aimed to explore further the participants' ability to apply morphological and orthographic information when spelling. Therefore, at this level the misspelled morphemes comprising the affixed words were recorded and classified under stems and suffixes. The suffixes category contained two sub-categories, namely the derivational and the inflectional suffixes (Level 4, Figure 4.1, p. 119). Only the phonologically plausible misspellings were included in these categories for similar reasons as in Level 3 of auditing. This fourth level aimed to detect any preponderance of errors in the component morphemes of polymorphemic words, which would indicate the competence of the children to apply morphological and/or orthographic information.

One of the common linguistic characteristics of English and Greek is that a large proportion of words consist of more than one morpheme. This is particularly evident in Greek, where, even in its simpler form, any word would include a stem and an inflectional suffix. In a morphologically complex word, a prefix, a stem, and an inflectional ending could be combined. All of these components are vectors of meaning adding significant features to the semantic identity of the word. According to Treiman (1993):

> "[In English] inflections are added to the ends of words to mark such things as tense and number. … The same principle holds for many derived words, in which affixes (prefixes or suffixes) have been added to change the meaning of the word" (p. 24).

Therefore, in the current study phonologically plausible misspellings of morphemes could indicate a failure to appreciate the contribution of the morpheme to the meaning of the word. Grammatical errors in suffixes were regarded as relevant indications, because aside from violating conventional morphological rules alteration of the grammatical type may signify lack of understanding of the meaning that the particular suffix conveys. In the literature correct spelling of inflectional morphemes is regarded as being based on statistical learning or inference of morphological rules (Bryant & Nunes, 2008), which enhance application of the appropriate suffix to unfamiliar words by analogy (Chliounaki & Bryant, 2007; Ehri, 2014; Nunes et al., 1997). Thus, an investigation of the misspellings in inflectional suffixes could be illustrative of the competence with which the participants employ these spelling strategies.

Furthermore, investigation of stems, derivational and inflectional suffixes was of interest to the present study, to capture the children's ability to employ orthographic information when spelling. All morpheme-specific misspellings, i.e., errors that altered the visual form of the target morpheme but could not be dictated by morphological rules were regarded as indications of imperfect orthographic knowledge following the definition of Protopapas et al. (2013).

> "Orthographic (alternatively termed etymological, historical, or visual) errors concerned alternative, phonologically equivalent, spellings of word stems, including roots and any derivational morphemes …. Orthographic errors indicate imperfect registration of word-specific (or root-specific) knowledge.

> Therefore, these errors index the maturity and specificity of the developing orthographic lexicon. A preponderance of orthographic errors would be consistent with difficulties in memorizing information relevant for particular items” (p. 624).

Many contemporary Greek words are products of historical orthography with routes in ancient Greek vocabulary. Similarly the contemporary English language has evolved from the Old English and Middle English, which often incorporated sounds and orthographic patterns borrowed from Latin, Anglo-Saxon, French, German, Italian and Greek (Venezky, 1999, pp. 95-124). This evolution of both languages over time extensively determines the spelling of orthographically inconsistent patterns occurring in the stems of simple contemporary words. However, etymological evolution is not explicitly taught to English or Greek pupils. Learning orthographically inconsistent spellings occurring in the stems of words for spellers in both countries depends primarily on word specific knowledge. An example of an orthographic error in English would be writing <nessecery> for <necessary> and in Greek <πεδιά> for <παιδιά> (/peðja/ = children). Along similar lines, a derivational suffix is often subject to specific knowledge, as is required in English to spell the derivational prefix of the English adjective <horrible>. Morpheme-specific knowledge would also be required in Greek to spell correctly the derivational suffix of the adjective <κοινωνικοί> (/kinoniki/=sociable), since pupils are taught and are encouraged to memorise that the adjective suffix <-ικος> is spelled with a <ι> which is consistent regardless of the inflection <-ος> related to gender, case and number. Any phonologically plausible misspelling of this <ι> would indicate poor visual representation of the pattern and should not be associated with grammatical knowledge. Correct spelling of these suffixes is largely dependent on the accuracy of the information stored in the orthographic lexicon, as is the spelling of the word-root (Nunes & Bryant, 2009; Protopapas et al., 2013). Therefore, in the present study such misspellings in the stems and derivations of affixed words were regarded as indications of imprecise orthographic (visual) representations. If inflectional spelling is enhanced by combined application of morphological rules and orthographic knowledge as previous research suggests (Chliounaki & Bryant, 2007; Ehri, 2014; Nunes et al., 1997), then error rates in inflectional suffixes could also indicate the competence of children with the employment of such knowledge.

Aside from grammatical rules and morpheme-specific knowledge, spelling errors in the component morphemes of affixed words could result from poor knowledge of the spelling rules regulating the specific orthographic system, as suggested by Nunes and Bryant (2009) :

> “There are many rules that apply when a suffix is added to a base form, which involve changing the visual form in order to preserve the phonological representation. A common rule is doubling letters when we add to a stem a suffix which starts with “e”. … In order to preserve (the vowel’s) sound the consonant is doubled at the end of the stem: “tan”-“tanned” ….” (p. 8).

In the present study such errors included writing <droped> for <dropped> and <happyer> for <happier>, as these might indicate overlooking the orthographic rule that when <y> meets <e> it becomes <ie>. Similarly in Greek, correct spelling of the noun <έγγραφο> (<εν+γραφο> = <έγγραφο> /eɟrafo/ = document) would require awareness that coalition of the letters <ν> (/n/) and <γ> (/γ/) produce the double <γγ> (/ɟ/) grapheme. Such rules are specific to these two orthographic systems and skilled spellers are expected to develop the ability to apply them over time and with practice.

Finally, phonologically plausible spellings that violated the “graphotactic” rules of the particular writing system were recorded at all levels of audit, following the definition of Deacon, Conrad, and Pacton (2008):

> “A second source of information useful to spelling comes from graphotactic regularities about the legal combinations of letters. … The term orthographic can also be used to refer to this knowledge, but it also refers to learning about the correct spellings of individual words (such as the classic example of the exception word yacht). We use the term graphotactic in this and other manuscripts to refer specifically to learning about the legal combinations of letters in the script as a whole” (p. 118).

An example of a graphotactic error in English would be writing <judj> for <judge>, since <j> cannot appear as a final consonant in conventional English. An example in Greek would be writing <ςυλεκτική> for <συλλεκτική>, since <ς> can only be used in the final position in conventional Greek words. In the present study, one English and one Greek native speaking researcher were asked to classify independently the errors of a random sample of the spellings collected. A discussion with the researcher of the study followed this task. The final categorisation was a product of agreement between the researcher and the independent examiners.

With regard to scoring, at the whole-word level each misspelled word was awarded with 1 point. This first scoring was followed by calculations at a finer grain-level to examine spelling errors in different word morphemes of the affixed words. Each misspelled morpheme was awarded with 1 point. Each child received an individual score for each error category consisting of the sum of points representing the total number of misspelled words or morphemes (Figure 4.1, p. 119). Mistakes included addition, omission or substitution of one or more graphemes in each word or morpheme.

A variety of spelling phenomena were represented in the lists of target words. Despite close matching in frequency levels, length, morphemic and phono-graphemic complexity, a discrepancy in the total number of graphemes comprising each spelling word list was inevitable due to the specific properties of the two languages. In order to draw comparisons between error categories, language samples and experimental spelling tasks, the number of corresponding opportunities for errors provided in each task was taken into account. Opportunities were defined as the total number of words or morphemes that could be misspelled under each error category. At the level of non-affixed and affixed words as well as at the morphemic level the number of words and morphemes was not balanced across language samples and spelling tasks. For this reason, in the single word spelling task the opportunities for errors were different for each category at these two levels but equal for all participants in the same language sample, since all children spelled the same 60 words. This is also true for the passage completion task. However, in the text composition task each child used a different number of words, despite the fact that participants were required to source target words from a given list of stimuli. Furthermore, even when there was an equal number of stimuli used by two participants, different target words could have been chosen by each child depending on the content of their narratives. In addition, repetition of the same stimulus in a story frequently occurred. In this case, only one misspelled version of the target word was scored. Therefore, for the text composition task the amount of opportunities was a unique number for each participant depending on which stimuli they chose to use. To account for these differences, the total number of errors of each participant were divided by the total number of opportunities for errors produced by them (i.e., total number of words or morphemes used). These ratios of $\frac{errors}{opportunities\ for\ errors}$ resulted in a unique score representing the proportion of errors produced by each child in each error category and each spelling task. These were positive values ranging from 0 to 1, with scores approaching 1 signifying a worse spelling performance than scores closer to 0. These proportions of errors were introduced to the statistical analyses.

Accounting for the number of opportunities for errors was essential to enable comparisons between error categories and participants. Particularly as concerns the text composition, it cannot be ruled out that less confident spellers would potentially employ a smaller number of stimuli to ensure better spelling performance in contrast with more confident spellers who might imperil high error rates by experimenting with more target words. Therefore in this task there were extensive differences in the error rates between and within subjects. A possible influence of the discrepancy in the number of opportunities for errors on these error rates cannot be ruled out, but allowing for the number of opportunities to vary was interwoven with the purposes of this study aiming to examine spelling in a semi-controlled but close to natural writing condition. Occasionally observations of zero errors occurred resulting in highly skewed distributions, especially in the text composition task. Nevertheless, the present study investigated spelling performance in all three spelling conditions, regardless of low error rates, to reveal any differences between error categories, groups of children and spelling tasks.

4.4.3 Statistical analysis

Data were analysed with the Statistical Package for Social Sciences (SPSS, 22). Due to the nature of the experimental tasks and the scoring system, there was large variance in the error rates produced by the participants. When the assumptions of normality, linearity and homoscedasticity were satisfied, analyses of variance were performed on raw data. When the assumptions were not adhered, square root, log and reciprocal transformations were performed to correct any positive or negative skewness (Field, 2013). However, frequently the transformations did not correct the skewness. For this reason, it was decided to perform ANOVAs on the uncorrected raw data. ANOVAs were preferred over nonparametric tests because they allow for examination of interactions between variables. Another advantage is that they allow for comparisons between the misspelling rates of children belonging in different groups with post hoc tests, thus satisfying the purposes of the present study in a more concise manner. Moreover, ANOVA is considered to be a very robust statistical method of analysis, often very resilient to violations of the normality assumption with relatively minor effects (Howell, 1992). When the raw data were non-normally distributed, the results of the ANOVAs were verified with Kruskal-Wallis and Mann-Whitney U nonparametric tests for independent samples. The Kruskal-Wallis test is commonly regarded as a test for differences between the distributions of data obtained from independent samples, and is the nonparametric equivalent for one-way ANOVA. The Mann-Whitney U test is employed to test for differences in data obtained from only two independent samples. Essentially they are rank-order tests, where the scores of each group of children are initially ranked and sums of ranks are compared. In the present study means and standard deviations are displayed for all data as indications of central tendency.

Differences in error rates classified in different error categories (e.g., phonologically misspelled words and phonologically plausible-orthographically misspelled words) within the same group of participants (e.g., dyslexic profile group) might reveal particular weaknesses and strengths in their spelling performance. In the present study repeated-measures and mixed design ANOVAs were employed to compare the error rates obtained from the same group of children. One-way ANOVAs and post hoc tests followed up the results to examine pairwise differences between error categories. When raw data were not normally distributed, the results of the analyses of variance were verified with Friedman's ANOVA and Wilcoxon signed-rank tests. Friedman's ANOVA is the nonparametric equivalent to repeated-measures ANOVA. Wilcoxon signed-rank test is a nonparametric method to compare a pair of scores obtained from the same sample without assuming a normal distribution. To avoid repetition, the results of the nonparametric tests are only presented in addition to the results of the ANOVAs, when these are different.

A number of comparisons between pairs of groups or pairs of error types were performed. Hence, there was a high probability of rejecting the null hypothesis when it was true (i.e., maximising chance due to repeated testing or "Type I" error). To control for Type I errors, Sidak corrections were performed in all analyses. Sidak and Bonferroni corrections are equivalently applicable to control the familywise error rate (FWER) by making the alpha level more stringent, but the Bonferroni correction is more conservative as the number of compared groups increases (Field, 2013). In the present study, the Sidak correction was preferred to Bonferroni in order to prevent the effect of inflation of “Type II” errors, i.e., failing to detect a difference that is present, which might occur when a very stringent alpha level is employed. Sidak correction was applied on the significance (*p*) value of .05, which was used for all comparisons.

4.5 Summary

In summary, this study used a cross-sectional and a cross-linguistic design to compare the spelling profiles of typically developing children and children with a dyslexic profile of primary school age across two countries, England and Greece. Participants were selected from state schools in urban areas of similar socio-economic background, and had enough educational experience to handle demanding writing tasks as required for this study. The first phase of the study consisted of baseline measures of non-verbal and verbal ability, reading and spelling ability, which were used to select suitable participants. The age discrepancy definition of developmental dyslexia was used to define the selection criteria for the dyslexic-profile groups, which were matched with a CA, a RA and a SA control group in each language sample based on the raw scores that pupils obtained in the baseline measures. The second phase of the study included three experimental spelling tasks to examine possible effects of semantic context on spelling performance. The stimuli were selected from age appropriate lists of words in the two languages and were matched in frequency levels, length, grammatical properties and grapho-phonemic complexity as much as possible across languages. Cross-linguistic comparisons were drawn on the basis that English and Greek have a morpho-phonemic structure and that when spelling several orthographically inconsistent patterns occur in both languages, which can be addressed with the application of different types of knowledge. In this chapter the key characteristics of the different groups of children were presented and the methods of classification, scoring and analysing of their spelling errors were described. These will be used in the following chapters examining the spelling development of typically developing learners, possible differences in the spelling profiles of children with and without dyslexia and any effect of semantic context on the spelling performance of all groups of children across the two language samples.

Chapter 5

Analysis of Spelling Errors of Primary School English and Greek Typically Developing Native Speakers

5.1 Introduction

This chapter investigates the spelling performance of typically developing English and Greek native speaking children in primary schools in their respective countries. Studies in languages with different levels of orthographic consistency have directed research attention towards different areas of spelling difficulties and the acquisition of spelling skills. This is a cross-sectional study designed to explore spelling performance of children belonging to four consecutive year groups, namely years 3-6 (7.6-10.7 years old) in English schools and grades 3-6 (8.6-11.5 years old) in Greek schools. Furthermore, cross-linguistic comparisons were included in order to investigate potential similarities in spelling performances between the two cohorts of children. Specific characteristics of each orthographic system are taken into account since they have the potential to influence mastery levels of the phonological, morphological and orthographic abilities. The following section briefly presents the findings of previous research on spelling performance and acquisition of spelling skills in English, Greek and other more transparent orthographic systems in order to contextualise the research.

5.2 Spelling performance in younger and older children

Previous research in writing systems of various levels of orthographic consistency has underlined the important role of good phonological skills in spelling achievement. In English, a longitudinal study by Caravolas, Hulme and Snowling (2001) examined the spelling ability of pupils of the first three years of primary education and concluded that phoneme awareness and knowledge of phoneme-to-grapheme correspondence rules correlated with the development of conventional spelling ability at this age. In another study Caravolas, Volín and Hulme (2005) conducted research with Czech and English native speakers between 6 and 12 years old. The results verified the strong correlation between phoneme awareness and spelling ability. Studies in Greek indicate that pupils with good phonological skills tend to make fewer errors in spelling (Aidinis & Nunes, 2001;

Porpodas, 1992, 1999). Diamanti, Goulandris, Campbell and Stuart (2005) have also verified the role of phonological awareness in the prediction of spelling ability by examining 28 Greek speaking pupils of 8 to 10 years old in phonemic deletion, spoonerism and spelling choice. Nikolopoulos, Goulandris, Hulme and Snowling (2006) conducted a study with 131 pupils in the second and fourth grades of primary education, which included tasks of phonemic deletion, spoonerism, speech rate and spelling and confirmed the importance of phoneme awareness for reading and spelling in agreement with previous studies in English and in more transparent languages (Greek: Porpodas, Pantelis, & Hantziou, 1990; Czech: Caravolas et al., 2005; Turkish: Babayiğit & Stainthorp, 2011; Oney & Durgunoglou, 1997; German and English: Wimmer & Goswami, 1994).

Spelling processes are encapsulated in theoretical models of spelling aiming to provide a conceptual framework constantly enriched by incorporating new research findings in the field. According to Ehri (1997), spellings of familiar words may be retrieved from memory, while spellings of novel words may be produced by analogy or be invented. In an analogous description of spelling by memory, connectionist dual-route models (e.g., Houghton & Zorzi, 2003) highlight the contribution of the semantic system and the orthographic lexicon in linking phonological analysis to written output, while the phonology to orthography (sub-lexical) conversion path provides a second route to spelling. As phonological, semantic and orthographic systems interact for spelling production, weaknesses in one component could influence the development of the other two components as well as the final spelling output. Dependence of orthographic knowledge on phonological skills has been suggested by Ehri’s (2014) orthographic mapping theory, Share’s (2008) self-teaching hypothesis and the lexical quality hypothesis (Perfetti, 1997; Perfetti & Hart, 2002).

A sense of morphological links between root-words and derived forms, and of the semantic contribution of the morphemes to the meaning of the word have been suggested as facilitators for the spelling of polymorphemic words (Nunes, Bryant, & Bindman, 2006). Application of morphological knowledge supports spelling in addition to phonological rules, which seem insufficient to provide guidance for accurate spelling in less consistent orthographies (e.g., Juel, Griffith, & Gough, 1985). Studies of morphological awareness indicate that it strongly predicts spelling ability of older pupils (e.g., Nunes, Bryant, & Olsson, 2003; Nunes et al., 2006). According to their findings, it seems that morphological strategies are not competently applied in spelling before the last years of primary school, since they depend on the development of phonological awareness in the first school years. However, Treiman et al. (1994) showed that children have sensitivity to the morphological components of polymorphemic words since kindergarten. Treiman and Cassar (1996) observed that first graders tended to omit nasals in one-morpheme words, such as FUND, more frequently than inflected words, such as TUNED, and suggested that even very young children have a sense of morphology and do not purely spell on a phoneme-to-grapheme basis. Nunes et al. (1997) related the ability of children to represent grammatical distinctions in spelling, such as forming irregular past participles, with their grasp of these phenomena in spoken language. For highly inflected languages, such as Greek, morphological information such as the gender, number and case contribute significantly in the correct spelling of word endings. In addition, spelling patterns in exception words, which do not rely on phoneme-to-grapheme correspondences or morphological knowledge, are dependent on visual orthographic information and are subject to word-specific learning, as for instance inconsistent vowels occurring in stems (Chliounaki & Bryant, 2007; Nenopoulou, 2005). Furthermore, awareness of the specific characteristics of the conventional orthographic system and graphotactic rules are necessary conditions for advanced spelling performance (Treiman & Bourassa, 2000).

Phase theory of spelling development (Ehri, 1986) has often been criticised along with stage theories (e.g., Frith, 1980; 1986) for describing spelling progress in a static view (Keuning & Verhoeven, 2008). According to Keuning and Verhoeven (2008), the common characteristic of these theories is approaching spelling development as instant qualitative changes in implementing strategies and information (phonological, morphological and orthographic). Alternative approaches, such as the overlapping waves theory (Rittle-Johnson & Siegler, 1999), have been proposed to better describe the adaptability of children's spelling skills to the demands of the spelling target. Recently, Ehri (2014) revisited her phase theory incorporating the concept of overlapping waves to suggest that children may use different types of connections between phonological and orthographic representations at any time but that there is a predominant orthographic connection, which develops over time, from non-alphabetic to partial to full and finally to consolidated spelling.

There is a lack of consensus in the research literature as to whether children understand the compound form of polymorphemic words or they address them as whole words. According to Deacon, Whalen and Kirby (2011), words with opaque base forms, i.e., when the pronunciation of the stem changes (e.g., MAGIC-MAGICIAN), might be more likely to be accessed as whole-word forms when reading, while it might be relatively easy to recognise the presence of a transparent base form (e.g., MAGIC-MAGICAL). On the other hand, according to Carlisle (1988) the ability to apply suffix conventions (i.e., rules) to nonsense words is an indication of the use of morphemic analysis in spelling. In French, Casalis, Deacon and Pacton (2011) found evidence that children use morphemic structure to spell derived words as early as in grade 3. In addition, evidence of the ability to extract the base word equally well from derived and inflected words has been found with English speaking pupils ranging from 6 to 15 years old (Deacon & Bryant, 2006; Deacon, Campbell, Tamminga, & Kirby, 2010; Deacon et al., 2011; Rabin & Deacon, 2008). Based on these results Rabin and Deacon (2008) suggested that the roots of transparent derived and inflected words are organised in a similar manner in the lexicon.

With regard to the spelling of suffixes, Nunes and colleagues (1997) proposed that children's morphemic spelling progresses from phonetic transcription to overgeneralisation to inappropriate forms, as for instance adding –ed suffixes to nouns, to restriction to the appropriate cases. Based on their findings in a series of studies with inflectional suffixes in words and pseudowords, Nunes and Bryant (2009) proposed that children generate morphemic rules, which they apply on inflectional spelling and which develop based on word-specific knowledge. Carlisle (1988) attributed correct spelling of suffixes in nonsense words to application of morphemic rules that govern the correct spelling of derived and inflected forms. According to Carlisle, these rules are learned by observation, direct instruction or word-specific memorisation. Chliounaki and Bryant (2007) related this process of generating the morphological reasons for many of the spelling patterns that phoneme-to-grapheme correspondence rules cannot explain to Frith's (1980) stages of spelling development, and Share's (2008) phonologically based self-teaching hypothesis. Evidence for employment of word-specific knowledge and appropriate application of morphemic spelling rules in pseudoword inflectional spelling was found in a series of studies described by Nunes and Bryant (2009) with children and adults in different languages including English and Greek. It is, therefore, suggested that advancement in morphemic spelling rules might depend on an underlying growth of word-specific knowledge.

At a more fine-grained level of error analysis, orthographic inconsistency and graphemic complexity, i.e., when the pattern consists of more than one letter (Treiman, 2005), may increase the difficulty of vowel spelling. Inconsistent vowels and consonants are sources of challenges for spellers of less transparent languages. Long and short vowels produce serious difficulties, particularly when represented by a digraph (Stainthorp & Hughes, 1999; Treiman, 1993). Nevertheless, misspellings frequently maintain the two-part nature of vowel diphthongs indicating some level of orthographic knowledge in young spellers, as has been observed by studies with English speaking first graders (Treiman, 1993) and year 1-3 pupils (Stainthorp & Hughes, 1999). Representing vowels with an alternative grapheme is not uncommon for primary school children (e.g., Greek: Diamanti et al., 2013; Loizidou-Ieridou et al., 2010; e.g., English: Bowman & Treiman, 2002; Rebecca Treiman & Kessler, 2006). Studies in both languages have found a sound-to-spelling contingency effect (Barry & Seymour, 1988; Diamanti et al., 2013). According to this view, children show a tendency to use common patterns more frequently than rare patterns when spelling vowel phonemes. In addition, studies in Greek (Bryant et al., 1999) and Portuguese (Nunes, Carraher, 1985 as cited in Bryant et al., 1999) revealed that beginning spellers initially show a preference for one vowel spelling but with reading experience and schooling they gradually widen their repertoire with alternative spellings. As concerns inconsistent consonants and particularly doublets, findings of studies on inflected verbs in English (Beers & Beers, 1992; Carlisle, 1988; Steffler, 2004; Walker & Hauerwas, 2006), have shown that children's application of the doubling rule is not consistent until late grades of primary education. Finally, studies examining final consonant clusters (Marcel, 1980; Treiman & Cassar, 1996; Treiman, Zukowski, et al., 1995) showed that the first consonant of the cluster is more susceptible to omission than the second (e.g. SINK spelled as <sik> rather than as <sin>) and that nasal and liquids are omitted more frequently before voiceless than before voiced stops (e.g. TENT vs BAND).

5.3 Aims of the present study

Recent findings from a brain study by Harris, Perfetti and Rickles (2014) on error-related negativities reflecting error-monitoring processes in adult brains during a spelling decision task indicate that phonological and orthographic information contribute uniquely to the activation of the representation of the word in the lexicon. In addition, the association between the participants' ability to detect a false response in the spelling decision task, as indicated by error-related negativities in their brain, and the breadth of their vocabulary knowledge highlights the importance of semantic information for correct spelling. According to the researchers, these results affirm the independent nature of phonological, orthographic and semantic knowledge components contributing to spelling processes. If different misspellings denote different spelling processes (Treiman, 1993) and component morphemes of polymorphemic words follow distinct developmental trajectories in accordance with the acquisition of relevant metalinguistic awareness (Diamanti et al., 2013), specific error analysis linking mistakes to the application of different types of knowledge (i.e., phonological, morphological and orthographic) may be an insightful tool to delineate spelling development. Additionally, the pace of acquisition or the developmental trajectories of distinct spelling skills might be influenced by specific linguistic characteristics of the orthographic system (Joshi & Aaron, 2006).

Therefore, one of the aims of the present study was to examine the pace with which different spelling skills develop in typically developing pupils attending the last four grades of primary school in England and Greece. Another aim of the study was to investigate the role of the orthographic system in spelling development. More specifically the study aimed to:

1) Employ a wide range of spelling features in various parts of speech, which would enable a detailed examination of spelling errors linked to the application of different types of knowledge (i.e., phonological, morphological, orthographic) in two morpho-phonemic languages (English and Greek).

2) Include participants of a wide age range, in order to investigate the incremental progress of typically developing children in primary education to apply these types of knowledge when spelling.

3) Draw direct comparisons between typically developing children who learn to write in an opaque (English) and a more orthographically consistent language (Greek), to enable a direct investigation of the role of the orthographic system in the acquisition of different spelling skills.

To achieve these goals the questions asked in this chapter are:

A) How does spelling ability improve, as delineated by the misspellings of typically developing children in the final four grades of primary school? Do different spelling skills follow different developmental trajectories?

To adress this question 60 words representing different parts of speech were dictated to the participants in each language sample. A first level of analysis examined their spelling errors at the level of whole words distinguishing between phonologically misspelled words and orthographically misspelled words. At a second level of analysis the morphemes composing polymorphemic words were examined for a closer investigation of the application of morphological and orthographic skills in spelling of morphologically complex words. Cross-sectional comparisons between children attending the four final grades of primary school were drawn to enable mapping of the paths followed for gradual acquisition of different spelling skills (i.e., phonological, morphological, orthographic).

B) What is the role of the orthographic system in the spelling performance of typically developing children writing in two languages with different levels of orthographic consistency (English and Greek)? To what extent are trajectories of spelling development dependent on the linguistic characteristics of the specific orthographic systems?

To answer this question the two experimental spelling lists were matched in frequency levels, approximate length of words and parts of speech to enable direct cross-linguistic comparisons of the spelling performance of children attending corresponding grades in primary education in England and Greece. The comparisons were drawn at a whole word and a morphemic level to reveal any similarities or differences in the way in which specific spelling skills (i.e., phonological, morphological, orthographic) develop as a consequence of writing in a more inconsistent orthographic system (English) or a more consistent and highly inflected system (Greek).

5.4 Method

5.4.1 Selection tools and participants

The English sample consisted of 155 typically developing pupils attending years 3, 4, 5 and 6 in five state mainstream primary schools in a middle-to-high socio-economic area of Berkshire, England. The Greek sample consisted of 170 typically developing children attending grades 3, 4, 5 and 6 in eleven state mainstream primary schools in a middle-to-high socio-economic area of Athens, Greece. The recruitment process, selection criteria, characteristics and estimation of baseline abilities of the two samples are thoroughly described in chapter 4, section 4.3.

5.4.2 Experimental spelling task and stimuli

The experimental spelling battery included three spelling tasks, which are described in detail in chapter 4, section 4.3.3. The present chapter focuses only on the data derived from the single word spelling task because it provided more opportunities for deep investigation of the children's spelling ability. The task consisted of 60 words, which were dictated to the pupils and included various parts of speech (verbs, nouns, adjectives, adverbs and participles) had various lengths (from a minimum length of 3 letters to a maximum length of 18 letters) and were of three levels of frequency (i.e. low-middle-high). The target words ranged from two to six syllables and contained combinations of single graphemes, digraphs and trigraphs. The final list of stimuli contained examples of base words, derivatives and inflections including orthographically consistent and inconsistent patterns appearing in stems and suffixes.

5.4.3 Scoring of errors and statistical analysis

Error analysis was employed on whole misspelled words and their component morphemes. Misspellings were subjected to four levels of analysis as described in chapter 4, section 4.4. For the initial analysis, each participant was given 1 point for each misspelled word and 0 points for each correctly spelled word. Their individual score represented the total number of misspelled words. Examples of misspellings are displayed in Table 5.1, p. 138. As the investigation proceeded to finer levels of analysis, opportunities for errors were taken into account. This resulted in calculating the proportions of errors for the specific unit under examination, i.e., affixed versus non-affixed words, morphemes (see chapter 4, section 4.4.2). Calculating the number of opportunities for errors is necessary to enable comparisons between categories of errors, both within the same group of children and between different cohorts of participants. There were differences in the number of errors falling into the different categories, sometimes resulting in positively skewed distributions with peaks around zero. The skewed data were transformed to approximate a normal distribution. The transformations were not successful, hence the raw data were entered in the analyses. Parametric methods of analysis were preferred over non-parametric to enable investigation of interactions between variables. The results were always verified by non-parametric equivalents. Statistical methods employed for the analysis are thoroughly presented in chapter 4, section 4.4.3. The possibility of inflation of Type I errors due to multiple comparisons was controlled with Sidak or Bonferroni corrections depending on the method of analysis, i.e., parametric or non-parametric and α level of significance was adjusted to the number of pairwise comparisons drawn at each level of analysis. For presentation purposes, means and standard deviations are displayed to indicate central tendencies in data.

Table 5.1

Examples of Misspelled Words and Morphemes in English and Greek

	English		Greek	
Error Category	Error	Correct Spelling	Error	Correct Spelling
P-OM	“acesdent”	“accident”	“μπριγκήπησα”	“πριγκίπισσα”
PT	/ækɪsdənt/	/æksɪdənt/	/brigipisa:/	/prigipisa:/
PP-OM	“appels”	“apples”	“κάικε”	“κάηκε”
PT	/æpəlz/	/æpəlz/	/kai:ke/	/kai:ke/
PP-Non-Affixed	“tuf”	“tough”	“έπιτα”	“έπειτα”
PT	/tʌf/	/tʌf/	/epita:/	/epita:/
PP-Affixed	“finely”	“finally”	“γελόντας”	“γελώντας”
PT	/faɪnəlɪ/	/faɪnəlɪ/	/ɟelonta:s/	/ɟelonta:s/
PP-Stem	“berning”	“burning”	“φονές”	“φωνές”
PT	/bɜ:nɪŋ/	/bɜ:nɪŋ/	/fones/	/fones/
PP-Derivational Suffix	“horiball”	“horrible”	“δανικό”	“δανεικό”
PT	/hɒrəbəl/	/hɒrəbəl/	/ðaniko/	/ðaniko/
PP-Inflectional Suffix	“leavs”	“leaves”	“ειδήσης”	“ειδήσεις”
PT	/li:vz/	/li:vz/	/iðisis/	/iðisis/

Note. P-OM = Phonologically-Orthographically Misspelled; PP-OM=Phonologically Plausible-Orthographically Misspelled; PP- = Phonologically Plausible; PT = Phonemic Transcription

5.5 Results

In order to answer the research questions of the present study, it was essential to investigate whether similar profiles emerged from the spelling performance of consecutive year groups in England and in Greece. The cross-linguistic comparisons that are presented in the next sections aimed to reveal any similarities and differences between the profiles of the two language samples in relation to the gradual acquisition of spelling skills at four levels of analysis of their spelling errors. Since spelling performance might depend on years of schooling, a first series of analyses was performed across language samples matched in years of schooling. Because children in the two countries had started school in different ages there was a significant age discrepancy between children attending the same year in England and Greece. Hence, the results of the first comparisons were verified by additional analyses matching the language samples in age in months to ensure that any effect of language was not due to the age discrepancy.

5.5.1 Comparisons between English and Greek children matched in years of schooling

A. Examination of overall misspelled words

In order to investigate the overall spelling performance for each year group, the total number of misspelled words for each participant was recorded. The data were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of parametric tests were verified with non-parametric tests. When the results produced by the latter were different, they are presented in brackets following the results of the ANOVAs.

To explore significant differences in the spelling performance of children attending different years, their error rates were compared with a two-way Analysis of Variance (ANOVA). The dependent variable was the total number of words misspelled in the single word spelling task. Year group membership (Year 3/Grade 3, Year 4/Grade 4, Year 5/Grade 5 and Year 6/Grade 6) and language group (English, Greek) were entered as between-participants variables. To control for inflation of Type I errors due to multiple comparisons, Sidak correction was applied. The results of the parametric analysis were verified with non-parametric tests. Descriptive statistics are presented in Table 5.2 and Figure 5.1, pp. 141-142.

The analysis showed a significant effect of year group membership on spelling performance (F (3, 205) = 35.27, p < .001, η_p^2=.34), but the effect of language was not significant (F (1, 205) = 0.79, p = .375, η_p^2=.00). The interaction between year group and language group was marginally significant (F (3, 205) = 2.24, p = .084, η_p^2=.03). Marginal significance of the interaction effect could possibly indicate that the effect of year might not have been consistent across languages. To explore this possibility further one-way univariate ANOVAs were performed to investigate the simple effect of year group for a) English and b) Greek samples.

English data. The analysis of the English data showed a significant main effect of year group on the number of misspelled words (F (3, 97) = 16.72, p < .001, η_p^2=.34). Post hoc pairwise comparisons were performed to explore differences between year groups. Results showed that Y3 and Y4 pupils did not differ significantly in number of misspelled words (p = .985). Both Y3 and Y4 children misspelled significantly more words than Y5 and Y6 pupils (all p values < .005). Finally, Y5 pupils misspelled significantly more words than Y6 children (p = .031).

Greek data. The analysis of the Greek data showed a significant main effect of year group on the number of misspelled words (F (3, 108) = 22.54, p < .001, η_p^2=.38). Post hoc pairwise comparisons showed that G3 children misspelled significantly more words than all other year groups (all p values < .001). The performance of G4 and G5 children was not significantly different (p =.074; but Bonferroni corrected Mann-Whitney U at α = .025 showed that G4>G5; U = 240.00, z = -2.78, p = .006). G4 pupils made significantly more errors than G6 children (p = .011). Finally, G5 and G6 children did not differ significantly in the number of misspelled words (p = .909).

Table 5.2

Means and Standard Deviations of Misspelled Words per Group of Participants per Language in the Single Word Spelling Task

	English								Greek							
	Y3 (N=25)		Y4 (N=24)		Y5 (N=29)		Y6 (N=23)		G3 (N=31)		G4 (N=24)		G5 (N=35)		G6 (N=22)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Misspelled Words	29.8	(12.0)	27.7	(12.9)	18.5	(11.7)	9.7	(5.3)	30.5	(9.1)	21.4	(8.0)	15.6	(8.6)	13.2	(8.9)
P-OM	13.0	(8.3)	10.9	(6.6)	7.6	(5.5)	3.7	(2.5)	2.2	(2.7)	1.3	(1.1)	0.7	(0.9)	0.7	(0.7)
PP-OM	16.8	(7.1)	16.7	(7.8)	10.9	(7.8)	6.0	(3.7)	28.2	(7.8)	20.0	(7.6)	14.8	(8.0)	12.5	(8.6)

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

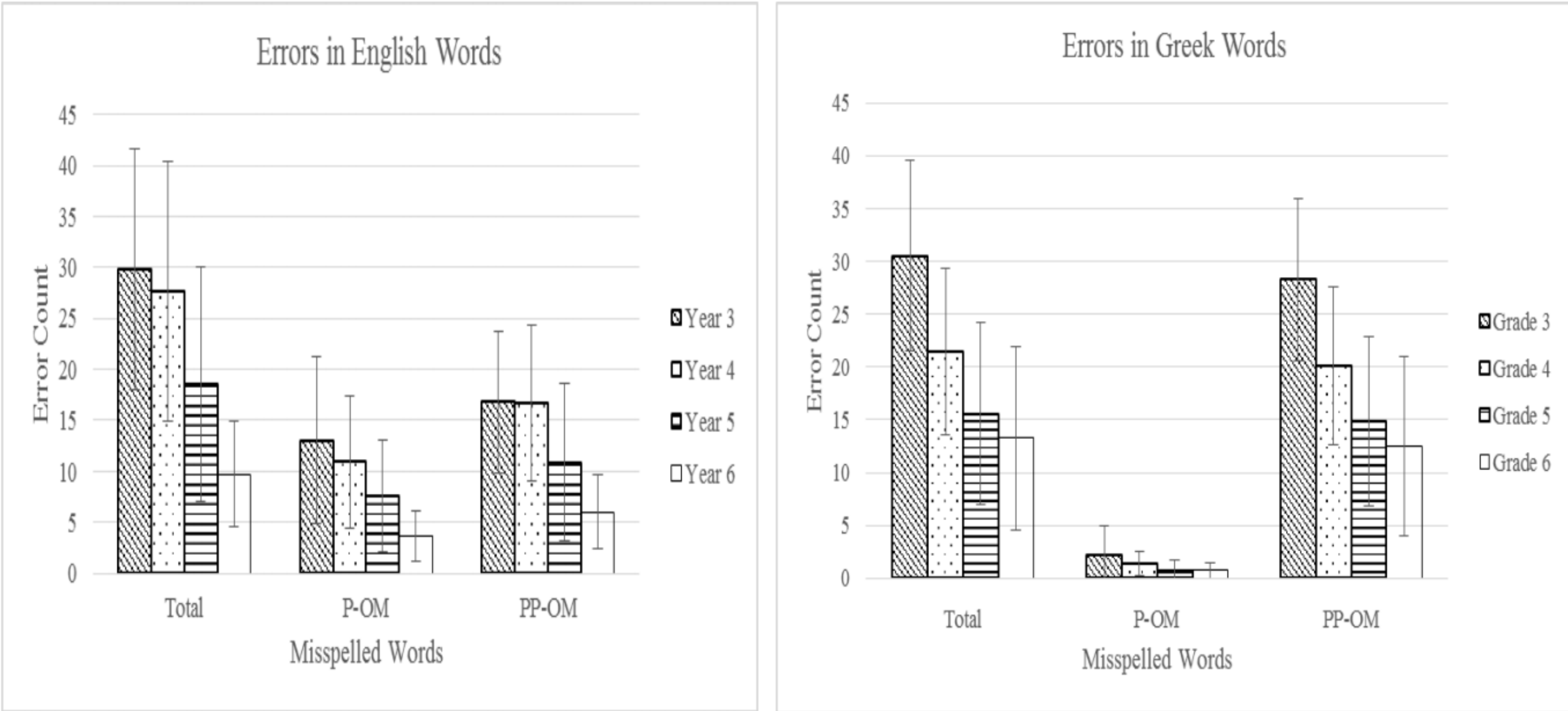


Figure 5.1

Means and Standard Deviations of Misspelled Words per Language Group (English, Greek).

Note. P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

To summarise, English children in the first two years did not differ in terms of overall misspelled words while Greek children in the corresponding grades differed significantly. The reverse pattern was revealed for English pupils in Y5, who made significantly more errors than Y6, in contrast with their Greek peers in the last two grades, who did not differ significantly.

B. Comparisons of phonologically misspelled and orthographically misspelled words

One of the aims of the study was to investigate the patterns of acquisition of different types of knowledge (phonological, morphological and orthographic) when spelling. For this purpose, misspelled words were categorised in two groups, namely phonologically misspelled and orthographically misspelled. As outlined in chapter 4, section 4.4.2, the first category included all misspelled words which contained a phonological error. This error, which could be an omission, addition or substitution of at least one grapheme, resulted not only in altering the phonological identity of the word but also affecting its visual form. Additionally, in some cases a phonological error in one part of a word was combined with a phonologically plausible orthographic misspelling in another part (e.g., <ritted> for WRITTEN, <heled> for HEATED, <hevest> for HEAVIEST). Hence, this category was named phonologically-orthographically misspelled (P-OM) words to take into account possible co-occurrence of a phonological and an orthographic misspelling in the same word. The remaining misspelled words, in which the phonological identity was preserved and only the visual form was affected, were subsumed under the second category, named phonologically plausible-orthographically misspelled (PP-OM) words. Examples of the misspelled words under each error category are presented in Table 5.1, p. 138. The data in both error categories were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis and results of the parametric analyses were verified with non-parametric tests.

A three-way mixed design ANOVA was performed to investigate differences between year groups and language groups as well as to compare their spelling performance on the two error categories. Since all the participants were required to spell the same number of items, the integers representing the number of errors in each category, i.e., P-OM words and PP-OM words, were entered as a within-subjects variable (error category). Year group membership (Y3/G3, Y4/G4, Y5/G5, Y6/G6) and language group (English, Greek) were entered as between-participants variables. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in, Table 5.2 and Figure 5.1, pp. 141-142.

The results showed a significant difference between the two error categories (F (1, 205) = 436.13, p <.001, η_p^2=.68) and a significant main effect of year group on spelling (F (3, 205) = 35.27, p <.001, η_p^2=.34) but the main effect of language was not significant (F (1, 205) = 0.77, p =.378, η_p^2=.00). A significant three-way interaction between error categories, year group and language group was evident (F (3, 205) = 8.17, p <.001, η_p^2=.10). In addition, there was a significant interaction between error categories and year group (F (3, 205) = 11.77, p <.001, η_p^2=.14), as well as between error categories and language group (F (1, 205) = 183.18, p <.001, η_p^2=.47). However, the interaction between year group and language group was not significant (F (3, 205) = 2.22, p =.086, η_p^2=.03).The significant interaction between error category, year group and language group was explored. To investigate the simple interaction between error category and year group on each level of language, a two-way mixed design ANOVA was performed for each language group separately.

English data. The analysis with regard to English data showed a significant main effect of error category (F (1, 97) = 28.34, p <.001, η_p^2=.22) indicating that words containing phonological errors were fewer than phonologically plausible-orthographically misspelled words. A significant main effect of year group membership was also detected (F (3, 97) = 16.70, p <.001, η_p^2=.34). The interaction between error category and year group was not significant (F (3, 97) = .99, p = .398, η_p^2=.03).

Greek data. The analysis of Greek data showed a significant main effect of error category (F (1, 108) = 573.38, p <.001, η_p^2=.84), a significant main effect of year group membership (F (3, 108) = 22.54, p <.001, η_p^2=.38), as well as a significant interaction between error category and year group (F (3, 108) = 19.14, p < .001, η_p^2=.34). To investigate the error category by year interaction, the simple effect of year group on each error category was explored with one-way univariate ANOVAs. The results on P-OM words indicated a significant effect of year group membership (F (3, 108) = 5.51, p < .005, η_p^2=.13). Sidak corrected post hoc pairwise comparisons showed that children in G3 and G4 did not differ significantly in their P-OM error rates (p = .291). However, G3 children made significantly more errors than older pupils attending G5 and G6 (p = .002 and p = .009 respectively). On the other hand, the P-OM error rates of pupils in G4, G5 and G6 did not differ significantly (all p values > .05). As concerns the PP-OM errors, the analysis showed a significant effect of year group membership (F (3, 108) = 21.73, p < .001, η_p^2=.37). Post hoc pairwise comparisons showed that G3 pupils made significantly more errors than G4 (p = .002), G5 and 6 (both p values < .001). The error rates of pupils in G4 and G5 did not differ significantly (p = .091), but the first made significantly more errors than G6 (p = .012). Finally, the PP-OM error rates of G5 and G6 did not differ significantly (p = .875).

Therefore, the source of error category by year interaction seems to be that despite all Greek year groups making consistently fewer phonological-orthographic errors than phonologically plausible-orthographic errors, children reached a plateau in phonological spelling by G4 while the phonologically plausible-orthographic error rates continued to decrease until the last two grades of primary school. In contrast, the lack of error category and year group interaction in the English results signified that the difference between phonological-orthographic errors and phonologically plausible-orthographic errors was consistent for children attending all year groups and that differences between consecutive year groups were comparable for the two error categories.

C. Comparisons of errors occurring in non-affixed and affixed words

To examine the extent to which morphological complexity might influence the spelling performance of younger and older typically developing children, the dictated words were categorised as either monomorphemic (non-affixed) or polymorphemic (affixed) words. Three of the 60 dictated words included prefixes (see Appendix A). Since the number of items did not provide enough opportunities to examine the spelling of prefixes, these words were excluded from the analyses. Because word-frequency and length might be factors influencing spelling performance (e.g., Alegria & Mousty, 1996; Deacon & Leung, 2013; Tainturier, Bosse, Roberts, Valdois, & Rapp, 2013), the frequency levels and the length of the remaining words (see Appendix A) were taken into account. As detailed in chapter 4, section 4.3.3.2, two databases were used to extract the frequency counts for each word in the list. The ratio $\frac{Frequency\ Count}{Total\ Stimuli\ in\ the\ Dataset}$ was calculated and converted into a percentage corresponding to the frequency level of the specific word in each database. The two percentages corresponding to each word were averaged across the datasets to produce the frequency level for each word in the list. The mean frequency (i.e., mean percentage) and length (i.e., mean number of letters) of non-affixed and affixed words were compared with independent samples *t* tests. The results with regard to English words showed that the frequency levels of non-affixed (M = 0.02, SD = 0.03) and affixed (M = 0.02, SD = 0.14) words were not significantly different ($t(55)= -0.19$, $p > .05$). The analysis of the mean number of letters per word category showed that non-affixed words (M letters= 6.11, SD = 1.66) had on average 1 letter less than affixed words (M letters= 7.16, SD = 1.66; *Mean Difference* = 1.05; $t(55)= -2.24$, $p < .05$). The results with regard to Greek words showed that non-affixed (M = 0.01, SD = 0.01) and affixed (M = 0.01, SD = 0.03) words did not differ significantly in mean percentages of frequency ($t(55)= .11$, $p > .05$). The analysis of the mean number of letters per word category showed that non-affixed words (M letters= 7.00, SD = 1.58) did not differ significantly from affixed words (M letters= 7.60, SD = 2.54; $t(55)= -.68$, $p > .05$). In order to focus on the application of orthographic and morphological skills when spelling, only the phonologically plausibly misspelled words were subsumed under each error category. Examples of the errors are presented in Table 5.1, p. 138. Because the number of the dictated non-affixed and affixed words was not equal, proportions of errors were used in the analyses. The proportions were calculated based on the total number of dictated words belonging to each category. The data in both error categories were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis and the results were verified with non-parametric tests.

Table 5.3

Means and Standard Deviations of Percentages of Misspelled Non-Affixed and Affixed Words per Group of Participants per language in the Single Word Spelling Task

	English								Greek							
	Y3 (N=25)		Y4 (N=24)		Y5 (N=29)		Y6 (N=23)		G3 (N=31)		G4 (N=24)		G5 (N=35)		G6 (N=22)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Non-Affixed Words	21.8	(14.1)	22.1	(15.0)	15.9	(14.7)	5.5	(5.6)	32.2	(14.1)	27.3	(16.3)	15.8	(13.8)	16.1	(13.5)
Affixed Words	29.7	(12.5)	28.9	(13.3)	17.5	(12.7)	10.3	(7.4)	48.0	(14.2)	32.9	(12.7)	24.9	(14.1)	20.9	(14.2)

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6. Percentages of Misspelled Words are presented for ease of interpretation. Percentage of Misspelled Words = $\frac{\text{Misspelled Words}}{\text{Total Dictated Words}}$ x 100.

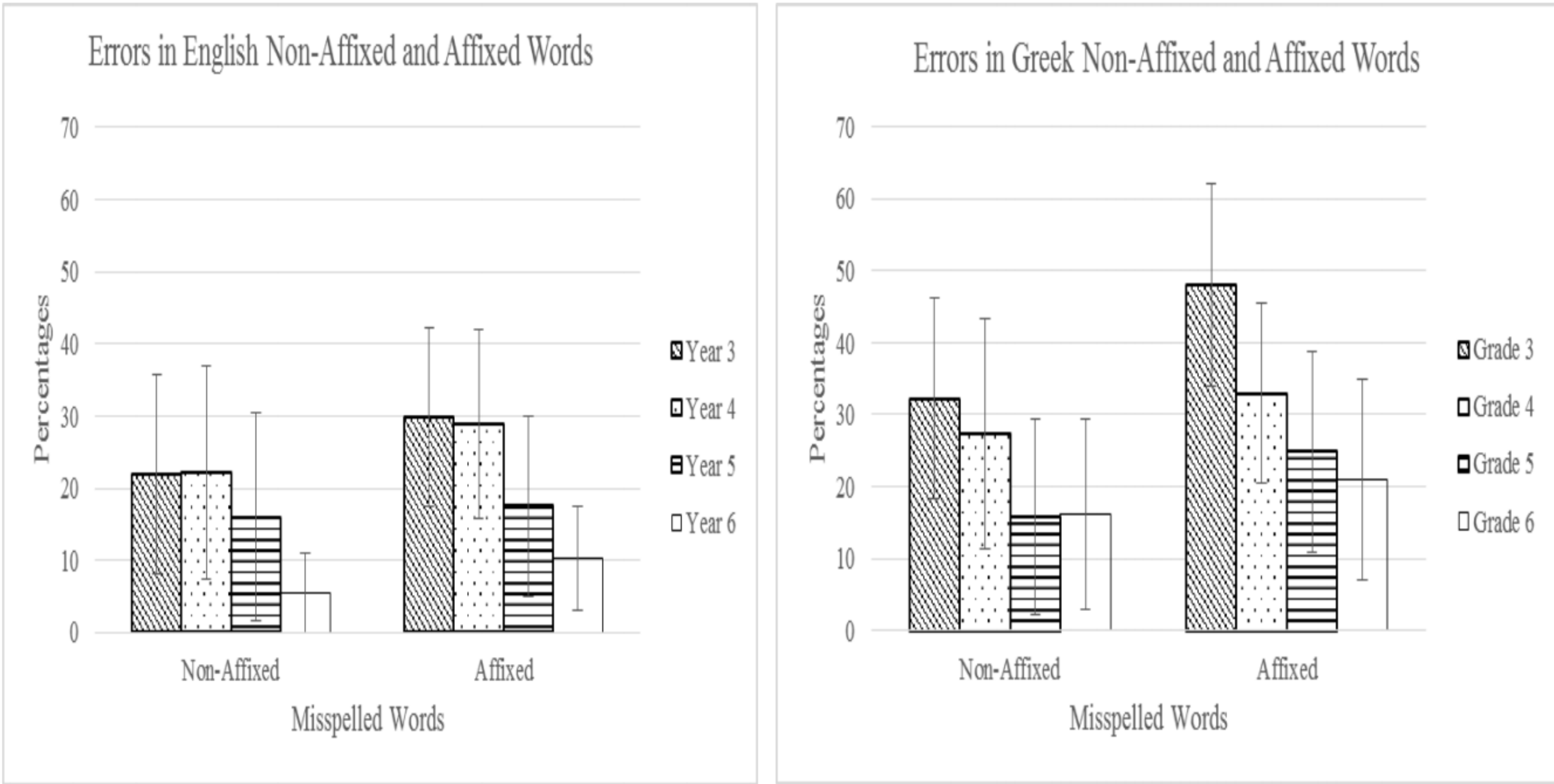


Figure 5.2

Means and Standard Deviations of Percentages of Misspelled Non-Affixed and Affixed Words per Language Group (English, Greek)

Proportions of errors in non-affixed and affixed words were entered as a within-subjects variable (word type) in a three-way mixed design ANOVA. Year group membership (Y3/G3, Y4/G4, Y5/G5, Y6/G6) and language group (English, Greek) were entered as between-participants variables. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in Table 5.3 and Figure 5.2 p. 147-148.

The results showed that higher error rates occurred in affixed words than in non-affixed words (F (1, 205) = 94.90, p <.001, η_p^2=.31). There was also a significant main effect of year group on spelling (F (3, 205) = 26.58, p <.001, η_p^2=.28) and a significant main effect of language (F (1, 205) = 23.49, p <.001, η_p^2=.10). There was a significant three-way interaction between word types, year group and language group (F (3, 205) = 2.77, p =.042, η_p^2=.04), a significant interaction between word types and year group (F (3, 205) = 5.29, p =.002, η_p^2=.07), as well as between word types and language group (F (1, 205) = 6.07, p =.015, η_p^2=.03). However, the interaction between year group and language group was not significant (F (3, 205) = 2.32, p =.076, η_p^2=.03). The significant interaction between word types, year group and language group was further explored. To investigate the simple interaction between word type and year group on each level of language, a two-way mixed design ANOVA was performed for each language group separately.

English data. Proportions of errors in the English non-affixed and affixed words were entered as a within-subjects variable and year group membership (Y3, Y4, Y5, Y6) as a between-participants variable. The analysis produced a significant main effect of word type (F (1, 97) = 37.34, p <.001, η_p^2=.27) and of year group membership (F (3, 97) = 12.49, p <.001, η_p^2=.28), as well as a significant interaction between word type and year group (F (3, 97) = 2.84, p < .05, η_p^2=.08). To further investigate the interaction, the simple effect of year group on each level of word type was investigated with one-way univariate ANOVAs. The results for non-affixed words indicated a significant effect of year group (F (3, 97) = 8.27, p < .001, η_p^2=.20). Post hoc pairwise comparisons showed that the error rates of children in Y3, Y4 and Y5 did not differ significantly (all p values > .05). However, pupils in these groups made significantly more errors than children in Y6 (Y3, Y4 > Y6, p < .001 and Y5 > Y6, p = .031). The analysis of affixed words showed a significant effect of year group (F (3, 97) = 15.14, p < .001, η_p^2=.32). Post hoc pairwise comparisons revealed that the error rates of Y3 and Y4 were not significantly different (p = 1.00), while both groups produced significantly more errors than pupils in Y5 and Y6 (all p values < .005). Finally, the errors of children in the last two years of primary school did not differ significantly (p =.176).

Greek data. The analysis of Greek data produced a significant main effect of word type (F (1, 108) = 60.27, p <.001, η_p^2=.35) indicating that higher error rates occurred in affixed than in non-affixed words. A significant main effect of year group membership (F (3, 108) = 17.39, p <.001, η_p^2=.32) as well as a significant interaction between word type and year group were found (F (3, 108) = 4.95, p =.005, η_p^2=.12). The word type by year group interaction was investigated by exploring the simple effect of year on each level of word type. The results of the one-way univariate ANOVA for non-affixed words indicated a significant effect of year group (F (3, 108) = 9.43, p < .001, η_p^2=.20). Sidak corrected post hoc pairwise comparisons showed that the error rates of children in G3 and G4 did not differ significantly (p =.759). However, the errors of G3 were higher than those of G5 and G6 (both p values < .001). In addition, the error rates of children in G4 were significantly higher than those of children in G5 (p = .021), while the difference between G4 and G6 as well as between G5 and G6 was not significant (both p values > .05). The analysis of affixed words showed a significant effect of year group (F (3, 108) = 21.51, p < .001, η_p^2=.37). Post hoc pairwise comparisons revealed that the error rates of G3 were significantly higher than those of all older year groups (all p values < .001). The numbers of errors produced by children in G4 were significantly higher than those of G6 (p = .024). Finally, the errors of children in G5 did not differ significantly from those of G4 and G6 (both p values > .05).

Therefore, the source of word type by year by language interaction seems to lie in that in both languages non-affixed and affixed words were acquired in a different pace by consecutive year groups. It appears that in English children showed a significant progress in non-affixed words after Y5 and in Greek after G4. A similar progress in affixed words was evident after Y4 in English and G3 in Greek while children in the last two grades in both countries appeared to have developed a stable performance in both word types. These results indicate that the pattern of acquisition is similar in the two language groups but it commenced earlier for the Greek than for the English children. However, the Greek pupils were older than the English children attending corresponding grades, which might be the reason for the earlier start in the decrease of errors.

D. Comparisons of errors occurring in different morphemes

Since the above analysis revealed that morphological complexity played a role in spelling performance, misspellings in polymorphemic words were further explored to reveal possible differences between the error rates attracted by their component morphemes. Affixed words were divided into stems and suffixes, the latter of which included two sub-categories, i.e., derivational and inflectional. To disentangle the ability to apply phonological knowledge from proficiency to employ morphological and orthographic information, only phonologically plausible misspellings were included in the analysis. Examples of errors are displayed in Table 5.1, p. 138. Since the English and Greek word lists were matched for whole items but not for morphemes, analysis focused on errors occurring within the same language group (i.e., English or Greek) but comparisons across languages were not performed. Because the number of morphemes was not equal across categories, proportions of errors were used in the analyses. The proportions were calculated by dividing the number of misspelled morphemes by the total number of dictated morphemes (i.e., $\frac{errors\ in\ stems}{total\ dictated\ stems}$, $\frac{errors\ in\ derivations}{total\ dictated\ derivations}$, $\frac{errors\ in\ inflections}{total\ dictated\ inflections}$). The data in all error categories were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests. When the results produced by the latter were different, they are presented in brackets following the results of the ANOVAs.

Table 5.4

Means and Standard Deviations of Percentages of Misspellings in Morphemes per Group of Participants per Language in the Single Word Spelling Task

	English								Greek							
	Y3 (N=25)		Y4 (N=24)		Y5 (N=29)		Y6 (N=23)		G3 (N=31)		G4 (N=24)		G5 (N=35)		G6 (N=22)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	32.4	(14.4)	30.9	(14.7)	19.9	(15.7)	9.9	(6.7)	41.8	(14.5)	26.6	(10.1)	19.6	(11.5)	16.1	(11.0)
Derivational Suffixes	26.0	(17.3)	26.7	(17.0)	17.9	(15.3)	9.0	(8.1)	19.2	(9.9)	9.3	(7.0)	8.0	(6.8)	6.9	(5.6)
Inflectional Suffixes	15.5	(7.7)	12.6	(12.0)	5.4	(6.5)	3.2	(3.5)	9.8	(4.7)	7.9	(5.7)	5.8	(5.2)	4.2	(5.0)

Note. Y3= Year 3; Y4= Year 4, Y5= Year 5; Y6= Year 6; G3=Grade 3; G4=Grade 4; G5= Grade 5; G6=Grade 6. Percentages of Misspelled Morphemes are presented for ease of interpretation. Percentage of Misspelled Morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Misspelled Morphemes}}$ x 100.

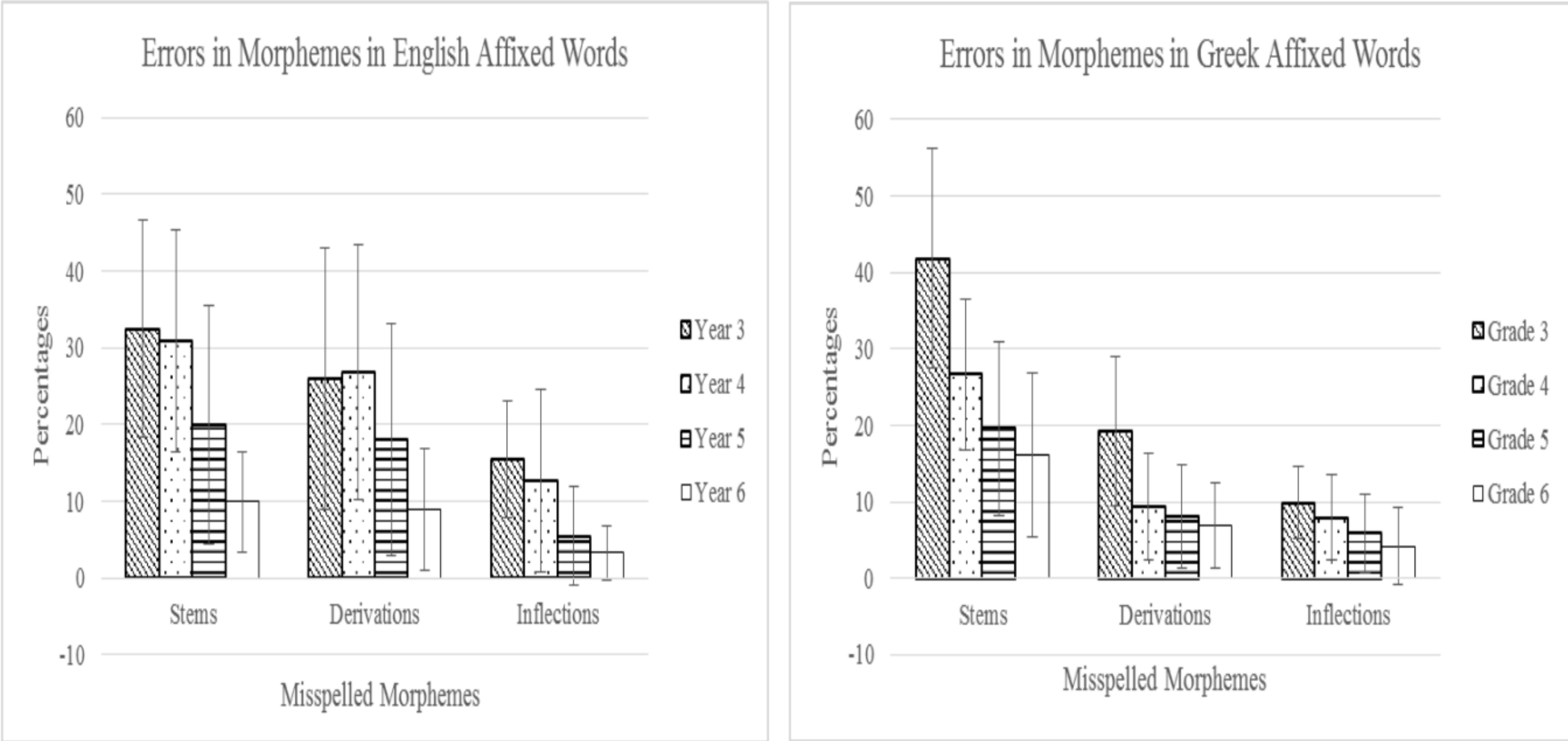


Figure 5.3

Means and Standard Deviations of Percentages of Misspelled Morphemes per Language Group (English, Greek)

English data. A two-way mixed design ANOVA was employed. Proportions of errors in stems, derivations and inflections were entered as a within-subjects variable (morphemes) and year group membership (Y3, Y4, Y5, Y6) as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. Descriptive statistics are presented in Table 5.4 and Figure 5.3, pp. 152-153. A Mauchly's test of sphericity indicated that the assumption of sphericity for morphemes had been violated ($\chi^2(2) = 14.42$, $p < .001$). Therefore, for all effects of morphemes, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .920$). The analysis showed a significant main effect of morphemes (F (1.84, 178.49) = 92.57, p <.001, η_p^2=.48) and a main effect of year group membership (F (3, 97) = 13.19, p <.001, η_p^2=.29). Furthermore, there was a significant interaction between morphemes and year group membership (F (5.52, 178.49) = 3.08, p = .008, η_p^2= .08). This signified that the performance of younger and older children was not consistent across morphemes.

To explore the simple effect of morphemes on each level of year group, one-way repeated-measures ANOVAs were performed. Mauchly's test for Y3 showed that the data complied with the assumption of sphericity for morphemes ($\chi^2(2) = 4.71$, $p > .05$). The results regarding year 3 data showed a significant main effect of morphemes (F (2, 48) = 25.34, p < .001, η_p^2= .51). Post hoc pairwise comparisons showed that children misspelled stems more frequently than derivational suffixes (p = .009) and much more frequently that inflectional suffixes (p < .001). Within suffixes, errors in derivations were more frequent than in inflections (p = .003). Mauchly's test for year 4 showed that the data adhered to the assumption of sphericity for morphemes ($\chi^2(2) = 1.55$, $p > .05$). The performance of children in Y4 was also influenced by a significant effect of morphemes (F (2, 46) = 28.98, p < .001, η_p^2= .55). Post hoc pairwise comparisons showed that the difference between errors in the stems and in the derivational suffixes was not significant (p = .252), while error rates in both these morphemes were significantly more frequent than in the inflectional suffixes (both p values < .001). Mauchly's test for Y5 showed a violation of the assumption of sphericity for morphemes ($\chi^2(2) = 9.74$, $p = .008$). Hence, for the effect of morphemes degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .803$). The analysis showed a significant main effect of morphemes (F (1.60, 44.98) = 30.63, p < .001, η_p^2= .52). Post hoc pairwise comparisons revealed that following a similar pattern as Y4s, the error rates of Y5 pupils in stems and derivational suffixes were not significantly different (p = .400). Additionally, inflectional suffixes were misspelled significantly less frequently than both aforementioned morphemes (both p values < .001). Finally, Mauchly's test for Y6 showed that the assumption of sphericity had not been violated for morphemes ($\chi^2(2) = 2.56$, $p > .05$). The results showed a significant main effect of morphemes (F (2, 44) = 11.52, $p < .001$, η_p^2= .34). Post hoc pairwise comparisons showed that in accordance with Y4 and Y5, the errors of children in Y6 in stems and derivational suffixes did not differ significantly (p = .887), but both these morphemes attracted higher error rates than inflectional suffixes ($p < .001$ and p = .010 respectively).

To investigate the pattern of acquisition of different morphemes, the simple effect of year group membership on the error rates in stems, derivations and inflections was explored. The one-way ANOVA on the errors occurring in the stems showed a significant effect of year group (F (3, 97) = 14.19, $p < .001$, η_p^2= .30). Sidak corrected post hoc pairwise comparisons showed that Y3 and Y4 children did not perform significantly differently when spelling the stems (p = .999). On the other hand, Y3 pupils misspelled significantly more stems than Y5 and Y6 (p = .007 and $p < .001$ respectively). A significant difference was also detected between the performance of Y4 in comparison to Y5 and Y6 (p = .026 and $p < .001$ respectively). However, the error rates produced by pupils in the two final years did not differ significantly (p = .058), although the p value was only slightly above the threshold of .05.

As concerns the suffixes, the analysis of the misspellings in derivational suffixes showed a significant effect of year group membership (F (3, 97) = 7.27, $p < .001$, η_p^2= .18). Post hoc pairwise comparisons showed that the difference in the error rates produced by children in Y3, Y4 and Y5 was not significant (all p values > .05). Additionally, there was no significant difference between the errors made by pupils in Y5 and Y6 ($p > .05$). On the contrary, Y6 pupils made significantly fewer errors than Y3 and Y4 (both p values < .001).The analysis of inflectional suffixes showed a main effect of year group membership (F (3, 97) = 12.85, $p < .001$, η_p^2= .28). Post hoc pairwise comparisons revealed that following a similar pattern as in the stems, Y3 and Y4 children did not perform significantly differently when spelling the inflections of the words (p = .779). However, Y3 pupils misspelled significantly more inflections than Y5 and Y6 (both p values < .001). A significant difference was also found between the performance of Y4 in comparison to

Y5 (p = .010; but Bonferroni corrected Mann-Whitney U at α = .0083 showed that Y4=Y5; U = 217.00, z = -2.40, p = .016) and between Y4 and Y6 (p < .001). Finally, the error rates produced by pupils in the two final years did not differ significantly (p = .910).

Therefore, it seems that children of all ages were least likely to misspell inflectional suffixes, and that the difference between stems and derivational suffixes was more profound for the youngest year group than for the rest three groups of children, which might be one source of the morphemes by year interaction. Another source might lie in the different pattern of acquisition of the three morphemes. Only younger children (Y3, Y4) appeared to perform at similar levels regarding the pace of acquisition of all morphemes. For all other year groups the pace of acquisition was different for each morpheme. Specifically, the error rates in stems decreased significantly from Y4 onwards, while the errors in derivational suffixes did not drop significantly before Y6 and in inflectional suffixes before Y5. A stable performance was evident as concerns the spelling of inflections in the last two years of schooling.

Greek data. A two-way mixed design ANOVA was employed to investigate the spelling performance of Greek children in the component morphemes of affixed words. Proportions of errors in stems, derivations and inflections were subjected to the analysis as a within-subjects variable (morphemes) and year group membership (G3, G4, G5 G 6) was a between-participants variable. Sidak corrections controlled for inflation of Type I errors. The results of the parametric analyses were verified with non-parametric tests. When the results produced by the latter were different, they are presented in brackets following the results of the ANOVAs. Examples of errors are displayed in Table 5.1, p. 138, and descriptive statistics are presented in Table 5.4 and Figure 5.3, pp. 152-153.

Mauchly's test on Greek data indicated that the assumption of sphericity for morphemes had been violated ($\chi^2(2)$ = 17.88, p < .001), therefore, for effects of morphemes, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .904). The analysis showed a significant main effect of morphemes (F (1.80, 195.25) = 255.97, p <.001, η_p^2=.70) and a main effect of year group membership (F (3, 108) = 24.48, p <.001, η_p^2=.40). There was a significant interaction between morphemes and year group membership (F (5.42, 195.25) = 14.76, p < .001, η_p^2= .29) implying an effect of year group on morphemes.

To investigate the simple effect of morphemes on each level of year group, one-way repeated-measures ANOVAs were performed. Mauchly's test for G3 showed that the data complied with the assumption of sphericity for morphemes ($\chi^2(2) = 3.28$, $p > .05$). The results on G3 data revealed a significant main effect of morphemes (F (2, 60) = 121.20, $p < .001$, $\eta_p^2 = .80$). Post hoc pairwise comparisons showed that children misspelled the stems more frequently than the derivational and the inflectional suffixes (both p values < .001), while errors in derivations were more frequent than in inflections ($p < .001$). Mauchly's test for G4 showed that the data adhered to the assumption of sphericity for morphemes ($\chi^2(2) = .83$, $p > .05$). There was a significant effect of morphemes on the performance of children in grade 4 (F (2, 46) = 74.53, $p < .001$, $\eta_p^2 = .76$). Post hoc pairwise comparisons showed that stems were misspelled more frequently than derivational and inflectional suffixes (both p values < .001), but the difference between errors in the derivational and the inflectional suffixes was not significant ($p = .756$). Mauchly's test for G5 showed a violation of the assumption of sphericity for morphemes ($\chi^2(2) = 9.88$, $p = .007$). Hence, for the effect of morphemes degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .827$). The analysis revealed a significant main effect of morphemes (F (1.65, 56.23) = 60.07, $p < .001$, $\eta_p^2 = .63$). Post hoc pairwise comparisons indicated that following a similar pattern as G4s, the error rates of pupils in G5 were higher in the stems than in derivational and inflectional suffixes (both p values < .001), but the difference between errors in the derivational and the inflectional suffixes was not significant ($p = .087$). Finally, Mauchly's test for G6 showed that the assumption of sphericity had been violated for morphemes ($\chi^2(2) = 12.22$, $p = .002$). Hence, for the effect of morphemes degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .718$). The analysis produced a significant main effect of morphemes (F (1.43, 30.16) = 26.58, $p < .001$, $\eta_p^2 = .56$). Post hoc pairwise comparisons showed that in accordance with G3, G 6 children made more errors in the stems than in derivational and inflectional suffixes (both p values < .001), while errors in derivations were more frequent than in inflections (p =.034; but Bonferroni corrected Wilcoxon Signed Ranks test at α = .0167 showed that derivations=inflections; $T = 7$, $z = -2.24$, $p = .022$).

To explore the pace of acquisition of different morphemes, the simple effect of year group membership on the error rates in each morpheme was investigated. A one-way univariate ANOVA with regard to the errors occurring in the stems showed a significant effect of year group (F (3, 108) = 25.61, $p < .001$, $\eta_p^2 = .41$). Post hoc pairwise comparisons showed that pupils in G3 made significantly more errors than all other year groups (all p values < .001). A significant difference was also detected between the performance of G4 in comparison to G6 (p = .025), but not to grade 5 (p = .172; but Bonferroni corrected Mann-Whitney U at α = .0083 showed that G4>G5; U = 228.50, z = -2.96, p = .003). The error rates produced by pupils in the two final years did not differ significantly (p > .879).

Regarding suffixes, the analysis of the misspellings in derivations showed a significant effect of year group membership (F (3, 108) = 15.95, p < .001, η_p^2= .30). Post hoc pairwise comparisons showed that children in G3 produced significantly more errors than all older pupils in (all p values < .001). However, the difference in the error rates of children in G4, G5 and G6 was not significant (all p values > .05). The analysis of inflectional suffixes showed a main effect of year group membership (F (3, 108) = 5.99, p < .005, η_p^2= .14). Post hoc pairwise comparisons revealed that G3 and G4 children did not perform significantly differently when spelling the inflections of the words (p = .695). However, G3 pupils misspelled significantly more inflections than children in G5 and G6 (p = .014 and p = .001 respectively). On the other hand, following a similar pattern as in derivations, the error rates produced in inflections by pupils in G4, G5 and G6 did not differ significantly (p > .05).

Therefore, one source of the morpheme by year interaction might lie in the fact that the performance of the Greek pupils attending the final three grades was different when errors in the stems and the suffixes were compared, but not when derivational versus inflectional suffixes were examined. This pattern differentiates them from the youngest pupils of the sample, who made significantly more errors in the derivations than in the inflections of the words. In addition, the interaction could be explained by the differences in the pace of acquisition of the three morphemes. Specifically, no significant decrease was detected in derivations and inflections for older children attending G4-G6. In contrast, a significant drop was observed in the error rates produced by pupils attending the first three grades under examination in the stems of the affixed words.

5.5.2 Comparisons between English and Greek children matched in age

Because children in Greece start school at a younger age than children in England, at the time of the study Greek pupils were older than their English peers of comparable grade. Because spelling ability might depend on age (Goulandris, 2003) as well as on schooling years (e.g., Cunningham & Carroll, 2011), the results of the cross-linguistic comparisons were verified by a second set of analyses, in which the children were matched in age in months, to ensure that any detected effect of language was not a product of the age discrepancy. For this purpose, English and Greek year groups were matched in age (i.e., English Y4 versus Greek G3, Y5 versus G4, and Y6 versus G5). This matching resulted in excluding the youngest year group of the English sample and the oldest group of the Greek sample. A new variable with three levels was created. The new variable was called "age groups" and the levels were "younger", "middle" and "older". The characteristics of the pupils are detailed in chapter 4, sections 4.3.1-4.3.2. Since the main effects of error category and year group were explored in the analyses performed for each language group separately, the comparisons employing age matching focused on exploring the main effect of language. Investigating the interaction between language and age group was also of interest because English children had experienced an additional year of schooling in comparison to their Greek peers of the same age, which might have influenced their spelling performance.

A. Examination of overall misspelled words

The overall number of misspelled words was subjected to a two-way ANOVA to investigate the effect of language (English, Greek) on error rates. Language (English, Greek) and age group ("younger", "middle" and "older") were entered as between-subjects variables. Descriptive statistics are displayed in Table 5.2, p. 141 and Figure 5.1, p. 142. The analysis revealed a significant main effect of language (F (1, 160) = 6.61, p =.011, η_p^2= .04) indicating that Greek children misspelled overall more words than their English peers of the same age. A significant main effect of age group was also detected (F (2, 160) = 40.13, p < .001, η_p^2= .33). However, the language by age group interaction was not significant (F (2, 160) = .44, p =.641, η_p^2= .00) signifying that the effect of language was consistent across all three age groups.

B. Examination of phonologically misspelled and orthographically misspelled words

The number of phonologically-orthographically misspelled (P-OM) words were subjected to a two-way ANOVA. Language (English, Greek) and age group ("younger", "middle" and "older") were employed as between-subjects variables to investigate any language by age group interaction. Descriptive statistics are displayed in Table 5.2, p. 141 and Figure

5.1, p. 142. The analysis of P-OM words showed a significant main effect of language (F (1, 160) = 99.68, p < .001, η_p^2= .38) and of age group (F (2, 160) = 18.25 p < .001, η_p^2= .18). In addition, the interaction between language and age group was significant (F (2, 160) = 7.88, p < .001, η_p^2= .09). The simple effect of language on each level of age group was explored with one-way ANOVAs. The results showed that Greek speaking children made significantly fewer P-OM misspellings than their English peers consistently in the younger group (F (2, 160) = 43.80, p < .001, η_p^2= .45), middle group (F (2, 160) = 28.82, p < .001, η_p^2= .36) and older group (F (2, 160) = 39.96, p < .001, η_p^2= .41) despite the fact that Greek children had experienced a year less of schooling than English children.

The phonologically plausible-orthographically misspelled words (PP-OM) were analysed with a two-way ANOVA. Age group and language were entered as between-subjects variables. Descriptive statistics are displayed in Table 5.2, p. 141 and Figure 5.1, p. 142. The analysis produced a significant main effect of language (F (1, 160) = 71.43, p < .001, η_p^2= .30) indicating that Greek pupils made significantly more PP-OM errors than their English peers of the same age. A significant main effect of age group (F (2, 160) = 36.34, p < .001, η_p^2= .31) was also detected. However, the interaction between language and age group was not significant (F (2, 160) = .54, p = .582, η_p^2= .00), which illustrates that the effect of language was consistent across age groups.

C. <u>Examination of errors occurring in non-affixed and affixed words</u>

The proportions of errors made in non-affixed words were subjected to a two-way ANOVA. Age group and language were entered as between-subjects variables. Descriptive statistics are displayed in Table 5.3 and Figure 5.2 p. 147-148. The analysis showed a significant main effect of language (F (1, 160) = 23.82, p < .001, η_p^2= .13) indicating that Greek pupils made significantly more errors in non-affixed words than their English peers of the same age. A main effect of age group was also evident (F (2, 160) = 20.26, p < .001, η_p^2= .20). However, the interaction between language and age group was not significant (F (2, 160) = .02, p = .971, η_p^2 = .00) implying that the effect of language was consistent across all year groups.

A two-way ANOVA on proportions of errors in affixed words revealed a significant main effect of language (F (1, 160) = 65.98, p < .001, η_p^2= .29) showing that Greek pupils made significantly more errors in affixed words than their English peers of the same age. The main effect of age group was also significant (F (2, 160) = 36.91, $p < .001$, η_p^2= .31). However, the interaction between language and age group was not significant (F (2, 160) = .46, p = .630, η_p^2= .00), signifying that the effect of language was consistent across age groups.

5.5.3 Summary of results

In summary, the cross-linguistic comparisons showed that Greek children produced fewer phonological errors (P-OM) than their English peers. These results were consistent both in analyses comparing years of schooling (i.e., G3 versus Y3) and in analyses comparing age-matched groups (i.e., G3 versus Y4). On the other hand, both sets of comparisons showed that English children were better than their Greek peers in orthographic spelling of whole words, non-affixed and affixed words.

English pupils in all year groups made significantly fewer phonological errors than phonologically plausible orthographic errors. In addition, most year groups misspelled a larger proportion of affixed than non-affixed words, which shows a difficulty with polymorphemic items. Within affixed words, only Y3 pupils misspelled the stems more frequently than the derivations, and the derivations more frequently than the inflections. In all other years, the difference between the error rates in stems and derivations was not significant, whereas inflections were always spelled more accurately. As concerns spelling progress, the comparisons between English year groups revealed significant differences in the spelling performance of pupils in consecutive pairs or larger blocks of year groups. More specifically, all the comparisons between Y3 and Y4 pupils showed that their performance did not differ significantly. As expected, pupils in the two final years were significantly better spellers than younger pupils. This pattern was obvious in phonological-orthographic misspellings and phonologically plausible- orthographic misspellings, since significant differences were detected only between blocks of years, i.e., when Y3 and Y4 were compared to Y5 and Y6. A similar pattern of progress was evident when examining the error rates in non-affixed and affixed words, as well as in the component morphemes of the latter. Finally, Y5 pupils made significantly more errors than Y6 children in all comparisons examining whole word spelling. The only exception was the spelling of whole affixed words, as well as of their component morphemes, for which the comparisons between the two final year groups did not produce significant results.

Greek pupils in all year groups made significantly fewer phonological-orthographic errors than phonologically plausible-orthographic errors. In addition, a larger proportion of affixed words was misspelled in comparison to non-affixed words in G3 and G5, but the difference was not significant in G4 and G6. Within affixed words, all year groups produced significantly higher error rates in the stems than in both the derivational and the inflectional suffixes. Within suffixes, inflections were less frequently misspelled than derivations only in G3, whereas the difference was not significant for the older children. With regards to spelling progress, the comparisons between Greek year groups showed that differences were more profound when the youngest children (G3) were compared with older year groups (G4-G6), as for example in whole misspelled words, phonologically plausible-orthographically misspelled words, whole affixed words, stems and derivations. However, there were error categories in which the performance of G3 and G4 pupils did not differ significantly, such as their phonological-orthographic errors, their misspellings of non-affixed words and of the inflectional suffixes. In a similar manner, many comparisons between consecutive year groups from G4 onwards did not produce significant results (e.g., P-OM, PP-OM, affixed words and their suffixes). This was distinctly evident in all comparisons between the last two grades of primary school. These results indicate that Greek children writing in a less opaque orthography acquire some spelling skills relatively early, such as the ability to apply phonological knowledge, and may reach a plateau of morphological and orthographic spelling by G4 or G5 depending on the morphological complexity of the item they are required to spell.

5.6 Discussion

In this study the spelling performance of native speaking children attending years 3-6 in England (7.6-10.7 years old) and grades 3-6 in Greece (8.6-11.5 years old) was investigated. The misspellings produced in the single word spelling task were analysed. One of the aims was to reveal any differences among year groups which would enable the delineation of the development of spelling ability in primary school aged children. Additionally, the misspellings were examined in relation to the morphological complexity of the words (affixed versus non-affixed) and the type of knowledge required for correct spelling of whole words and their component morphemes, namely phonological, orthographic and morphological, in two orthographic systems with different levels of transparency.

5.6.1 Mastering spelling ability in different orthographic systems

Comparisons between successive year groups' misspellings showed that overall English and Greek native speakers gradually obtain a deeper understanding of the linguistic properties of the orthographic system in which they are writing. There was considerable variability in the pace with which distinct orthographic features were acquired depending on complexity, orthographic consistency and the type of knowledge required. A common finding among the assessed spelling patterns was that pupils in pairs of successive year groups often showed a similar spelling profile. Lack of significant differences was more frequently evident between older participants, i.e., between Y5 and Y6 and between G5 and G6, although children's performance was not at ceiling yet indicating further amplitude for improvement. Findings regarding the phonological, morphological and orthographic properties of spelling are discussed separately to account for the unique contribution of each aspect to spelling process (Harris et al., 2014; Treiman, 1993) and investigate distinct trajectories of acquisition of the skills required to spell monomorphemic and polymorphemic words in the two orthographic systems under examination.

In general, English and Greek primary school children showed comparable spelling profiles in that they appeared to produce fewer phonological errors than phonologically plausible errors. This finding suggests that they encountered more difficulties in applying morphological and orthographic knowledge than phoneme-to-grapheme correspondence rules, in line with previous research in both languages (e.g., Porpodas, 1989, 1999; Stainthorp & Hughes, 1999; Waters, Bruck, & Seidenberg, 1985). The results of different sets of analyses consistently showed that English native speaking children achieved incrementally better spelling scores after Y4 and throughout the final two years of primary school (e.g., total misspelled words, P-OM words, PP-OM words). In contrast, Greek native speakers showed signs of significant progress in spelling in as early as G3, but seemed to reach a level of maximum competence by G5 in all examined error categories, although their performance had not yet reached ceiling levels. Pairwise comparisons between year groups revealed significant differences in the spelling performance of pupils attending consecutive pairs or blocks of years, although the effect of year group differed across languages. More specifically, Greek G4 pupils were better spellers than G3 pupils in phonologically plausible spelling of whole words, whole affixed words, stems and derivations, whereas comparisons between English Y3 and Y4 pupils showed that their performance did not differ significantly in all examined error categories. As expected, pupils in the final years (English Y5 and Y6 and Greek G5 and G6) were significantly better spellers than younger pupils (English Y3 and Y4 and Greek G3 and G4). This was not true for Greek pupils' phonological and orthographic spelling of whole words (P-OM, PP-OM) and the spelling of the affixed words and their suffixes, since no significant difference between G4 and G5 was detected. Moreover, pupils in G5 and G6 did not perform significantly differently in any of the examined categories. It, therefore, seems that Greek children had reached their maximum spelling ability by G4 or G5 depending on the properties of the item they were required to spell. As concerns the English sample, the error rates followed a declining trend until the final year of primary school. The only exception was the spelling of whole affixed words and their component morphemes, in which English children seemed to reach a plateau of spelling ability by Y5.

One possible explanation of the differences in their spelling profiles might be the age discrepancy between the English and the Greek sample. As noted by Goulandris (2003), the age at which children start formal education might play a role in the pace of developing their literacy skills. Taking into account that English pupils were younger and were writing in a more opaque orthographic system might explain why quantifiable progress appeared later in primary school for them, while Greek pupils, who were older and were writing in a less opaque system reached a plateau of their spelling ability before the final grade. Nonetheless, the spelling profiles of English and Greek pupils shared common characteristics. Phonological errors were rarer than orthographic errors and polymorphemic (affixed) words attracted higher error rates than monomorphemic (non-affixed) words. Additionally, children seemed to perform comparably when spelling the different morphemes of polymorphemic words. Everyone appeared to be better at spelling the inflectional suffixes, while stems and derivational suffixes produced greater difficulties for the children. Therefore, within each language there were aspects of words that led to shorter or longer time periods needed for accuracy independently of the age at which children had started school. This is in agreement with previous research highlighting the contribution of quantity and quality of schooling to the development of literacy skills above and beyond the effect of age (e.g., Caravolas et al., 2001; Cunningham & Carroll, 2011; Ehri & Wilce, 1987).

Phonological errors. The comparisons between successive years showed that there were differences in the pace with which phonological spelling is acquired depending on the orthographic system. On one hand, Greek participants made a small amount of phonologically implausible errors gradually decreasing from 3.7 % in G3 to 1.2 % in G6 (examples in Table 5.1, p. 138). Error rates between successive grades were not significantly different indicating that Greek pupils had reached a plateau of phonological spelling ability by G3. This finding is in line with previous research with first and fourth graders in Greek by Porpodas (1989, 1999) as well as with first to fifth graders by Loizidou-Ieridou and colleagues (2010), who observed that spelling performance in regular words had reached ceiling from G2 onwards. Hence, the results of the present study confirm the notion that Greek spellers master application of phoneme-to-grapheme correspondence rules early in primary school. From G3 onwards they appear to continue producing a relatively small number of phonologically unacceptable errors. The fact that this percentage seems to be constant throughout primary education might indicate that it consists of random slips, i.e., unintended errors, as is often observed in children and adult writing studies (Harris et al., 2014). On the other hand, English children appeared to encounter more difficulties with phonological spelling. More specifically, children in Y3 produced a mean of 21.7 % of mistakes altering the sound of the words examined, a rate which dropped significantly to 12.7 % (Y5) and 6.1 % (Y6) for older children (examples in Table 5.1, p. 138). Such a decrease would indicate that, in contrast to Greek children, English pupils seem to continue reinforcing their phonological skills throughout primary education gradually progressing to a higher level of phonological spelling at their final year. It is noticeable that English children manage to eliminate their phonological errors by the end of primary school, yet their error rates appear to be higher than the youngest cohort writing in Greek.

Spelling of orthographically challenging words. In the present study orthographically challenging words, requiring application of morphological or orthographic knowledge to select the correct grapheme among alternative options, were examined. The finding that phonologically plausible but orthographically inaccurate spellings were persistently higher than phonologically implausible spellings throughout the four grades of primary school in both languages signifies that mastery of the relevant skills occurs later and more slowly, as documented for primary school children in previous studies (English: Nunes et al., 1997; Stainthorp & Hughes, 1999; Treiman & Cassar, 1996; Greek: (Diamanti et al., 2013; Loizidou-Ieridou et al., 2010; Protopapas et al., 2013). The finding that error rates dropped significantly as children progressed from Y3-Y4 to Y5-Y6 in England and from G3-G4 to G5-G6 in Greece is in line with results of previous studies with children of various ages (e.g., Loizidou-Ieridou et al., 2010; Protopapas et al., 2013; Stainthorp & Hughes, 1999; Walker & Hauerwas, 2006) and indicates a gradually deeper understanding of the contribution of morphological and orthographic knowledge to spelling, as well as an augmenting application of relevant spelling strategies.

Therefore, a very strong effect of language was evident in the examination of the phonologically misspelled words. English pupils appeared to produce a higher proportion of phonological errors, while Greek pupils made a stable very low percentage of such errors. This discrepancy was evident both in comparisons drawn between groups matched in years of schooling and between age-matched groups across the two countries. These results are in agreement with previous studies suggesting that proficiency of phonological spelling skills depends greatly on the level of phonological consistency of the orthographic system in which the children are writing (e.g., Goswami et al., 2005), regardless of years of schooling and maturity. The difference in the pace of development of phonological spelling in the two languages is an excellent indication of the effect of different levels of orthographic consistency on phonological skills, as observed in previous cross-linguistic studies of reading and phonological awareness (Caravolas & Bruck, 1993; Caravolas, 2006; Georgiou et al., 2012). On the other hand, Greek pupils seemed to be poorer than English pupils in the orthographic spelling of whole words, affixed and non-affixed, both when year groups and age-matched groups were compared. This indicates that mastering of the skills which surpass phonologically plausible spelling is strongly affected by years of schooling rather than by age, since age-matching did not seem to constrain the observed discrepancy between the performance of English and Greek children in orthographic and morphological spelling. These results are in line with previous research postulating that children writing in more orthographically consistent languages, such as Greek, make extensive use of their phonological skills to access printed words in comparison to users of a more opaque orthography, such as English (e.g., Ellis et al., 2004).

Application of morphological and orthographic knowledge. The results of the present study showed that although children seem to have a general sense of how phonology maps onto morphology from an early age, employment of specific morphological knowledge for correct spelling seems to be mastered later on. This is evident in the decline of the percentages of the errors in affixed words and specifically in their suffixes. If significant differences between the error rates of younger and older pupils indicate progress in spelling, the results of the present study support that children in both countries progressively widen their knowledge of how morphology is represented orthographically from as early as Y3/G3. In contrast to older children, whose performance in the suffixes did not differ significantly between Y5/G5 and Y6/G6, Greek pupils in G3 have made significantly more errors than their peers in G4, G5 and G6. In a similar manner English pupils in Y3 and Y4 have made significantly more errors than their peers in Y5 and Y6. These results indicate a continuous progress to wider application of morphological and orthographic knowledge to the spellings of children in both countries. These findings are in line with previous research postulating that application of morphological strategies in spelling is better detected after the third grade of primary education (Harris & Giannouli, 1999; Waters, Bruck, & Malus-Abramowitz, 1988).

With respect to application of orthographic knowledge, as mapped in the phonologically plausible orthographic misspellings of non-affixed words and the stems of affixed words (examples in Table 5.1, p. 138), this seems to have been a slowly acquired skill for all the participants. Since the base word was not provided in the present study, children had no option but to rely on their root-specific (orthographic) knowledge to spell the stems of derived and inflected forms. In English, most comparisons showed that children made better use of their orthographic knowledge to spell the non-affixed words than the affixed words and that within the affixed words the stems were often more challenging than the suffixes. Nevertheless, there were signs of incremental spelling progress, as indicated by differences between younger and older children from an early age until late in primary school. Children in Y3 misspelled 21.8% of the examined non-affixed words and the error rates dropped to 5.4% for the oldest children in the sample (Y6). Along similar lines Y3 pupils misspelled 31% of the stems of affixed words to reach 10% in Y6. If errors in the stems reflect children's visual (orthographic) representations of base words stored in their lexicon, then these results show that, in the final two years of primary school, English pupils have developed their orthographic knowledge adequately to spell correctly the majority of the words dictated. Thus, a plausible explanation for the difference between affixed and non-affixed words might be that they possess a range of orthographic representations, which is wide enough to dictate correct base word spelling but which is relatively constrained to address the demands of spelling the stems of polymorphemic words.

The spelling profile of Greek children shares some similarities with that of English pupils. Greek participants misspelled 32.2 % (G3) to 16.1 % (G6) of the non-affixed words and 41.8 % (G3) to 16.2 % (G6) of the stems of affixed words. However, in Grade 6 this difference was no longer significant possibly indicating that they had developed a wide enough lexicon of root-specific (orthographic) representations and were able to apply this knowledge to both affixed and non-affixed words. The age discrepancy between English and Greek pupils at the time of the study is noticeable. Nevertheless, English pupils were significantly better at employing orthographic knowledge to spell both categories, which possibly indicates that orthographic improvement is a result of schooling rather than of aging. Another plausible explanation might lie in differences in the general spelling ability of the two language samples at least for the final two years of primary school. As shown by the t-test comparisons on the pre-test standardised spelling scores of the participants (chapter 4, section 4.3.2.2), English pupils had an above average spelling ability for their age, while Greek G5 and G6 pupils' performance was not significantly different from the expected average mean for their age. Their superiority in general spelling ability might have been an additional reason for English Y5 pupils to have reached the maximum level of orthographic spelling skills for children at the end of primary education, while Greek pupils attending the final two grades had further latitude to decrease their orthographic error rates.

The finding that affixed words attracted more error rates than non-affixed words is in agreement with results of previous studies in English investigating morphological and orthographic spelling with children of this age range. Waters et al. (1988) observed a larger difficulty of English speaking children of 8-11 years old with spelling inflected words than "strange" words, i.e., words whose spellings should be retrieved from memory. The present study provides further evidence with children of a wider age range spelling stems of various parts of speech in two different orthographic systems. On the other hand, the findings of the present study may seem to be in contrast with Carlisle (1988), who found that 9-11 year olds made use of the root-word to spell derived forms (e.g., HEAL-HEALTH) and Deacon and Bryant (2006), who observed that 6-8 year olds spelled the stem of derived forms better than simple words (e.g., the <rock> in ROCKED as opposed to ROCKET). The latter studies suggest that children's spelling performance is better at morphologically than at orthographically dependent patterns. This apparent contradiction is most probably due to the difference in research designs. One of the aims of the present study was to include spelling conditions that would resemble naturalistic daily spelling at school as much as possible. For this purpose base words for the derived and inflected forms were not provided. Hence, participants were forced to rely on their established knowledge of word-roots to spell the stems of the inflected and derived words, which makes the task relatively more demanding. In contrast, in the two reviewed studies root-words were provided possibly aiding spelling with the employment of morphological strategies.

Spelling the suffixes. In order to achieve correct spelling of suffixes, accuracy must be accomplished in all three dimensions: phonological, morphological and orthographic. Grasp of the phonological dimension reflects an understanding of the conventional phoneme-to-grapheme correspondences. Success in comprehending the morphological aspect of the suffix would result in consistent application of a morpheme at the final position of the word, even if this morpheme is not orthographically correct (e.g., HOPPED and DROPPED spelled as <hoppid> and <droppid>; see Walker & Hauerwas, 2006). Application of orthographic knowledge is reflected in spellings where, in addition to consistent application of a morpheme, unit-specific knowledge is also employed to spell correctly the specific suffix (e.g., the <-ed> in DROPPED signifies both morphological and morpheme-specific knowledge). Only in this last case perfectly correct spelling is achieved with all dimensions expressed accurately. In the present study, the spelling of suffixes was scored at the level of whole morpheme. Therefore, often the morphological and orthographic dimensions of the morpheme were indistinguishable. Lack of appreciation of one of the two or both dimensions was depicted by scoring the spelling of a suffix as phonologically plausible but orthographically inaccurate (examples in Table 5.1, p. 138).

Spelling patterns in the derivational and inflectional categories produced challenges to the pupils of both language samples. As concerns application of morphological and orthographic strategies when spelling different components, spelling performance appears to depend on the linguistic properties of the specific orthographic system. The statistical analysis showed that English speaking pupils were better at spelling the inflections than the derivations of affixed words (e.g., the <es> in GLASSES vs the <ible> in HORRIBLE) throughout the four year groups. Specifically, they misspelled 15.5% (Y3) to 3.2% (Y6) of the examined inflectional suffixes as opposed to 26% (Y3) to 9% (Y6) of the derivational endings. Greek speaking pupils showed a similar spelling profile (e.g., the <εις> /i:/ in ΠΟΛΕΙΣ vs the <ι> /i/ in ΚΟΙΝΩΝΙΚΟΙ) only in G3, having misspelled 9.8% of the inflectional suffixes as opposed to 19.2% of the derivational suffixes, whereas in G4, G5 and G6 morphological and/or orthographic spelling strategies were employed equally well to spell inflections (7.9 - 4.2%) and derivations (9.3 - 6.9%).

These findings are in agreement with previous studies on derivational and inflectional morphology in English and partly in agreement with research in Greek (Carlisle, 1988; Chitiri & Willows, 1994; Deacon & Bryant, 2005; Diamanti et al., 2013; Peters, 1997; Protopapas et al., 2013). Deacon and Bryant's (2005) study with English speaking pupils of 6-8 years old documented that acquisition of inflectional morphology (e.g., correct spelling of <–er> in SMARTER as opposed to CORNER) precedes that of derivational morphology (e.g., no distinction between spelling <–al> in MUSICAL and METAL). In Greek, Diamanti et al. (2013) and Protopapas et al. (2013) demonstrate similar findings with typically developing children in the last three grades of primary school. Possible reasons why Greek older participants in the present study showed a different spelling profile might lie in the research design, i.e., the frequency and consistency levels of the derivational and inflectional suffixes examined in the present study as opposed to those used in the aforementioned studies or possible differences in the classification of the suffixes in one or the other category. However, the findings concerning the performance of the youngest Greek participants attending G3 are in line with previous studies. This might indicate that factors such as the relative frequency and consistency of the morphemes might influence the magnitude of the effect of suffix category (i.e., derivation versus inflection) especially when spellers of a wider range of age and proficiency levels are assessed. Such a hypothesis could stem from findings of previous studies. Deacon and Leung (2013) observed that orthographic choices of English speaking children in grades 1-4 were influenced by the frequency levels of the two derivational allomorphs assessed (<–er> versus <–or>). Consistency effects on reading accuracy have been detected in cross-linguistic studies (e.g., Frost, Katz, & Bentin, 1987) and on spelling the <-ing> and <-ed> inflectional suffixes in English (Nunes & Bryant, 2009). Lete et al. (2008) also detected a word-frequency and consistency effect on French spelling. Possible effects of both these factors on a wider range of suffixes would be worth exploring in future studies.

As concerns the acquisition of derivations, frequency and position effect have been suggested as possible reasons for the significant difficulty of children with derivational suffixes in Greek (Diamanti et al., 2013; Protopapas et al., 2013). It has been noted that morphemes occurring frequently (Peters, 1997) and morphemes in a final position are more salient (Slobin, 1973) and for this reason correct spelling of these morphemes is acquired more easily. This could explain the difficulty of participants in the present study with derivational endings as opposed to inflectional endings, although more profound for the English than for the Greek sample. However, derivations have been suggested to be more frequent than inflections in English (Bourassa & Treiman, 2009) and are always positioned at the end of the word, whereas Greek is a highly inflected language and a significant proportion of derivations occur in a middle position before the inflectional ending (Protopapas et al., 2013). Hence, the discrepancy between the spelling profiles of the two language samples might lie in the examined English derivational suffixes being less frequent or orthographically consistent than the Greek examined suffixes. Another plausible explanation might be that derivational suffixes often carry subtle linguistic distinctions (e.g. <–ion>: abstract noun as in FRUSTRATION versus <–ian>: agentive noun as in MUSICIAN; see Bourassa & Treiman, 2009), which are not easy to grasp, especially for younger children. This might be the reason why English pupils and the youngest Greek pupils found the derivational suffixes more difficult to spell than the inflectional suffixes, whereas Greek older pupils seemed to possess the knowledge required to spell derivations equally well as the inflections.

Regarding the pace of acquisition of inflections, the spelling profiles of English and Greek pupils shared common characteristics. This is despite potential differences in the statistical properties of inflections in the two orthographic systems. Since Greek is a highly inflected language, one would expect a particular inflectional suffix to occur less frequently than in English, as for example in the case of the plural ending. In English <–s >or <–es> are used to form the plural of nouns consistently in all cases (e.g., CATS, GLASSES), whereas in Greek different endings are used to form the plural of nouns depending on the gender and the case (e.g., ΑΝΔΡΕΣ for the masculine, ΠΗΓΕΣ for the feminine and ΒΟΥΝΑ for the neuter, in nominative, accusative and vocative case). Another example is the case of adjectives, which are also highly inflected in Greek whereas in English the same form is used to accompany singular and plural nouns. Correct spelling of inflectional morphemes is regarded as being based on statistical learning or inference of morphological rules (Bryant & Nunes, 2008; Deacon et al., 2008), which enhance application of the appropriate suffix to unfamiliar words by analogy (Chliounaki & Bryant, 2007; Ehri, 2014; Nunes et al., 1997). Hence, children writing in Greek would be expected to either find it more difficult to spell the inflections influenced by the lower frequency levels of the specific suffix they are required to spell or to be better at this task due to extended practice with different inflections in their daily writing routine. The results of the present study indicate that older pupils in both language samples seemed to have had internalised the properties and systematic function of inflectional endings of their orthography. If statistical properties contribute to generating a grammatical rule on the basis of which pupils spell unfamiliar words, it seems that English pupils over 9 years old were as competent as their Greek same-age peers to use this morphological strategy in the framework of the orthographic system in which each group was writing. Statistical learning or rule-based learning of inflectional morphology, English children in the last two years and Greek children in the three last grades of primary school appeared to have developed the strategies required to show a stable spelling performance in inflectional spelling.

The finding that the performance in derivational suffixes was not as stable before Y5 in English and G4 in Greek could be explained by the suggestion that inflectional spelling may be aided by the application of grammatical rules (Nunes & Bryant, 2009), while derivational spelling mainly relies on unit-specific knowledge resulting in a much slower progress. Nevertheless, since suffixes convey certain syntactic information contributing to the meaning of the word (morphology), this finding also indicates that in both orthographic systems children found it easier to appreciate the morphological dimension as represented in inflectional suffixes than to apply unit-specific (orthographic) knowledge to spell the derivational suffixes correctly. If comprehending the semantic information is perceived as the first level and adding unit-specific information as the second level of correct spelling of morphemes (Walker & Hauerwas, 2006), this result affirms qualitative observations postulating that complete morphological spelling is achieved through word-specific knowledge, as has been previously suggested (Chliounaki & Bryant, 2007; Ehri, 2014; Nunes et al., 1997).

To conclude, it is important to note that overall English and Greek children seemed to follow similar paths to correct spelling. This is to signify that despite discrepancies in the speed with which phonological, morphological and orthographic spelling skills are mastered, possibly due to differences in the linguistic properties of different writing systems, spelling development seems to adhere to similar processes across orthographies (Bryant et al., 1999).

5.7 Conclusions

Results from both orthographies suggest that despite properties of the language affecting children's error rates, their mistakes were not qualitatively different. The present study furthers our knowledge about how spelling skills of primary school children develop by providing a detailed analysis of whole words and morphemes in relation to the types of knowledge required to spell each error category. With regard to development, spelling progress was obvious in the gradual decrease of all error rates between consecutive year groups or pairs of year groups of children. Investigation of these error categories in two languages with different levels of orthographic consistency has provided evidence suggesting that differences attributable to the characteristics of the specific orthographic system mainly affect the pace with which phonological, morphological and orthographic spelling skills are mastered (Joshi & Aaron, 2006) rather than the developmental trajectories followed (Bryant et al., 1999). Despite small differences between year groups and language samples, it seems that all pupils found polymorphemic words more challenging than monomorphemic words. Additionally, the application of orthographic knowledge (i.e., in stems) appeared to be more challenging than the employment of orthographic information in combination with morphological cues (i.e., in suffixes), whereas phonologically implausible spellings occurred least frequently. This is in agreement with previous research suggesting that morphological and orthographic spelling of inconsistent patterns is mastered later on in primary education, while phonological spelling is easier to conquer (e.g., Porpodas, 1989, 1999; Stainthorp & Hughes, 1999; Waters et al., 1985) and may constitute the base for orthographic learning (Share, 2008).

Chapter 6

Analysis of Spelling Errors of English and Greek Native Speaking Children with Dyslexia in Comparison to Typical Spellers

6.1 Introduction

This chapter focuses on the spelling performance of primary school children with and without dyslexia writing in two different orthographic systems. Previous research in opaque orthographies, such as English, has highlighted the persistence of phonological difficulties in combination with weaknesses in mastering orthographically demanding spelling patterns. There is a lack of consensus regarding the magnitude of these difficulties for students with dyslexia in more consistent orthographies. The present study aims to further explore spelling difficulties of English and Greek native speaking children with dyslexia belonging to three sequential year groups (Y4-Y6 and G4-G6). The following section provides an overview of previous research in spelling in English and deep orthographies in comparison with Greek and other more consistent orthographic systems. The main focus is on studies analysing spelling errors of children with dyslexia in comparison to typically developing pupils.

6.2 Spelling difficulties and dyslexia

Spelling difficulties can be associated with weaknesses in phonological, morphological and orthographic skills as shown by studies with typically developing spellers. It has been argued that the progress in acquiring new morphological knowledge depends on advanced phonological skills (Nunes, Bryant, & Bindman, 1997; Wimmer & Schurz, 2010). In addition, awareness of the specific characteristics of the orthographic system and rules for phoneme-to-grapheme correspondences are necessary for advanced spelling performance. Models of the spelling process (Houghton & Zorzi, 2003; Tainturier & Rapp, 2001) and models describing the typical development of spelling (orthographic mapping theory: Ehri, 2014, Share's self-teaching hypothesis: Share, 2008) are often employed to explain weaknesses of spellers with dyslexia in a comprehensive theoretical framework, as detailed in chapter 2, section 2.5.

Studies often research spelling weaknesses by comparing the performance of children with dyslexia with that of typically developing age-matched controls (e.g., Egan & Tainturier, 2011; Mavrommati & Miles, 2002; Tsesmeli & Seymour, 2006). Significant underachievement in spelling in comparison to a chronological age-matched group provides an indication for a possible delay in the development of the spelling skills of the dyslexic group. In addition, typically developing younger children are often matched in reading or spelling ability with the dyslexic group. Significant differences between the latter group and their controls, may indicate that children with dyslexia follow a different trajectory in acquiring spelling skills in comparison to typically developing children (Kessler & Treiman, 2001). Limiting the research design to include only a reading ability-matched control group does not account for possible discrepancies in the spelling ability of the two groups, which might influence the conclusions of the study (Egan & Tainturier, 2011). It is, therefore, meaningful to also include a spelling ability-matched group to draw conclusions about children with dyslexia facing a delay or a deviance from typical spelling (e.g., Bourassa et al., 2006; Bourassa & Treiman, 2008; Cassar, Treiman, Moats, Pollo, & Kessler, 2005; Cassar & Treiman, 2006; Egan & Tainturier, 2011; Ellis, 1994).

There is evidence to support the view that spelling difficulties of children with dyslexia are prominent and persistent over time. Research in English has highlighted the phonological weaknesses of children with dyslexia (e.g., Bruck & Treiman, 1990; Bruck & Waters, 1988; Snowling, 1994). Such weaknesses are indicated by phonological spelling errors. A large proportion of phonological mistakes are regarded as an indication of lack of understanding of the alphabetic principle. On the other hand, phonologically plausible errors might well comply with the alphabetic principle but fail to represent the orthographic identity of the target word.

Studies frequently show that children with dyslexia make proportionally more phonological errors than same-age typically developing children but not than younger spelling ability-matched pupils (Ellis, 1994), indicating a delay in spelling development. In accord with this, Bernstein's study (2009) highlighted the phonological difficulties confronted by pupils with dyslexia by assessing the spelling of words and non-words in English. According to his findings, children with dyslexia made significantly more phonologically implausible vowel misspellings, such as <bet> for BAT than phonologically plausible errors, such as <bate> for BAIT, but performed at the expected level for their spelling ability. Along similar lines, Cassar and Treiman (2006) suggested that phonological skills are closely linked to spelling development based on their findings that pupils with dyslexia aged 8-15 years made similar types of errors to spelling-matched controls in a phoneme counting task with non-words (e.g., /dɑr/, /vɛl/,/blop/,/fimp/). In another study involving non-word spelling, Cassar, Treiman, Moats, Pollo, and Kessler (2005) showed that both children with dyslexia and typical first graders struggled with the same phonological structures (e.g., consonant clusters, unstressed vowels and phonemes that matched letter names). Additional findings were reported by Kemp, Parrila, and Kirby (2008), who observed that adults with dyslexia spelled pairs of words that shared a stem with simple phonological structure (e.g., APT-APTLY) as successfully as typically developing spelling ability-matched pupils. However, they did not perform as well in pairs of words that shared a stem containing orthographically inconsistent spelling patterns (e.g., DECEIT-DECEITFUL). The researchers concluded that their participants were able to use some phonological skills to spell familiar words but were not as able with unfamiliar words when phonological cues were not provided. There is some evidence that children with dyslexia may make significantly more phonological errors than younger spelling-ability matched pupils in older studies, as for example in the study by Bruck & Treiman (1990) investigating initial consonant clusters. However, their misspellings were not different in nature to those of their controls, supporting the notion about a delay rather than a deviance in phonological spelling development.

Research with children writing in more consistent orthographic systems suggests that spellers are more likely to overcome any difficulties with phonological spelling relatively early (e.g., Landerl & Wimmer, 2000; Nikolopoulos, Goulandris, & Snowling, 2003). In contrast, difficulties with orthographically inconsistent spellings requiring specific word (orthographic) knowledge or morphological awareness persist to the end of primary education (e.g., in German: Landerl & Wimmer, 2000; in French: Alegria & Mousty, 1996). Studies in the Greek language have reached similar conclusions regarding enduring orthographic difficulties for older children with dyslexia, whereas there is a lack of consensus with regards to phonological spelling errors. For instance, a study by Nikolopoulos, Goulandris and Snowling (2003) involving pupils with dyslexia in grades 2 and 4 showed that despite the fact that they extensively misspelled the stimuli, all errors were phonologically plausible, indicating adequately developed phonological skills. In agreement with this finding, Fakou and colleagues (2010) observed a negligible amount of phonological misspellings made by pupils with dyslexia in grades 2-8. Findings from research in French (Alegria & Mousty, 1996) and in German (Landerl & Wimmer, 2000) are consistent with these results. Additional evidence has been provided by comparisons with younger ability-matched groups by Caravolas and Volín (2001) in Czech, as well as Diamanti and colleagues (2005) and Protopapas and colleagues (2013) in Greek. In detail, the results of the study by Caravolas and Volín (2001) showed that Czech children with dyslexia attending grade 5 made significantly more phonologically implausible errors than their chronological controls but performed at the same level as younger spelling-age matched typically developing peers. Along similar lines were the findings of Diamanti and colleagues (2005) with Greek students with dyslexia of 12 years old, who produced higher phonological error rates than same-age peers but performed comparably to younger reading-matched controls. In agreement with this finding, Protopapas and colleagues (2013) found a discrepancy only in comparison with age-matched children but not with younger reading-matched children. The researchers argued in favour of a delay in phonological development. Therefore, in more transparent writing systems phonological errors appear to be either absent from dyslexic pupils' spelling performance (Alegria & Mousty, 1996; Fakou et al., 2010; Landerl & Wimmer, 2000; Nikolopoulos, Goulandris & Snowling, 2003) or at least as frequent as for younger children who are matched in reading or spelling ability with them (Caravolas & Volín, 2001; Diamanti et al., 2005) suggesting a delay rather than a deviance in phonological spelling.

Research examining phonologically plausible but orthographically inaccurate spellings has also shown that students with dyslexia score lower than their chronological controls (e.g., Egan & Tainturier, 2011; Mavrommati & Miles, 2002; Tsesmeli & Seymour, 2006). However, in order to understand where the weaknesses of spellers lie when examining orthographically inaccurate errors, it is important to distinguish between spellings which depend on morphological knowledge (i.e. meaning, grammar) and those depending on orthographic knowledge (i.e. memorisation of visual form). On one hand, morphological awareness is essential for the recognition of morphemes, the smallest units of meaning in a word, which in turn can facilitate the spelling of unfamiliar words (Bourassa, Treiman & Kessler, 2006; Nagy, Berninger, & Abbott, 2006). On the other hand, orthographic knowledge refers to an understanding of legal letter sequences in the conventional orthographic system, otherwise called graphotactics (Cassar & Treiman, 2006), and representations of specific sounds, at the level of graphemes, syllables, rhymes or whole words by rote memorisation (Seidenberg & McClelland, 1989).

Few Greek studies have made this distinction between morphological and orthographic skills in spelling. In the study by Nikolopoulos, Goulandris and Snowling (2003) involving suffixes, children with dyslexia in grades 2 and 4 were poorer as compared to chronological age-matched peers only in word endings consisting of more than two letters. However, there was no distinction between the derivational and inflectional components of the suffixes examined, which could have provided a better insight into the types of knowledge (i.e., morphological and/or orthographic) in which children's weaknesses lie. Furthermore, no comparisons were drawn between participants with dyslexia and younger ability-matched children. Hence, no further conclusions can be derived with regard to the nature of their spelling difficulties (i.e., delay or deviance). In a closer investigation of derivational morphology, Diamanti et al. (2013) analysed the errors of 12 year olds with dyslexia in the derivational components of Greek suffixes in comparison to a younger spelling age-matched control group. In contrast with their earlier findings, the results showed that the first group performed at the same level as their spelling-age controls. In agreement with the notion that suffixes are particularly challenging for children with dyslexia, Protopapas and colleagues (2013) showed that older Greek students with dyslexia (grade 7) produced a significantly larger proportion of misspellings in derivational and inflectional suffixes as well as in stem vowels than in all other examined error categories (e.g., phonological, morphological in stems, orthographic, stress, punctuation).

Research in deeper orthographies, such as English, often distinguishes between morphological and orthographic spelling. Studies investigating the spelling of morphological components of words in English regularly include typical children matched in chronological age with the sample with dyslexia. The results suggest that children with dyslexia lag behind their peers in spelling morphologically complex words (e.g., Hoefflin & Franck, 2005). Many of these studies also compare the performance of children with dyslexia with that of younger reading ability-matched pupils. For example, Tsesmeli and Seymour (2006) compared adolescents with dyslexia and reading-age controls. They found that the first group failed to employ morphological strategies when spelling pairs of base-words and derivatives, since they used different spellings in each part of the pair, e.g., <wieed-width> for WIDE-WIDTH. The researchers concluded that the observed difficulty with applying morphological strategies when spelling derivatives was rather a consequence of phonological and orthographic problems, as indexed by high phonological error rates and proportionally large misspelling of the base-words. However, due to the absence of a spelling age-matched control group, it is impossible to conclude whether the observed inconsistency in spelling base and derived forms is an effect of dyslexia or of generally less advanced spelling skills even for typically developing pupils. Egan and Tainturier (2011) found additional evidence to support this notion by examining stems and suffixes of past tense inflected verbs with 10 year olds with dyslexia and spelling-age controls. They observed that a sub-group of participants with dyslexia were more prone to phonetically transcribe the –ed suffix with a <t> grapheme and were significantly less consistent in stem-inflection spelling (e.g., <cover-kuverd>) than the younger spelling ability-matched controls. The researchers concluded in favour of a specific difficulty in inflectional spelling for children with dyslexia. In addition, they assessed the spoken morphological awareness (i.e., inflecting non-words) and the orthographic lexical memory (i.e., a composite score of spelling and reading irregular words) and examined their contribution to the spelling of the –ed suffix. They found that orthographic lexical memory was a unique predictor for the past tense suffix spelling for the dyslexic group, while both measures predicted the spellings of the younger spelling ability-matched children. This finding was interpreted as suggesting that despite of the fact that both groups of children possessed equal levels of spoken morphological awareness, children with dyslexia did not apply a morphological spelling strategy when spelling the –ed suffixes with the same competence as their spelling-age controls.

In contrast, Bourassa, Treiman and Kessler (2006) in their study involving children with dyslexia (9-15 years old) did not find a significant deficit relative to one younger group of controls matched in reading and spelling grade performance in their ability to apply morphological knowledge when spelling. Specifically, it was observed that both groups failed to spell stem-final consonants accurately in inflected verbs (e.g., the /n/ in TUNED) but not in base words (e.g., the /n/ in TUNE) and nouns (e.g., the /n/ in BRAND). However, there was no explicit link between base words and inflections as words in the two lists were presented separately and in a random order making morphological inferences more challenging. It is possible that children with dyslexia and younger spellers were not experienced enough to infer the morphological link between bases and inflections when no explicit link was drawn between them. It would have been interesting to assess this skill in comparison to a chronological age-matched group to examine whether this is an ability that increases with years of schooling and print exposure.

Investigation of orthographic spelling in English frequently provides evidence for the severe difficulties encountered by children with dyslexia. In the framework of orthographic spelling, researchers have investigated children's understanding of graphotactic rules of the conventional system. For instance, in a study by Nelson (1980), 11 year olds with dyslexia and spelling age-matched children were tested in a list of words including those with orthographically challenging spellings. Statistical comparisons did not show any significant difference in the number of orthographically illegal spellings (e.g., <ckak> for CAKE) produced by dyslexics as compared to their controls. The aforementioned study conducted by Egan and Tainturier (2011) provided further evidence supporting the lack of difference in the graphotactic knowledge of children with dyslexia and spelling-matched pupils in a list of 10 words and 10 non-words. The only qualitative differences that the researchers observed was a significantly larger proportion of using the final –e marker, such as <tripe> for TRIP and significantly more omissions in double consonants in words, such as <diner> for DINNER. The researchers concluded that children with dyslexia use their orthographic knowledge to compensate for their phonological weaknesses when spelling.

In another study investigating graphotactic errors, Cassar et al. (2005) compared children with dyslexia (8-15 year old) with younger spelling grade level-matched controls on a list of real words. According to their results, there was no significant difference between the performances of the two groups. In contrast with an earlier study by Bourassa and Treiman (2003), Cassar et al. (2005) found no evidence for a compensating spelling strategy of children with dyslexia employing orthographic knowledge to balance their phonological weaknesses. A possible limitation of the research design of this study raising questions about the reliability of the results might be the wide age range of the participants in the dyslexic group when a possible effect of age on spelling ability has not been accounted for in the method of analysis. An interesting addition to the aforementioned results is provided by the findings of the study of Katzir and colleagues (2006). The researchers compared children with dyslexia and reading ability-matched controls' performance in an orthographic choice task and found no significant difference in the error rates produced by the two groups.

To summarise, what is evident from research in phonological, morphological and orthographic spelling is that children with dyslexia lag behind same-age peers but there is no consensus on whether they underachieve in comparison to younger typically developing children. Possible reasons may lie in the research design. Adequately inclusive testing batteries, inclusion of both chronologically matched and spelling ability-matched control groups, as well as scoring of different error categories linked to the types of knowledge required (i.e., phonological, morphological or orthographic), might contribute to a better understanding of where the difficulties lie and how great they are. The present study aims to include these elements by employing a variety of stimuli in order to investigate a range of error categories. Dyslexic-profile pupils are compared with three carefully matched control groups, a chronological age-matched group (CA) and separate reading (RA) and spelling ability-matched groups (SA), to account for potential differences in schooling years and experience with reading which could affect spelling performance.

6.3 Aims of the present study

A lack of consensus regarding discrepancies in the spelling performance of dyslexic participants and typically developing children is evident in the literature (e.g., Alegria & Mousty, 1996; Caravolas & Volín, 2001; Diamanti et al., 2013; Hatcher & Snowling, 2002; Protopapas et al., 2013; Snowling et al., 1991). However, this inconsistency in findings might be due to experimental design. For example, there is not always assignment of a reading and a spelling-age control group, which might result in overlooking useful information. Research findings in different languages have provided evidence to support the universality of dyslexia which affects children's spelling performance. However, the linguistic characteristics of the orthographic system may play a significant role in the manifestation of spelling difficulties aiding or obstructing the application of different spelling skills (e.g., Landerl & Wimmer, 2000; Nikolopoulos et al., 2003).

Hence, the main aim of the present study was to detect any differences in the spelling performance of participants with and without dyslexia supporting the delay or deficit argument. Another aim of the study was to examine the ways in which the properties of the orthographic system may impact on manipulating challenging spelling patterns in two languages with different levels of orthographic consistency but with a morpho-phonemic structure. More specifically the study aimed to:

1) Employ a wide range of spelling features in various parts of speech, which would enable a detailed examination of spelling errors linked to the application of different types of knowledge (i.e., phonological, morphological, orthographic).

2) Include one-to-one chronological age, reading and spelling ability matching for the dyslexic-profile pupils, in order to trace any discrepancies the ability of children with and without dyslexia to apply different types of knowledge when spelling.

3) Draw direct comparisons between children with dyslexia who learn to write in an orthographically inconsistent language (English) and a more consistent language (Greek), to allow for a direct investigation of the role of the orthographic system in the manipulation of challenging spelling patterns.

To achieve these goals, this chapter addresses the following research questions:

A) Do children with dyslexia make similar misspellings to typically developing pupils matched in chronological age, reading age and spelling age? Is there a specific misspelling profile that could characterise the experimental group and distinguish it from their control groups?

To answer this question the spelling errors were analysed at two levels as in the study of typical development (chapter 5), namely at the whole word level and at the morphemic level. The first level differentiated between phonologically misspelled words and orthographically misspelled words to permit direct investigation of the phonological deficit hypothesis, according to which individuals with dyslexia often exhibit persisting phonological difficulties (e.g., Snowling, 1995). The second level of analysis aimed to reveal any prominent difficulties with the application of morphological and orthographic skills when spelling morphologically complex words.

B) What is the role of the orthographic system (English or Greek) in the spelling performance of children with dyslexia writing in two different languages? How could weaknesses in spelling be interpreted in the light of different types of knowledge?

To address this question direct cross-linguistic comparisons of the spelling performance of children with a dyslexic-profile of the same age and attending corresponding grades of primary education in England and Greece were drawn. The extent to which children with dyslexia employ specific spelling skills (i.e., phonological, morphological, orthographic) as a consequence of writing in a more inconsistent orthographic system (English) or a more consistent and highly inflected system (Greek) was investigated by examining their performance at a whole word and a morphemic level of analysis. Direct cross-linguistic comparisons were drawn were permissible and further evidence was extracted by investigating spelling errors within the same language sample.

6.4 Method

6.4.1 Participants, experimental spelling tasks and stimuli

The participants in this study were selected from the same schools as the pupils participating in the cross-linguistic study of typical spelling development discussed in chapter 5. The final dyslexic-profile groups consisted of 18 English native-speaking pupils and 17 Greek native-speaking pupils. Each dyslexic-profile group was matched with a chronological-age (CA) control group, a reading-age (RA) group and a spelling-age (SA) group. Twenty one typically developing children comprised the English CA group, 18 pupils the RA group and 18 pupils the SA group. In Greece 19 pupils formed the CA group, 18 pupils the RA group and 17 pupils the SA group. The selection criteria and characteristics of the two language samples are thoroughly presented in chapter 4, section 4.3.2. The participants completed the same experimental spelling tasks employed for the cross-linguistic study of typical spelling development. The spelling tasks, as well as the properties of the test stimuli and procedure of task administration are described in detail in chapter 4, section 4.3.3.

6.4.2 Statistical analysis

Due to the characteristics of the two orthographic systems, a discrepancy in the total number of letters in the two word-lists was inevitable. As in the study of typical spelling development, integers representing whole misspelled words and proportions of errors were employed in the analyses. The classification of errors, levels of analysis, scoring and statistical methods employed are thoroughly presented in chapter 4, section 4.4. To examine potential phonological weaknesses of the dyslexic-profile children as suggested by the phonological deficit hypothesis (e.g., Snowling, 1995) under the prism of writing in an opaque system (English) and a more transparent system (Greek), the phonologically misspelled words category employed in the study with typically developing children was further divided in two sub-categories. A first category, called phonologically misspelled words, contained the words where at least one phoneme was phonologically misspelled (i.e., its sound was altered). Nonetheless, in some cases phonological and orthographic misspellings co-occurred in the same word. This happened when one phonologically misspelled phoneme was combined with another phoneme whose sound was preserved but was depicted with an alternative grapheme. Hence, a second category of phonological errors was created to include both error types. This category was called phonologically-orthographically misspelled words. Examples of the errors subsumed under each error category are displayed in Table 6.1-Table 6.2, pp. 185-186. Skewed data were transformed to approximate normal distribution but most transformations did not correct the skewness. Nevertheless, all observations were retained to investigate possible differences between groups and parametric methods were preferred to allow for the examination of any interaction effect between variables. Sidak corrections were performed to control for the possibility of inflation of Type I errors due to multiple comparisons. All the results generated from skewed data were confirmed with Mann-Whitney U non-parametric tests. The results are presented in the following section. Means and standard deviations are displayed to indicate central tendencies in the data.

Table 6.1

Examples of English Misspelled Words and Morphemes

	Error				Correct Spelling
Error Category	DP	RA	SA	CA	
PM Word	"assting"	"axadend"	"axadont"	"asident"	"accident"
PT	/æstɪng/	/æxadənd/	/æxadont/	/æsɪsdənt/	/æksɪdənt/
P-OM Word	"arajman"	"aragmat"	"eragment"	"aragment"	"arrangement"
PT	/ə'reɪdʒmən/	/ə'reɪdʒmət/	/ə'reɪdʒmənt/	/ə'reɪdʒmənt/	/ə'reɪndʒmənt/
PP-OM Word	"riton"	"ritn"	"riten"	"ritten"	"written"
PT			/'rɪtən/		
PP-Non-Affixed Word	"cort"	"cout"	"caut"	"court"	"caught"
PT			/'kɔ:t/		
PP-Affixed Word	"memores"	"memorys"	"memerys"	"memoreys"	"memories"
PT			/'meməriz/		
PP-Stem	"<u>bern</u>ing"	"<u>bun</u>ing"	"<u>bern</u>ing"	"<u>burnn</u>ing"	"<u>burn</u>ing"
PT			/bɜ:nɪŋ/		
PP-Derivational suffix	"horibol"	"hori<u>ball</u>"	"horibel"	"horibel"	"horri<u>ble</u>"
PT			/hɒrəbəl/		
PP-Inflectional suffix	"heet<u>id</u>"	"het<u>id</u>"	"heat<u>id</u>"	"heat<u>id</u>"	"heat<u>ed</u>"
PT			/'hi:tɪd/		

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM=Phonologically Plausible-Orthographically Misspelled; PP- = Phonologically Plausible; PT = Phonemic Transcription

Table 6.2

Examples of Greek Misspelled Words and Morphemes

	Error				Correct Spelling
Error Category	DP	RA	SA	CA	
PM Word	"φλιξτάνι"	"φλιντάνι"	"φλινζάνι"	"φλιτσάνι"	"φλιτζάνι"
PT	/flikstani/	/flintani/	/flinzani/	/flit͡sani/	/flid͡zani/
P-OM Word	"μπρηγήπησα"	"πριγκίπισε"	"πρικήπισα"	NA	"πριγκίπισσα"
PT	/briɣipisa/	/prigipise/	/prikipisa/		/prigipisa/
PP-OM Word	"αρόστια"	"αρώστια"	"αρόστια"	"αρρώστεια"	"αρρώστια"
PT			/arostia:/		
PP-Non-Affixed Word	"έπιτα"	"έπυτα"	"έπητα"	NA	"έπειτα"
PT			/epita:/		
PP-Affixed Word	"εκίνισει"	"εκίνιση"	"εκείνιση"	"εκίνηση"	"εκκίνηση"
PT			/ekinisi/		
PP-Stem	"εφτηχέστερη"	"ευτιχιέστερι"	"ευτηχέστεροι"	"ευτιχέστεροι"	"ευτυχέστεροι"
PT			/efticesteri/		
PP-Derivational suffix	"κοινονοικί"	"κοινονηκή"	"κοινωνηκοί"	"κοινωνοικοί"	"κοινωνικοί"
PT			/cinonici/		
PP-Inflectional suffix	"λάθει"	"λάθοι"	"λάθι"	"λάθοι"	"λάθη"
PT			/laθi/		

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM=Phonologically Plausible-Orthographically Misspelled; PP- = Phonologically Plausible; PT = Phonemic Transcription; NA = Non-Applicable

6.5 Results

The present study focused on the children's performance in the single word spelling task because it comprises the largest and most detailed spelling test of all three experimental conditions. In the single word spelling task a constant number of stimuli were dictated. To preserve clarity, separate analyses for the English and the Greek data are presented in the following sections. A subsequent presentation of cross-linguistic comparisons between the two groups of children with dyslexia aims to investigate the effect of language on the children's spelling performance.

6.5.1 Comparisons between the English dyslexic-profile group and typically developing controls

A. Examination of overall misspelled words

In order to evaluate the overall spelling performance of each group of children, the total number of misspelled words was recorded for each participant. Pupils received one point for each misspelled word. Descriptive statistics are presented in Table 6.3, p. 187. The total number of misspelled words were subjected to a one-way Analysis of Variance (ANOVA). Group membership (dyslexic-profile group, reading ability-matched, spelling ability-matched and chronological age-matched control groups) was entered as a between-participants variable. The data obtained from the reading ability group were positively skewed. Transformations did not correct the skewness, hence, raw data were entered in the analysis. The results were verified with non-parametric tests. Sidak corrections were applied to control for inflation of Type I errors due to multiple comparisons.

The results showed a significant main effect of group membership on spelling performance (F (3, 71) = 15.05, $p < .001$, η_p^2=.39) indicating that there were significant differences in the performance of children belonging to different groups. Sidak corrected post hoc pairwise tests between different levels of group membership (DP, RA, SA, and CA) were conducted. The comparisons showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls ($p < .001$). However, the dyslexic-profile children did not differ significantly from their younger reading and spelling ability-matched control groups in overall misspelled words (both p values > .05).

Table 6.3

Means and Standard Deviations of English Misspelled Words per Group of Participants in the Single Word Spelling Task

	English							
	DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	42.5	(9.5)	37.9	(11.6)	37.5	(11.1)	19.7	(13.4)
Phonologically Misspelled Words	8.5	(5.9)	6.5	(4.3)	5.0	(2.6)	3.1	(2.2)
Phonologically-Orthographically Misspelled Words	14.2	(6.6)	11.9	(6.5)	11.3	(6.1)	5.7	(5.4)
PP-Orthographically Misspelled Words	19.8	(7.4)	19.1	(6.7)	20.7	(6.1)	10.4	(8.0)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Maximum number of Misspelled Words = 60. PP-=Phonologically Plausible

B. Comparisons between phonologically misspelled and orthographically misspelled words

An aim of the present study was to examine whether pupils with dyslexia would encounter more difficulties with applying different types of knowledge, i.e., phonological, morphological and orthographic, when spelling in comparison to typically developing children. For this purpose, misspelled words were categorised in three groups, as outlined in chapter 4, section 4.4.2. A first category contained the words where at least one phoneme was phonologically misspelled. All misspelled words where a combination of phonological mistakes and phonologically plausible orthographic errors occurred were subsumed under the phonologically-orthographically misspelled category. When the phonological identity of all phonemes was preserved but were spelled with alternative graphemes, the word was classified under the phonologically plausible-orthographically misspelled category. Examples of the misspelled words under each error category are presented in Table 6.1, p. 185. The data obtained from the chronological-age group in both error categories were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests.

A two-way mixed design ANOVA was performed to investigate differences between dyslexic-profile and control groups and compare their spelling performance in the three error categories. Since all the participants were required to spell the same number of items, integers representing the total number of phonologically misspelled words, phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words were entered as a within-subjects variable (error category) and group membership (DP, RA, SA and CA) as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in Table 6.3, p. 187.

A Mauchly's test revealed that the assumption of sphericity for error categories had been violated ($\chi^2(2) = 25.14$, $p < .001$). Hence, for all effects of error categories degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .815$). The analysis showed that the main effect of error category was significant (F (1.63, 115.72) = 87.58, $p < .001$, η_p^2=.55). In addition, there was a significant main effect of group membership (F (3, 71) = 14.56, $p < .001$, η_p^2=.38) indicating significant differences between children belonging to different groups. However, the interaction between error category and group was not significant (F (4.89, 115.72) = 2.07, $p = .075$, η_p^2=.08) indicating that the difference between phonologically and orthographically misspelled words were comparable at all levels of the group variable. To explore differences between a) the three error categories, as well as b) between the performances of the dyslexic-profile participants and their control groups, post hoc pairwise comparisons were conducted. Since the interaction between error category and group membership was not significant, for (a) the comparisons did not distinguish between groups and for (b) the comparisons did not differentiate between phonologically and orthographically misspelled words. The comparisons between error categories (a) showed that the phonologically misspelled words were significantly fewer than the phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words. In addition, the phonologically-orthographically misspelled words were significantly fewer than the phonologically plausible-orthographically misspelled words (all p values < .001). Along similar lines as the whole-word comparisons, the results of comparisons between groups (b) showed that the dyslexic-profile cohort misspelled significantly more words under all three error categories than their chronological-age controls ($p < .001$) but performed at the same level as their reading and spelling-age controls (both p values $> .05$).

C. Comparisons between errors occurring in non-affixed and affixed words

To examine the effect of morphological complexity on the spelling performance of the dyslexic-profile group, the phonologically plausible errors in monomorphemic and polymorphemic words were analysed. Classification and scoring followed the same principles as for typically developing children (see chapter 4, section 4.4.2). Examples of the errors are presented in Table 6.1, p. 185. The proportions of errors in each error category were calculated to account for the discrepancy in the number of dictated non-affixed and affixed words, i.e., $\frac{Number\ of\ Misspelled\ Non{-}Affixed\ Words}{Total\ Number\ of\ Dictated\ Non{-}Affixed\ Words}$ and $\frac{Number\ of\ Misspelled\ Affixed\ Words}{Total\ Number\ of\ Dictated\ Affixed\ Words}$ respectively. The data obtained from the chronological-age controls in both error categories were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests.

A two-way mixed design ANOVA was performed to investigate differences between groups and compare their spelling performance in the two error categories. Proportions of errors in non-affixed and affixed words were entered as a within-subjects variable (word type) and group membership (DP, RA, SA and CA) as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Because the proportions of errors in some instances were very low, in

Table 6.4, p. 191, percentages of errors, rather than proportions, are presented for ease of interpretation.

Table 6.4

Means and Standard Deviations of Percentages of English Misspelled Non-Affixed and Affixed Words per Group of Participants in the Single Word Spelling Task

	English							
	DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Non-Affixed Words	29.5	(11.9)	30.1	(11.9)	30.9	(14.0)	14.7	(16.1)
Affixed Words	34.8	(14.2)	32.7	(13.3)	35.8	(10.2)	18.0	(13.4)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of Misspelled Patterns are presented for ease of interpretation. Percentage of Misspelled Words = $\frac{\text{Misspelled Words}}{\text{Total Dictated Words}}$ x 100.

The analysis produced a significant main effect of word type (F (1, 71) = 9.99, p = .002, η_p^2=.02) indicating that affixed words attracted significantly more errors than non-affixed words. There was a significant main effect of group membership (F (3, 71) = 8.65, p < .001, η_p^2=.26). However, the interaction between word type and group was not significant (F (3, 71) = 0.24, p = .868, η_p^2=.01) indicating that a) affixed words were consistently misspelled more frequently than non-affixed words by all groups and b) the differences between groups were consistent across word types. To explore differences between the dyslexic-profile participants and their control groups, post hoc pairwise comparisons were conducted. Since no significant interaction between word type and group membership was detected, the comparisons did not distinguish between non-affixed and affixed words. Along similar lines with whole-word comparisons, the results showed that the dyslexic-profile cohort misspelled significantly more non-affixed and affixed words than their chronological-age controls (p = .001) but performed at the same level as their reading and spelling-age controls (both p values > .05).

D. Comparisons of errors occurring in the component morphemes of polymorphemic words

In order to examine whether the dyslexic-profile groups differed from their control groups when spelling the component morphemes of polymorphemic words, further analyses were conducted. Affixed words were divided in stems, derivational and inflectional suffixes. Only phonologically plausible misspellings were included in the analysis. Examples of errors are displayed in Table 6.1, p. 185. Because the number of morphemes was not equal across categories, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Dictated\ Stems}$, $\frac{Number\ of\ Misspelled\ Derivations}{Total\ Number\ of\ Dictated\ Derivations}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Dictated\ Inflections}$. The data in most error groups were normally distributed, with the exception of the errors produced by the chronological-age control group, which produced positively skewed data in all categories and the reading-age controls, who produced positively skewed data in the inflectional suffixes. Transformations did not correct the skewness, hence raw data were entered in the analysis. Proportions of errors in the stem category and the two suffix sub-categories were subjected as a withn-participants variable (morphemes) consisting of three levels (stems, derivations, inflections) to a two-way mixed design ANOVA. Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. The results were verified with non-parametric tests. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions are presented in Table 6.5, p. 193.

A Mauchly's test of sphericity indicated that the assumption of sphericity for morphemes had been violated ($\chi^2(2) = 14.06$, $p < .001$). Therefore, for all effects of morphemes, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .901$). The analysis showed a significant main effect of morphemes (F (1.80, 127.94) = 124.40, p <.001, η_p^2=.63) and a significant main effect of group membership (F (3, 71) = 9.70, p <.001, η_p^2=.29). The interaction between morphemes and group membership was significant (F (5.40, 127.94) = 3.08, p = .016, η_p^2 = .10) indicating that a) the difference between morphemes was not consistent across all groups and/or b) the differences between groups were not consistent across error categories.

Table 6.5

Means and Standard Deviations of Percentages of Misspellings in English Morphemes per Group of Participants in the Single Word Spelling Task

	English							
	DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	45.7	(12.5)	40.7	(15.7)	43.8	(15.5)	20.68	(17.6)
Derivational Suffixes	35.3	(9.6)	35.3	(20.4)	39.2	(17.3)	19.3	(17.5)
Inflectional Suffixes	19.2	(12.3)	16.9	(8.6)	17.1	(7.1)	7.3	(9.4)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of Misspelled Patterns are presented for ease of interpretation. Percentage of Misspelled Morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Misspelled Morphemes}}$ x 100.

To investigate the simple effect of group membership on the error rates at each level of morphemes, separate one-way univariate ANOVAs were performed. The analysis of the errors in stems showed a significant main effect of group (F (3, 71) = 11.09, $p < .001$, η_p^2=.32). Post hoc pairwise comparisons showed that the dyslexic-profile group produced significantly higher error rates when spelling the stems of the words than the chronological-age controls ($p < .001$), but their error rates were not significantly different from those of their younger reading and spelling-age controls (both p values > .05). The analysis of derivational suffixes revealed that the differences between groups were significant (F (3, 71) = 5.56, p = .002, η_p^2=.19). Along similar lines with stems, post hoc pairwise comparisons showed that the dyslexic-profile group made significantly more errors in the derivations than the chronological-age controls (p = .025). However, they did not perform significantly differently from their younger reading and spelling-age controls (both p values > .05). Finally, the results of the analysis of the inflectional suffixes showed a significant main effect of group (F (3, 71) = 6.16, p = .001, η_p^2=.20). As for the stems and derivations, post hoc pairwise comparisons showed that the dyslexic-profile group misspelled significantly more inflections than the chronological age-matched children (p = .001), but that the performances of the dyslexic-profile group, the reading and the spelling-age controls were not significantly different (both p values > .05).

To explore the simple effect of morphemes on each level of group membership, one-way repeated-measures ANOVAs were performed for each group of participants. Mauchly's test for the dyslexic-profile group indicated that the data complied with the assumption of sphericity for Morphemes ($\chi^2(2) = 1.20$, $p > .05$). The results on the data obtained from the dyslexic-profile group showed a significant main effect of morphemes (F (2, 34) = 40.71, $p < .001$, $\eta_p^2 = .70$). Post hoc pairwise comparisons revealed that children misspelled stems more frequently than derivational suffixes ($p = .003$) and considerably more frequently than inflectional suffixes ($p < .001$). Within suffixes, errors in derivations were more frequent than in inflections ($p < .001$). Mauchly's test for the chronological-age controls showed a violation of the assumption of sphericity for morphemes ($\chi^2(2) = 9.23$, $p < .05$). Hence, for the effect of morphemes degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .763$). The analysis showed a significant main effect of morphemes (F (1.52, 30.53) = 15.68, $p < .001$, $\eta_p^2 = .44$). Post hoc pairwise comparisons revealed that the error rates of the chronological-age controls in stems and derivational suffixes were not significantly different ($p = .832$). On the other hand, inflectional suffixes were misspelled significantly less frequently than stems and derivational suffixes ($p < .001$ and $p = .003$ respectively). Mauchly's test for the reading-age controls indicated that the data adhered to the assumption of sphericity for morphemes ($\chi^2(2) = 3.16$, $p > .05$). The analysis revealed a significant main effect of morphemes (F (2, 34) = 27.52, $p < .001$, $\eta_p^2 = .61$). Post hoc pairwise comparisons indicated that following a similar pattern as the chronological-age group the error rates of the reading-age controls in stems and derivational suffixes were not significantly different ($p = .232$). Additionally, significantly higher error rates occurred in the inflectional suffixes than in the stems and in the derivations ($p < .001$ and $p = .001$ respectively). Finally, Mauchly's test for the spelling-age controls indicated that the data conformed to the assumption of sphericity for morphemes ($\chi^2(2) = 3.92$, $p > .05$). The analysis illustrated a significant main effect of morphemes (F (2, 34) = 44.41, $p < .001$, $\eta_p^2 = .72$). Post hoc pairwise comparisons showed that similarly to all other control groups, the errors of spelling-age controls in stems and derivational suffixes did not differ significantly ($p = .192$), but both these morphemes attracted higher error rates than inflectional suffixes (both p values < .001). Therefore, it seems that the difference between stems and derivational suffixes was more profound for the dyslexic-profile group, whereas the typically developing controls did not perform significantly different when spelling these morphemes. On the other hand, inflectional suffixes were consistently more accurately spelled than both the stems and the derivations. These differences in the spelling profiles of the dyslexic-profile group and the typically developing children, as well as the distinctive approach to individual morphemes might be the sources of the morphemes by group interaction.

In summary, the examination of whole-word performance showed that the dyslexic-profile participants misspelled significantly more target-words than typically developing children of the same age. However, they performed at similar levels with their younger controls matched in reading and spelling ability. A similar pattern was obvious in phonological misspellings, phonological-orthographic misspellings and phonologically plausible-orthographic misspellings, non-affixed and affixed words, as well as in the component morphemes of the latter. As concerns the comparisons between error categories, the phonological errors (both phonologically misspelled and phonologically-orthographically misspelled words) were significantly fewer than the phonologically plausible orthographic errors for English pupils in the dyslexic-profile and the control groups. In addition, all groups misspelled a larger proportion of affixed than non-affixed words, which shows a profound difficulty with polymorphemic items. Within affixed words, only the dyslexic-profile group misspelled the stems more frequently than the derivations, and the derivations more frequently than the inflections. In all control groups, the difference between the error rates in stems and derivations was not significant, whereas inflections were always more accurately spelled than the first two morphemes.

6.5.2 Comparisons between the Greek dyslexic-profile group and typically developing controls

A. Examination of overall misspelled words

Integers representing the total number of misspelled words were subjected to a one-way ANOVA. Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were applied to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in Table 6.6, p. 196. The analysis produced a significant main effect of group membership on spelling performance (*F* (3, 67) = 28.60, $p < .001$, η_p^2=.56). Post hoc pairwise comparisons between different levels of group membership (DP, RA, SA, and CA) showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls ($p < .001$). The dyslexic-profile group did not differ significantly from their younger reading and spelling ability-matched control groups in overall misspelled words (both *p* values > .05).

Table 6.6

Means and Standard Deviations of Greek Misspelled Words per Group of Participants in the Single Word Spelling Task

	Greek							
	DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	40.2	(8.2)	34.7	(10.0)	37.2	(8.6)	16.6	(7.0)
Phonologically Misspelled Words	1.7	(1.1)	1.1	(1.2)	1.2	(1.4)	0.4	(0.8)
Phonologically-Orthographically Misspelled Words	2.7	(1.6)	2.0	(2.3)	3.0	(3.5)	0.4	(0.6)
PP-Orthographically Misspelled Words	35.7	(7.9)	31.5	(8.8)	32.9	(6.6)	15.7	(6.5)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Maximum number of Misspelled Words = 60; PP-=Phonologically Plausible-

B. Comparisons of phonologically misspelled and orthographically misspelled words

Examples of the Greek misspelled words are presented in Table 6.2, p. 186. The data obtained from the all three control groups in the phonologically-orthographically misspelled category were positively skewed producing positively skewed variables. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests.

Integers representing the total number of phonologically misspelled words, phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words were subjected to a two-way mixed design ANOVA as a within-subject variable (error category). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in Table 6.6, p. 196.

A Mauchly's test revealed that the assumption of sphericity for error categories had been violated ($\chi^2(2) = 112.31$, $p < .001$). Hence, for all effects of error categories degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .578$). The results indicated a significant main effect of error category (F (1.15, 77.39) = 891.17, $p < .001$, η_p^2=.93). In addition, there was a significant main effect of group membership (F (3, 67) = 28.57, $p < .001$, η_p^2=.56) and a significant interaction between error category and group (F (3.46, 77.39) = 20.65, $p < .001$, η_p^2=.48).

The interaction was explored by investigating the simple effect of group membership on the error rates at each level of error category was explored with separate one-way univariate ANOVAs. The analysis of the phonologically misspelled words showed a significant effect of group (F (3, 67) = 3.71, $p = .016$, η_p^2=.14). Post hoc pairwise comparisons showed that the dyslexic-profile group produced significantly more phonologically misspelled words than the chronological-age controls ($p = .011$), but their error rates were not significantly different from those of their younger reading and spelling-age controls (both p values > .05). A significant effect of group was also revealed for the phonologically-orthographically misspelled words (F (3, 67) = 4.73, $p = .005$, η_p^2=.17). Post hoc pairwise comparisons showed that the dyslexic-profile group produced significantly more phonologically misspelled words than the chronological-age controls (p

= .018), but their error rates were not significantly different from those of their younger reading and spelling-age controls (both p values > .05). The analysis of phonologically plausible-orthographically misspelled words indicated that the differences between groups were significant (F (3, 67) = 25.86, p < .001, η_p^2=.53). Post hoc pairwise comparisons showed that the dyslexic-profile group made significantly more errors than the chronological-age controls (p < .001), but did not perform significantly differently from their younger reading and spelling-age controls (both p values > .05).

Table 6.7

Results of Post Hoc Pairwise Comparisons between Phonologically and Orthographically Misspelled Words per Group of Greek Participants

Error Categories	DP	RA	SA	CA
PM = P-OM	p = .056	p = .211	p = .071	p = 1.00
PM < PP-OM	p < .001	p < .001	p < .001	p < .001
P-OM < PP-OM	p < .001	p < .001	p < .001	p < .001

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically misspelled words; P-OM = Phonologically-orthographically misspelled words; PP-OM = Phonologically plausible-orthographically misspelled words

To investigate the simple effect of error category on each level of group membership, the three categories of misspelled words were subjected to one-way repeated-measures ANOVAs for each group of participants. A Mauchly's test on the data obtained from the dyslexic-profile group showed that the assumption of sphericity for error categories had been violated (χ^2(2) = 31.56, p < .001). Hence, for all effects of error categories degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .539). The results showed a significant main effect of error category (F (1.07, 17.25) = 285.01, p < .001, η_p^2 = .94). Post hoc pairwise comparisons showed that phonologically and phonologically-orthographically misspelled words did not differ significantly, while both these error categories contained lower error rates than the phonologically-plausible orthographically misspelled words (see (Table 6.7, p. 198). Similar results were produced for all control groups. The results on data obtained from the CA group showed a significant effect of error category (Mauchly's test χ^2(2) = 47.97, p < .001; df corrected at ε = .518; F (1.03, 18.65) = 107.92, p < .001, η_p^2 = .85). Similar were the results for the RA group (Mauchly's test χ^2(2) = 31.96, p < .001; df corrected at ε = .543; F (1.08, 18.47) = 205.00, p < .001,

η_p^2 = .92) and the SA group (Mauchly's test $\chi^2(2) = 13.80$, p = .001; *df* corrected at ε = .652; F (1.30, 20.85) = 307.06, $p < .001$, η_p^2 = .95). Post hoc pairwise comparisons produced similar results as for the dyslexic-profile group (Table 6.7, p. 198). An inspection of the sizes of the simple effect of group on different error categories indicates that the effect of group on phonologically plausible-orthographically misspelled words was stronger than the effect of group on phonologically misspelled and phonologically-orthographically misspelled words, which might be the source of the error category by group interaction.

C. Comparisons of errors occurring in non-affixed and affixed words

Examples of the errors in Greek non-affixed and affixed words are presented in Table 6.2, p. 186. For similar reasons as for the English data, the counts were normalised by calculating the ratios of non-affixed and affixed words, i.e., $\frac{Number\ of\ Misspelled\ Non{-}Affixed\ Words}{Total\ Number\ of\ Dictated\ Non{-}Affixed\ Words}$ and $\frac{Number\ of\ Misspelled\ Affixed\ Words}{Total\ Number\ of\ Dictated\ Affixed\ Words}$ respectively. The data obtained from the dyslexic-profile group and the chronological-ability group in non-affixed words were positively skewed. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests. Proportions of errors in non-affixed and affixed words were subjected as a within-subjects variable to a two-way mixed design ANOVA to explore differences between these two error categories. Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions, are presented in Table 6.8, p. 200.

The results showed a significant main effect of word type (F (1, 67) = 84.54, p <.001, η_p^2=.55) signifying that the error rates in affixed words were significantly higher than those in non-affixed words. There was a significant main effect of group membership (F (3, 67) = 23.42, $p < .001$, η_p^2=.51) but the interaction between word type and group was not significant (F (3, 67) = 1.80, p = .156, η_p^2=.07) implying that a) affixed words attracted consistently more errors than non-affixed words for all groups and b) the differences between groups were consistent across error categories.

Table 6.8

Means and Standard Deviations of Percentages of Greek Misspelled Non-Affixed and Affixed Words per Group of Participants in the Single Word Spelling Task

	Greek							
	DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Non-Affixed Words	44.4	(14.1)	38.8	(13.8)	43.1	(12.3)	18.7	(11.7)
Affixed Words	60.5	(14.2)	53.4	(16.4)	55.6	(12.8)	26.4	(11.1)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of Misspelled Patterns are presented for ease of interpretation. Percentage of Misspelled Words = $\frac{\text{Misspelled Words}}{\text{Total Dictated Words}}$ x 100.

To explore differences between the dyslexic-profile participants and their control groups, post hoc pairwise comparisons were conducted. Since the error category by group interaction was not significant, comparisons did not distinguish between non-affixed and affixed words. The results showed that the dyslexic-profile group misspelled significantly more non-affixed and affixed words than their chronological-age controls ($p < .001$). However, no significant differences were found between the first and their reading and spelling-age controls (both p values > .05).

D. <u>Comparisons of errors occurring in the component morphemes of polymorphemic words</u>

Examples of errors produced in the component morphemes of the Greek affixed words are displayed in Table 6.2, p. 186. Because the number of morphemes was not equal across categories, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Dictated\ Stems}$, $\frac{Number\ of\ Misspelled\ Derivations}{Total\ Number\ of\ Dictated\ Derivations}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Dictated\ Inflections}$. The data obtained from all three control groups in derivational suffixes were positively skewed. In addition, the chronological-age and the reading-age controls produced positively skewed data in the inflectional suffixes. Square root transformations did not correct the skewness, hence raw data were entered in the analysis. The results were verified with non-parametric tests. A two-way mixed design

ANOVA was employed to explore between errors in the stems, in the derivational suffixes and in the inflectional suffixes and between groups (morphemes). Proportions of errors under each morpheme were entered as a within-subjects variable and group membership (DP, RA, SA and CA) as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. Percentages of errors are presented in Table 6.9, p. 201.

Table 6.9

Means and Standard Deviations of Percentages of Misspellings in Greek Morphemes per Group of Participants in the Single Word Spelling Task

	Greek							
	DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	53.4	(15.4)	47.4	(16.3)	49.6	(15.2)	20.6	(8.5)
Derivational Suffixes	20.4	(9.3)	19.5	(12.6)	22.6	(10.5)	7.2	(6.8)
Inflectional Suffixes	15.3	(5.4)	11.7	(5.8)	13.6	(5.4)	6.2	(5.1)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of Misspelled Patterns are presented for ease of interpretation. Percentage of Misspelled Morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Misspelled Morphemes}}$ x 100.

A Mauchly's test of sphericity indicated that the assumption of sphericity for morphemes had been violated ($\chi^2(2) = 8.45$, $p < .05$). Hence, for all effects of morphemes, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .957$). The analysis produced a significant main effect of morphemes (F (1.91, 128.17) = 297.06, p <.001, η_p^2=.81) and a significant main effect of group membership (F (3, 67) = 20.19, p <.001, η_p^2=.47). The interaction between morphemes and group membership was significant (F (5.73, 128.17) = 9.85, p < .001, η_p^2 = .30) indicating that a) the difference between morphemes was not consistent across all groups or b) the differences between groups was not consistent across error categories.

The interaction was investigated with one-way univariate ANOVAs, which were performed to explore the simple effect of group membership on the error rates at each level of morphemes. The analysis of the errors in stems showed a significant effect of group (*F* (3, 67) = 20.77, $p < .001$, η_p^2=.48). Post hoc pairwise comparisons revealed that when spelling the stems of the words the dyslexic-profile group made significantly more errors than the chronological-age controls ($p < .001$), but their error rates did not differ significantly from those of the younger reading and spelling-age controls (both *p* values > .05). The analysis of derivational suffixes showed a significant main effect of group (*F* (3, 67) = 8.84, $p < .001$, η_p^2=.28). Following a similar pattern as in stems, post hoc pairwise comparisons showed that when spelling derivations the dyslexic-profile group made significantly more errors than the chronological-age controls ($p = .001$), but did not perform significantly differently from their younger reading and spelling-age controls (both *p* values > .05). Finally, the results of the analysis of inflectional suffixes showed a significant difference between groups (*F* (3, 67) = 9.48, $p < .001$, η_p^2=.29). In accord with stems and derivations, post hoc pairwise comparisons showed that the dyslexic-profile group made significantly more errors than the chronological age-matched children ($p < .001$), whereas the differences with their reading and spelling-age controls were not significant (both *p* values > .05).

Further exploring the interaction, one-way repeated-measures ANOVAs were employed to investigate the simple effect of morphemes on each level of group membership. Mauchly's test for the dyslexic-profile group indicated that the data had violated the assumption of sphericity for morphemes ($\chi^2(2) = 8.25$, $p < .05$). Therefore, degrees of freedom for morphemes were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .750$). The results showed a significant main effect of morphemes (*F* (1.50, 23.99) = 110.83, $p < .001$, $\eta_p^2 = .87$). Post hoc pairwise comparisons indicated that the dyslexic-profile children misspelled stems more frequently than derivational and inflectional suffixes (both *p* values < .001). Within suffixes, errors in derivations were more frequent than in inflections ($p = .033$). Mauchly's test for the chronological-age controls showed that the data adhered to the assumption of sphericity for morphemes ($\chi^2(2) = 0.40$, $p > .05$). The analysis showed a significant main effect of morphemes (*F* (12, 36) = 39.10, $p < .001$, $\eta_p^2 = .68$). Post hoc pairwise comparisons indicated that the error rates of the chronological-age controls in the stems were significantly higher than those in the derivational and inflectional suffixes (both *p* values < .001), but that the errors in derivations and inflections were not significantly different (p = .924). Mauchly's test for the reading-age controls indicated that the data complied with the assumption of sphericity for morphemes ($\chi^2(2) = 0.70$, $p > .05$). The analysis produced a significant main effect of morphemes (F (2, 34) = 72.83, $p < .001$, $\eta_p^2 = .81$). Post hoc pairwise comparisons indicated that following a similar pattern as the dyslexic-profile group the error rates of the reading-age controls in the stems were significantly higher than in derivational and inflectional suffixes (both p values < .001) and that the errors in derivations were more frequent than in inflections (p = .036). Finally, Mauchly's test for the spelling-age controls indicated no violation of the assumption of sphericity for morphemes ($\chi^2(2) = 2.47$, $p > .05$). The analysis illustrated a significant main effect of morphemes (F (2, 32) = 75.31, $p < .001$, $\eta_p^2 = .82$). Post hoc pairwise comparisons showed that similarly to the dyslexic-profile group and the reading-age group, the spelling-age controls misspelled the stems more frequently than the derivational and the inflectional suffixes (both p values < .001), and the derivations more frequently than the inflections (p = .005). Therefore, it seems that the spelling profiles of the dyslexic-profile group and the younger control groups were similar, while the performance of the chronological-age controls when spelling the various morphemes followed a unique pattern. More specifically, the CA group seemed to misspell the stems of the words more frequently than the suffixes but their errors in derivations and inflections did not differ significantly. On the contrary the derivations were misspelled significantly more frequently than the inflections of the words by the DP, RA and SA group. This discrepancy in spelling profiles seems to be the source of the morphemes by group interaction.

In summary, as illustrated by the results of all the between-group comparisons, Greek pupils with a dyslexic-profile produced significantly higher error rates than their chronological-age controls but their performance was not significantly different from that of the younger reading and spelling ability-matched controls. With regard to differences between error categories, all groups of children made significantly more phonologically plausible orthographic errors (PP-OM) than phonological errors (P-OM). Additionally, all groups made significantly higher error rates in the affixed than in the non-affixed words, confirming that polymorphemic words are particularly challenging for both children with dyslexia and typically developing children. Finally, the dyslexic-profile group produced significantly more errors in the stems of affixed words than in the derivational suffixes, while the inflectional suffixes were consistently spelled more accurately than stems and derivations. The spelling profile of the two younger control groups (i.e., RA and SA) followed a similar pattern as the dyslexic-profile group, while the chronological-age controls showed a unique profile where stems were more frequently misspelled than derivations, but the difference between derivations and inflections was not statistically significant.

6.5.3 Comparisons between the English and the Greek dyslexic-profile groups

The analyses of the data obtained from the English and the Greek sample revealed common characteristics in their spelling profiles as compared with the performances of the three control groups. In addition, specific error categories appeared to produce significantly more challenges than others despite the fact that the children were writing in two different orthographic systems. On the other hand, there were error categories that seemed to attract particularly high error rates for the dyslexic-profile pupils of one or the other language sample. To investigate the effect of language, cross-linguistic comparisons were drawn. Since the language effect on the spelling performance of typically developing spellers was investigated in chapter 5, this section focuses on any effect of language on the performance of the two dyslexic-profile groups. The interest of the analysis is particularly directed on the main effect of language, since the differences between error categories were explored in the analyses on separate language samples. Since the English and Greek word lists were matched for whole items but not for morphemes, comparisons across languages were not performed for the component morphemes of polymorphemic words. Because spelling performance might depend on years of schooling and age, the two groups were matched on both variables and non-verbal ability (see chapter 4, section 4.3.2.4).

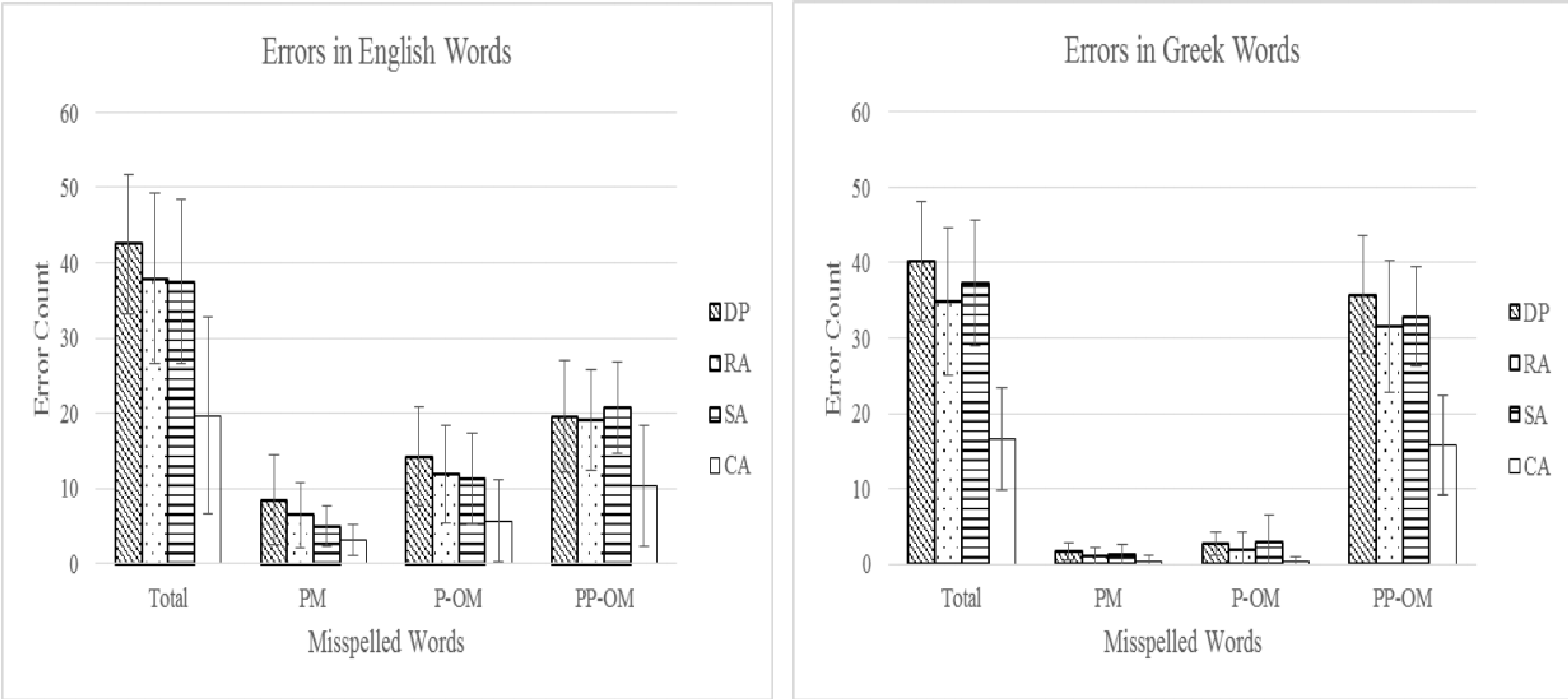


Figure 6.1

Means and Standard Deviations of Misspelled Words per Language Group (English, Greek).

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

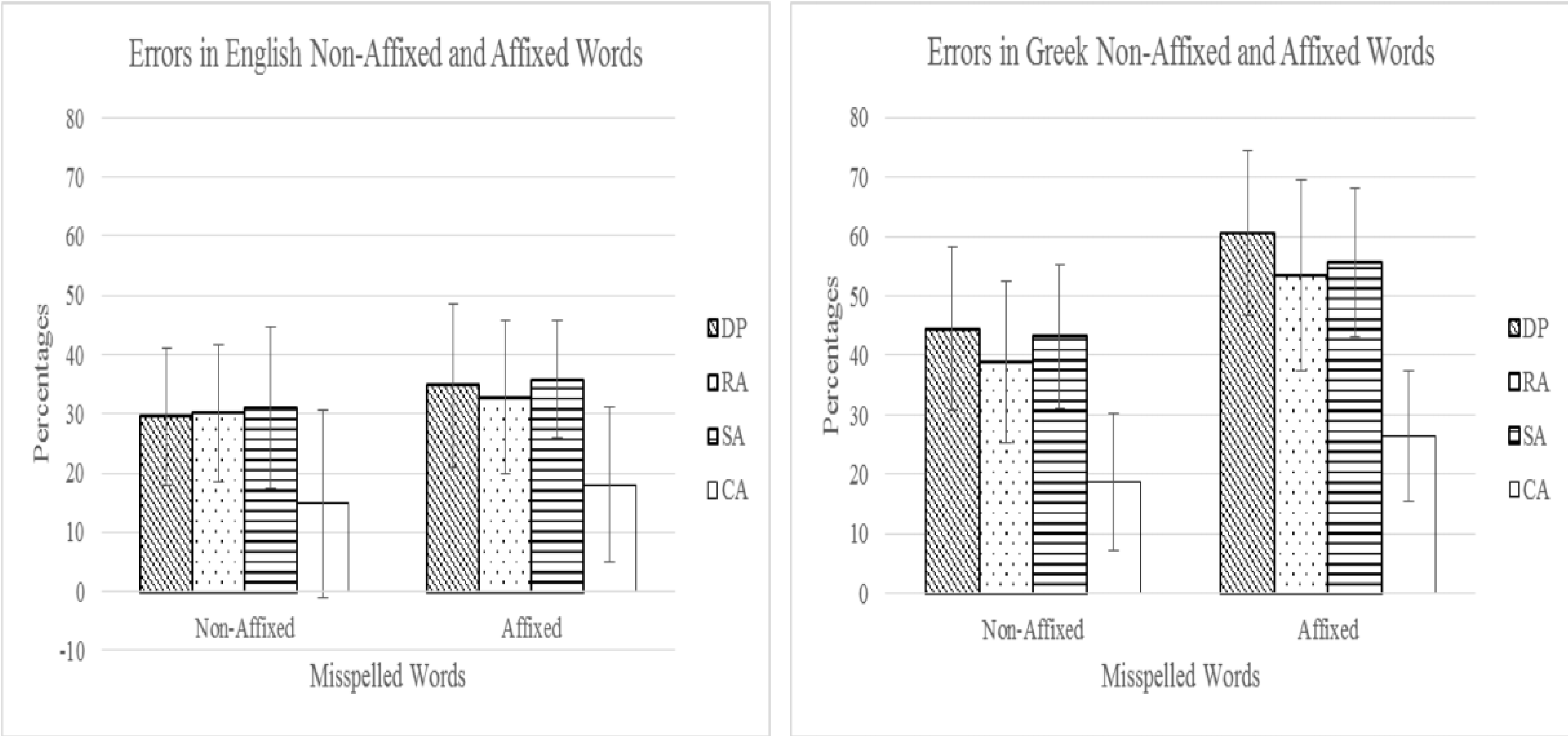
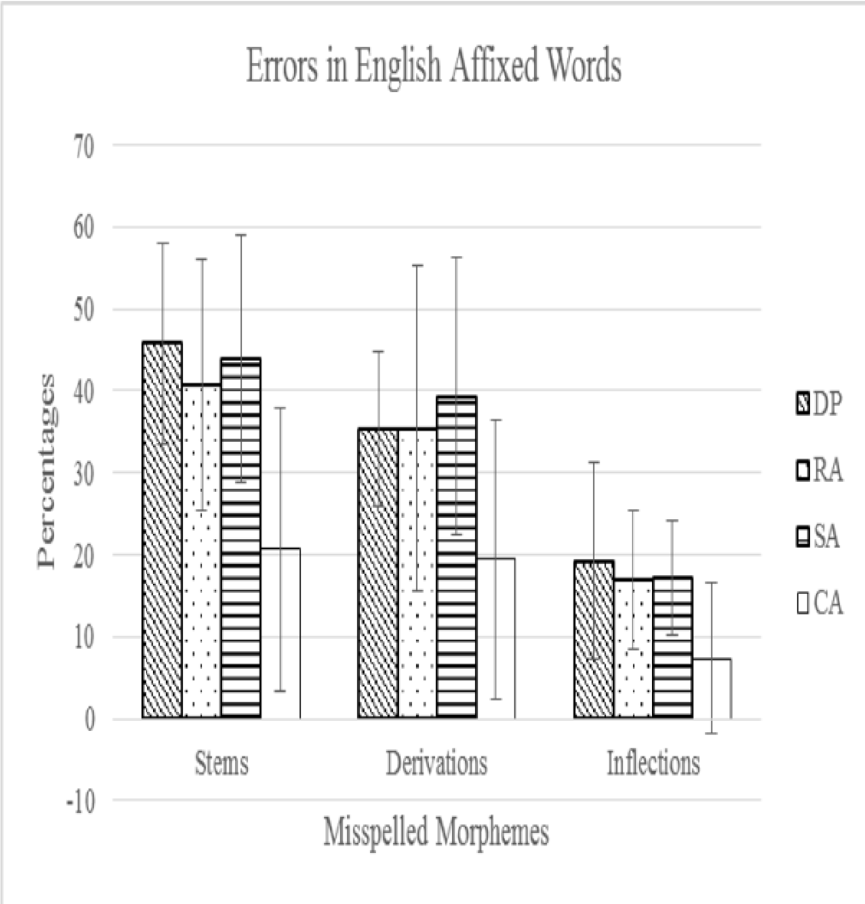


Figure 6.2

Means and Standard Deviations of Percentages of Misspelled Non-Affixed and Affixed Words per Language group (English, Greek)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age



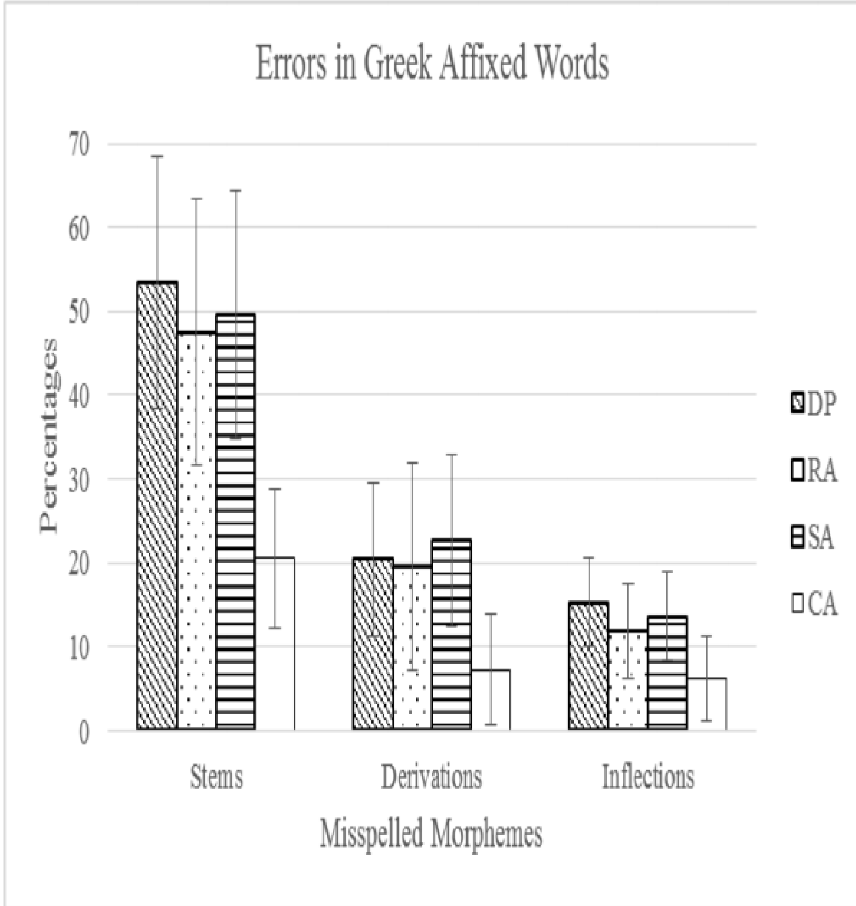


Figure 6.3

Means and Standard Deviations of Percentages of Misspelled Morphemes per Language group (English, Greek)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age

All comparisons were drawn with parametric analyses. When skewed data were included in the analyses, the results were verified with non-parametric tests (Mann-Whitney U). Since the differences between groups and between error categories were explored in the previous sections the interest of these analyses focused on any cross-linguistic discrepancies in each error category. The data under each error category were subjected to separate one-way ANOVAs. Language group membership (English, Greek) was entered as the independent variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Integers representing the total number of misspelled words were employed for whole misspelled words, phonologically misspelled, phonologically-orthographically misspelled and phonologically plausible-orthographically misspelled words. Descriptive statistics are displayed in Table 6.3 - Table 6.6, pp. 187-196, and Figure 6.1 - Figure 6.2, pp. 205-206. For affixed and non-affixed words, proportions of errors were used. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions, are presented in Table 6.4 and Table 6.8, pp. 191 and 200.

The ANOVA on overall misspelled words showed that English and Greek dyslexic-profile children did not perform significantly differently to each other (F (1, 33) = 0.59, p = .448, η_p^2=.02; Figure 6.1, p. 205). Possible differences between dyslexic-profile children writing in two languages of different level of orthographic consistency were explored by subjecting each error category (phonologically misspelled, phonologically-orthographically misspelled and phonologically plausible-orthographically misspelled words) in a separate one-way ANOVA. A significant main effect of language was revealed for phonologically misspelled words (F (1, 33) = 21.27, p < .001, η_p^2=.39) and phonologically-orthographically misspelled words (F (1, 33) = 47.81, p < .001, η_p^2=.59) implying that English pupils made significantly more phonological errors than Greek pupils. On the other hand, the significant main effect of language revealed by the analysis of the phonologically plausible-orthographically misspelled words (F (1, 33) = 38.25, p < .001, η_p^2=.53) suggested that Greek dyslexic-profile pupils made significantly more orthographic errors than their English peers. Two separate one-way ANOVAs were also performed for each word type (non-affixed and affixed words). The results of the analysis of non-affixed words indicated a significant main effect of language (F (1, 33) = 11.34, p = .002, η_p^2=.25) implying that the Greek dyslexic-profile group made significantly more errors than the English group. The analysis of affixed words produced similar results (F (1,

33) = 28.62, $p < .001$, η_p^2=.46) indicating that Greek children misspelled significantly more polymorphemic words than their English peers.

In summary, the cross-linguistic analyses showed that Greek children with dyslexia performed better than their English peers in both categories containing phonological errors and English pupils performed better than Greek children in the phonologically plausible orthographic errors' category. In accord with the latter result, Greek pupils with a dyslexic-profile seemed to be poorer in comparison to their English peers when spelling both the non-affixed and the affixed words.

6.6 Discussion

The present study aimed to compare the spelling performance of children with dyslexia and typically developing spellers attending years 4-6 in England and grades 4-6 in Greece. The first aim of the analysis was to investigate potential differences among groups which would illustrate a spelling profile related to dyslexia. The effect of orthographic inconsistency, morphological complexity, type of morpheme and type of knowledge required for correct spelling was also explored by comparing the performance of the participants when spelling a variety of stimuli. Close matching of the word-lists in frequency levels, grapho-phonemic complexity, parts of speech and length allowed for a detailed examination of atypical spelling performance in two orthographic systems. The target-words consisted of various combinations of consonant and vowel phonemes, which are considered to pose certain challenges for spelling and which were included both in the stems and the suffixes. In this section the results of the analyses are discussed in relation to findings of previous research with the aim to further our knowledge about spelling difficulties of children with dyslexia and delineate possible similarities or differences in the spelling profiles of children writing in two languages of different orthographic consistency.

Primarily, the results of all pairwise comparisons showed that the dyslexic-profile participants in both language samples produced significantly more misspellings than typically developing children matched in chronological-age. However, they performed at similar levels with their younger controls matched in reading and spelling ability. This finding was consistent when analysing error rates in whole target-words, phonologically misspelled, phonologically-orthographically misspelled and phonologically plausible-orthographically misspelled words, non-affixed and affixed words, as well as the component morphemes of the latter.

With regard to cross-linguistic comparisons, the examination initially focused on overall misspelled words. The results showed similar spelling profiles for English and Greek participants of all groups indicating that words requiring competent application of phonological, morphological and orthographic knowledge produce significant challenges for pupils with dyslexia in both language groups. Nonetheless, the role of the orthographic system became evident when the misspelled words were further distinguished in those containing phonological errors and those containing only morphological and orthographic errors. When phonologically misspelled words were compared, significantly higher error rates were evident for the English children in comparison to the Greek children. This is in accord with literature suggesting that in more transparent orthographic systems difficulties in phonological spelling gradually diminish as pupils grow older (Landerl & Wimmer, 2000; Nikolopoulos et al., 2003). In contrast, English pupils were significantly better than Greek children in orthographic spelling, at all levels of analysis. In particular, English pupils seemed to be better at applying morphological and orthographic knowledge when spelling both monomorphemic and polymorphemic words. The results obtained from the typically developing children (chapter 5) showed a comparable discrepancy in the spelling profiles of the English and Greek samples, indicating that the magnitude of phonological error rates may be attributable to the level of orthographic consistency of the two languages. Furthermore, apart from enhancing phonological spelling, semi-transparency of the Greek language might also result in Greek spellers over-relying on their phonological knowledge as has been suggested in previous studies (e.g., Nikolopoulos et al., 2003). Overreliance on phonological skills would, therefore, result in children with dyslexia overlooking morphological rules and making less extended use of their stored orthographic representations in spelling. This might be an explanation of their higher error rates in comparison to their English peers in all error categories examining phonologically plausible misspellings. Moreover, the advantage of English pupils in orthographic spelling may be supported by previous studies assessing reading in English and German (Goswami et al., 2003; Wimmer & Goswami, 1994; Ziegler et al., 2001). A common finding stemming from those studies was that children learning to read a more consistent orthography, i.e., German, tended to rely more extensively on grapheme-to-phoneme correspondence (GPC) rules, whereas English speaking children reinforced GPC decoding with rhyme or whole word strategies. The results of the present study are in line with this suggestion and provide evidence for its application to spelling processes as well.

The important role of language could be additionally supported when inspecting the spelling profiles of the two dyslexic-profile groups in relation to their control groups. In detail, the English children with dyslexia showed a unique profile in comparison to all three control groups, since the latter misspelled the stems of the words as frequently as the derivations. On the other hand, the Greek dyslexic group showed a similar spelling profile to the younger reading-age and spelling-age controls spelling the inflections more accurately than the derivations. In turn, all three groups differed from the chronological-age controls, whose performance did not differ significantly between derivations and inflections.

6.6.1 The spelling portrait of children with a dyslexic profile writing in different orthographic systems

Overall, the comparisons between the spelling performance of children with dyslexia and typically developing children are in agreement with previous studies in English and Greek (e.g., Diamanti, Goulandris, Stuart, & Campbell, 2013; Egan & Tainturier, 2011; Nikolopoulos et al., 2003; Protopapas et al., 2013; Tsesmeli & Seymour, 2006). The findings appear to support the notion that dyslexia affects the speed of spelling development resulting in children lagging behind their chronological-age controls but not their younger reading and spelling ability-matched controls.

The observed differences between reading and spelling ability-matched groups were neither quantitatively nor qualitatively significant. This is in agreement with findings of previous research (e.g., Bruck & Treiman, 1990) and would indicate that spellings produced by children with dyslexia are not different in nature to those of younger typically developing pupils. An inspection of the errors produced by the participants of the present study confirmed that the majority of the pupils with a dyslexic-profile did not make "abnormal" mistakes. This is in accord with the suggestion that a deviant spelling profile can only be inferred when "bizarre" spellings occur (Kessler & Treiman, 2001; Treiman, 1997). Hence, findings in both English and Greek comply with the claim that pupils with dyslexia exhibit a delay in the development of spelling skills rather than a deviance, as suggested by previous research (e.g., Treiman, 1997).

The pattern of developmental delay was also evident when examining the errors in relation to the type of knowledge required for correct spelling, namely phonological, orthographic and morphological. As concerns phonological error rates produced by the Greek dyslexic-profile group (examples are presented in Table 6.2, p. 186), no significant discrepancy was apparent in comparison to typically developing children belonging in all three control groups. These results are in agreement with the studies by Caravolas and Volín (2001) in Czech, Diamanti (2005), Douklias, Masterson and Hanley (2009), Protopapas et al. (2013) in Greek and Hoefflin and Franck (2005) in French. In addition, the mean percentage of phonologically misspelled words produced by pupils with dyslexia was 2.8 % and the mean percentage of phonologically-orthographically misspelled words was 4.6 % of the dictated words, in accord with findings of previous studies in orthographically consistent writing systems suggesting that phonological errors are not as prevalent as orthographic errors and decrease as pupils proceed to the final grades of primary school (Angelelli et al., 2004; Nikolopoulos et al., 2003; Protopapas et al., 2013; Wimmer & Schurz, 2010). Nevertheless, the present findings support the notion that children with dyslexia are confronted with enduring phonological difficulties even at the final grades of primary school although not significantly more than what is expected for their ability.

Similar results were produced for the English dyslexic-profile group, which were significantly weaker in phonological spelling in comparison to the chronological-age control group but not to the younger reading and spelling-age matched children (examples are presented in Table 6.1, p. 185). The present results conform to the phonological deficit hypothesis (e.g., Ramus et al., 2003; Snowling, 1995; Stanovich & Siegel, 1994) regarded as a delay in the development of phonological spelling skills. The lack of a significant difference in the phonological error rates of children with a dyslexic profile in comparison to younger reading and spelling ability-matched children might also be explained by the extensive phonics teaching implemented in schools in the framework of the National Literacy Strategy (1998). Furthermore, all participants with a dyslexic profile had received explicit phonics training aiming to improve their phonological skills both in the mainstream classroom and as part of the additional support in literacy provided by their schools to pupils attending the action and action plus programmes. It is interesting to note that all groups of English speaking children produced more phonological errors than their Greek peers. Especially the English dyslexic-profile group produced phonological errors in 14.1 % of the dictated words and phonological-orthographic errors in 23.7 %, both of which are significantly higher percentages than the corresponding error rates of the Greek dyslexic-profile group (2.8 % and 4.6 % respectively). This result is in line with findings from previous research in languages with different levels of consistency (e.g., Alegria & Mousty, 1996; Landerl & Wimmer, 2000). In addition, the fact that higher phonological error rates were produced by all groups of children further supports the notion that the orthographic consistency of the writing system impacts on the phonological spelling skills of both typical and atypical learners. Especially because the phonological weaknesses of children with dyslexia are well established by previous research (e.g., Bruck & Treiman, 1990; Bruck & Waters, 1988; Snowling, 1994), it was not surprising to find that children with dyslexia writing in the more opaque English orthographic system would be most challenged.

Beyond phonological errors, a very high proportion of orthographic misspellings was evident in the writing samples. In both writing systems the participants with dyslexia often produced phonologically plausible errors but failed to represent the morphological and/or orthographic identity of the spelling pattern. As indicated by the magnitude of effect sizes the discrepancy between phonologically misspelled and phonologically plausible-orthographically misspelled words was more profound for Greek participants than it was for English pupils. This finding was consistent across groups and is in agreement with the results of previous research in different languages highlighting the magnitude of orthographic difficulties in comparison to phonological difficulties (Berninger, et al., 2008; Coleman, et al., 2009; Sterling, et al., 1998; Sumner, 2013).

Concerning the effect of morphological complexity, the results showed that children with a dyslexic profile found polymorphemic words more challenging than monomorphemic words. This is an indication that morphological complexity impacts on spelling performance as suggested in previous research (e.g., Egan & Tainturier, 2011). It is important to note that this effect did not appear to influence exclusively the dyslexic-profile children, since it consistently emerged in the performance of the three control groups and the typically developing children participating in the study discussed in chapter 5. This finding contributes to the notion that there are commonalities in the manner in which young spellers approach polymorphemic words in different languages with a morpho-phonemic structure, such as English and Greek, as proposed by Bryant and colleagues (1999). It is in accord with similar findings of the study of Egan and Tainturier

(2011) in English, which were attributed to over-reliance of the pupils with dyslexia on phonetic spelling and unsuccessful attempts at memorising the entire representation for polymorphemic words rather than using a morphological rule to aid their spelling of inflectional suffixes.

Errors indicating insufficient employment of morphological knowledge (e.g., SCARY spelt as <scare>; ΠΟΛΕΙΣ /pole:s/ as <πόλης>) occurred when spelling the suffixes. In many cases, the spelling of suffixes would be enhanced by competent application of grammatical information or a sense of morphology (i.e., understanding of the change in meaning and syntactic status that the suffix conveys). In the present study there was a significant difference between the proportions of these misspellings made by dyslexic-profile participants and those obtained from typically developing children of the same age. This is in agreement with previous research (Treiman, 1997) and might be an indication that the dyslexic-profile participants have not yet reached the level of competence expected for their age with regard to applying the grammatical rules of the conventional orthographic system. These difficulties appear to persist even for older dyslexic pupils despite the expected greater extent of exposure to polymorphemic words and engagement with suffixes in comparison to younger pupils.

Along similar lines, pupils with a dyslexic-profile lagged behind their chronological-age controls in applying orthographic knowledge when whole non-affixed words, whole affixed words and their components were examined (e.g.,, SAW spelled as <sor>, FUNNIER as <funnyer>, HORRIBLE as <horibol>; ΕΙΔΑ /e:ða/ spelled as <ήδα>, ΚΟΙΝΩΝΙΚΟΙ /cinonici/ spelled as <κοινωνοικί>). The results are in accord with previous research in several languages highlighting the severe difficulties children with dyslexia exhibit with orthographic spelling of exception words and morphemes (Bourassa et al., 2006; Cassar et al., 2005; Diamanti et al., 2013; Egan & Tainturier, 2011; Hoefflin & Franck, 2005; Nikolopoulos et al., 2003; Protopapas et al., 2013; Tsesmeli & Seymour, 2006). However, the dyslexic-profile groups did not seem to perform differently to their reading and spelling ability-matched controls. It, therefore, seems that items requiring competent employment of morphological and orthographic skills are challenging not only for pupils with dyslexia but also for younger typical spellers regardless of the language in which they are writing, as suggested by previous studies in different writing systems (e.g., Bourassa et al., 2006; Cassar et al., 2005; Diamanti et al., 2013; Egan & Tainturier, 2011;

Nelson, 1980; Protopapas et al., 2013). Especially the finding that higher error rates occurred in morphemes whose spelling is less likely to depend on morphological rules and which provide an indication of the breadth of the orthographic lexicon, namely the stems and derivations, in comparison to inflections, provides further evidence to support that the difficulty with applying orthographic knowledge might be attributable to the demand for fully specified orthographic representations when writing, as suggested by Frith (1980). In contrast, inflections always carry additional grammatical information, which might aid in generating morphological rules. These rules can subsequently be applied to spell unfamiliar words (Nunes & Bryant, 2009). According to Bryant and Nunes (2008), individual differences endorse the use of a morphological strategy or a non-morphological strategy, i.e., statistical learning of the suffixes, or a combination of the two depending on the demands of the spelling task. Having more than one strategy available for spelling might be the reason why the children with and without dyslexia were better at spelling the inflections than the derivations and the stems of the words.

The findings of the present study appear to be in disagreement with research suggesting that children with dyslexia are poorer than reading/spelling ability-matched children in morphologically or orthographically dependent spelling patterns (e.g., Egan & Tainturier, 2011). However, as discussed by Egan and Tainturier, (2011) individual characteristics might play a significant role in the prevalence of a deficit, such as the one detected in their study for –ed past tense suffixes. More specifically, these researchers showed that it was a sub-group of 7 children with dyslexia that exhibited severe difficulties with inflectional spelling even when compared to a younger spelling ability-matched group of typically developing pupils. However, they did not differ in the spelling of one-morpheme words, regular words, and non-words as well as in morphological and phonological awareness. These findings were interpreted as supporting the notion that literacy difficulties in developmental dyslexia are not a product of a unitary impairment as suggested by previous research (e.g., Castles & Coltheart, 1993; Di Betta & Romani, 2006; Sprenger-Charolles, Colé, Lacert, & Serniclaes, 2000; Zoccolotti & Friedmann, 2010). Taking into account the different types of developmental dyslexia that can result in heterogeneity in spelling performance (e.g., Angelelli, Judica, Spinelli, Zoccolotti, & Luzzatti, 2004; Cholewa, Mantey, Heber, & Hollweg, 2010; Kohnen, Nickels, Brunsdon, & Coltheart, 2008; Temple, 1985; Valdois et al., 2003), it is possible that among the participants of the present study were children belonging to either or both sub-groups who could exhibit specific morphological or orthographic difficulties in comparison to younger reading or spelling-age controls. In order to examine this possibility, it would be necessary to account for the heterogeneity in the sample and individual characteristics possibly affecting spelling performance. For this purpose, a method of analysis sensitive to intra-individual differences (e.g., generalised linear mixed-effects models) might be more useful than the conventional ANOVA that was used in the present study. However, the small number of participants per group did not permit a successful employment of such methods, since group-size is a factor impacting significantly on the robustness of the results produced by such methods of analysis. Individual characteristics within atypically developing spellers would be worth exploring in a future study with a larger sample of participants to provide a better insight into their spelling performance in different types of words and morphemes.

A possible explanation for the observed difficulties with orthographic spelling might be the effect of limited exposure to print. The error categories examining the application of orthographic knowledge included visual errors related to word-specific or suffix-specific knowledge (e.g., the <aw> in SAW, the <horror> and <-ible> in HORRIBLE) and familiarity with the orthographic rules of the conventional system (e.g., the <i> in FUNNIER). Hence, the spelling performance of the participants should be indicative of the range of lexical units stored in their memory. From this perspective, the wider the visual vocabulary a speller possesses the lower their orthographic error rates would be. Additionally, these errors should be representative of the speller’s competence to apply system-specific rules, such as <funny> + <er> = <funnier> for English. Previous research has associated print exposure and reading performance of children and adolescents with dyslexia (e.g., Castles, Datta, Gayan, & Olson, 1999). Hence, limited experience with reading and writing might be one of the factors resulting in less developed orthographic skills and particular difficulty with the application of orthographic information for pupils with dyslexia in both language samples and for younger Greek controls in the present study.

Overall, the results of the present study support the notion that a more consistent orthographic system, such as Greek, would enable pupils with dyslexia to develop some phonological skills and manage to retain a relatively low level of phonological error rates in spelling, as suggested by previous research (e.g., Caravolas & Volín, 2001; Diamanti, Goulandris, Campbell, & Stuart, 2005; Landerl & Wimmer, 2000; Nikolopoulos, Goulandris, & Snowling, 2003; Protopapas et al., 2013). This is not as easy for children writing in the English orthography resulting in persisting difficulties with phonological spelling, as sometimes reported in research in more opaque orthographies (Bernstein, 2009; Bruck & Treiman, 1990; Ellis, 1994). However, in the present study English participants with dyslexia did not differ from their reading and spelling-age matched controls in whole word spelling. A more detailed investigation at a finer grain-level (e.g. graphemic level) while taking into account individual differences might reveal subtle differences in phonological spelling skills between participants with dyslexia and the latter control groups. This would be worth investigating in future studies. In turn, English dyslexic-profile pupils were significantly better than their Greek peers in morphological and orthographic spelling. This is in accord with the results of previous cross-linguistic studies on reading (Goswami et al., 2003; Wimmer & Goswami, 1994; Ziegler et al., 2001) proposing that English speaking pupils supplement phoneme-to-grapheme strategies by rhyme and whole word strategies, which provides them with an advantage when accessing irregular words in comparison to children speaking more consistent languages.

6.7 Conclusions

In conclusion, data obtained from both orthographies suggest that despite dyslexic-profile children producing more errors than their controls, the spelling profiles of all four groups in both languages followed similar lines. Despite them differing in the proportions of errors produced in comparison to same-age peers, their spelling errors were not qualitatively different. In addition, their error rates were not quantitatively different than those produced by reading and spelling ability-matched controls. Therefore, there is not enough evidence stemming from the present data to indicate a deviant developmental trajectory for children with dyslexia. It appears that their spelling profile complies with a slower pace of spelling skills' development, as is frequently reported for dyslexic participants (e.g., Treiman, 1997).

The present study furthers the knowledge about how spelling skills of primary school children with dyslexia develop by providing evidence from four levels of analysis of the errors produced in a list of stimuli assessing various spelling phenomena and by attempting to distinguish between the types of knowledge on which different spelling patterns depend, namely phonological, morphological and orthographic. Examination of these error categories in two languages with different levels of transparency has suggested that differences, occurring in phonological and orthographic spelling, can be attributed to the characteristics of the specific orthographic system (Landerl & Wimmer, 2000; Nikolopoulos et al., 2003). Phonological spelling was particularly difficult for English speaking participants, while orthographic spelling seemed to be challenging for pupils with and without dyslexia in both languages (e.g., Bourassa et al., 2006; Cassar et al., 2005; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Protopapas et al., 2013). Beyond these differences, children with dyslexia appeared to develop their spelling skills in a comparable manner.

Chapter 7

The Role of Semantic Context in Spelling Performance of Greek and English Native Speaking Children with and without Dyslexia

7.1 Introduction

The current research examines the role of semantic and syntactic context in the spelling performance of primary school children writing in English and Greek. In the two previous chapters differences attributable to the properties of the two orthographic systems were detected in the spelling performance of typical and atypical learners. However, similarities regarding common challenging areas were also revealed between cohorts writing in different orthographic systems. Since the fundamental role of correct spelling is to attend to written communication, different spelling conditions may facilitate or hinder spelling performance of learners whose spelling ability is still under development. The main aim of this chapter is to investigate whether including semantic context would affect the performance of pupils with dyslexia attending years 4-6 in England and grades 4-6 in Greece, as well as their typically developing controls (Y3-Y6 and G3-G6 respectively). Spelling performance across spelling tasks is examined while taking into account the specific characteristics of each orthographic system. In the following section, findings of research on spelling when writing in context for typical and atypical spellers in English and Greek are discussed.

7.2 Spelling in semantic context

Supplementary to reading ability that enables comprehension, spelling ability serves primarily to communicate ideas in written language and, thus, can constrain or facilitate written communication (Nunes, Bryant, & Bindman, 1997). Spelling in the context of a writing task is different from spelling-to-dictation in various ways. One difference is that during written composition tasks there is generally no acoustic input of the words. Spelling in this condition becomes more challenging, since in the absence of phonological cues a fully specified orthographic representation is essential for correct spelling (Frith, 1980). Another distinctive characteristic of writing tasks is the flexibility provided to the writer to select the vocabulary or use synonyms to construct a meaningful text. Spelling skill influences and spelling performance is affected by these properties of the task. For the purpose of writing for meaning, knowledge of morphology is also engaged in text composition, since correct sentence composition requires skilful manipulation of the morphological properties of the language (e.g., tense, voice, derivational/inflectional rules).

Few studies investigating the effect of contextual information on spelling performance of primary school children have been conducted in English or Greek. Examples of relevant studies (e.g., in English: Ouellette & Fraser, 2009; Ouellette, 2010; Wang, Castles, Nickels, & Nation, 2011; in Hebrew: Share, 1995) have showed that primary school pupils benefited in terms of their spelling accuracy from learning the meaning of novel words embedded in the context of an oral story. Text writing has been employed to assess spelling development in English speaking typical learners (see theoretical framework of the components of writing of Berninger and Swanson (1994) and a review of relevant studies in chapter 2).

Spelling in semantic context is not so frequently compared to single word spelling. One study by Treiman and Cassar (1996) examined spelling of final clusters in one-morpheme and two-morpheme words by comparing performance of a group of grade 2 children writing selected target words in a single-word condition with that of a second group of peers, who were asked to create sentences with the target words. They reported no significant difference between performances of the two groups. However, since different children were tested in each spelling condition, this result might be attributable to individual differences between children assigned to the two groups rather than equality of the contribution of the two tasks to spelling performance. Furthermore, the young age of the children might have resulted in reduced use of semantic context to facilitate spelling in the sentence-generating condition. In a more recent study with dictation tasks (Walker & Hauerwas, 2006) children attending grades 1-3 showed no difference in spelling past tense <-ed> in a single-word and a sentence condition. However, dictated and self-generated semantic context may contribute differently to spelling performance (Berninger et al., 1994; Pattison & Collier, 1992).

Text writing experience might be different for individuals with dyslexia and typical writers. Difficulties with storing and retrieving information from verbal and visual memory (Rose, 2009; Singleton, 2002), automatisation deficits (Wagner & Torgesen, 1987) and

RAN deficits (Bowers & Wolf, 1993; Georgiou et al., 2010; Powell, Stainthorp, & Stuart, 2013) have been associated with dyslexia and might impose additional load to spelling processes in text composition. In addition, experience with print has been suggested to play a role in pupils' vocabulary knowledge (Wise, Sevick, Morris, Lovett, & Wolf, 2007). In written composition tasks there is the additional demand for spelling the writer's vocabulary choices, which could limit the amount and variability of vocabulary and hence the length and quality of the texts produced. Furthermore, experience with reading/writing and morphological knowledge have been proposed to causally interact (Nunes, Bryant, & Bindman, 2006). If dyslexic pupils' engagement with reading and writing tasks is limited due to their difficulties with print, then correct spelling in text writing condition would be expected to be a very challenging task for them. On the other hand, writing for meaning provides a more naturalistic condition for spelling and it might result to a focused engagement with morphology, which would facilitate rather than impair spelling performance. Particularly as concerns accurate spelling of stems and inflections, if children rely on application of orthographic information linked to statistical learning of the specific morpheme (Deacon, Conrad, & Pacton, 2008; Nunes & Bryant, 2009), then semantic information as provided by printed or self-generated context could be exploited to activate retrieval of the orthographic form of familiar morphemes. If, on the other hand, a sense of the context enhances children's appreciation of the grammatical status of the target word, as suggested by Nunes and colleagues (1997), then syntactic cues could be sourced from the surrounding text to facilitate the spelling of those target morphemes bearing grammatical information.

Evidence from research with adults suggests that college students with dyslexia and chronological-age controls only differed in spelling and handwriting fluency when composing texts (Connelly, Campbell, MacLean, & Barnes, 2006). Research examining the texts produced by university students with dyslexia (Coleman, Gregg, McLain, & Bellair, 2009; Sterling, Farmer, Morgan, & Matthews, 1998) identified difficulties with detecting markers of morphology, phonological processing and phonological misspellings. As concerns research with children with dyslexia, Puranik, Lombardino, and Altmann (2006) examined the writing performance of a wide age range of participants with dyslexia (11-20 years old) in comparison to a group with language impairment and a chronological-age matched control group. Younger dyslexic participants performed significantly lower than the chronological-age controls, but not than the language impaired group, on the number of grammatically complex sentences produced, which indicated a difficulty with manipulating morphological knowledge when writing. In addition, younger dyslexic participants made significantly more spelling errors than their chronological-age controls. A larger study by Berninger, Nielsen, Abbott, Wijsman, and Raskind (2008) examined written composition in a sample of 122 children with a dyslexic profile and found a significant contribution of spelling skills to the quality of the text. However, comparing their error rates with those of a control group was not within the scopes of this paper.

More recently, Sumner in her doctoral thesis (2013) investigated the spelling error types of 31 children with dyslexia, a chronological-age and a spelling-age group in a standardised spelling task (BAS-II; Elliott, Smith, & McCulloch, 1996) and a free-text narrative writing task (WOLD; Rust, 1996). Overall, children with dyslexia appeared to produce significantly more phonological (called phonetically implausible) and orthographic (called orthographically inaccurate) errors than both groups in the spelling list, but performed at the same level as the spelling-age group at the text composition task. The researcher argued that better spelling performance of children with dyslexia in the writing task was a consequence of the freedom they had to avoid writing challenging words. The high error rate of orthographically inaccurate spellings produced by children with dyslexia was attributed to their poor phonological skills assessed with separate phonological tests. A very small amount of morphological errors was observed for all participants. This was attributed to low challenges for errors of this type provided by the specific standardised spelling task and the freedom for selecting simple words to spell in the writing task. Future research should consider devising spelling tasks that would control for this imbalance. Furthermore, devising tasks that would examine each of the spelling components (phonological, morphological, and orthographic) is suggested by the researcher for a better understanding of the spelling difficulties of children with dyslexia. To date there are no studies in Greek investigating spelling in text writing condition nor drawing comparisons between spelling in dictation and self-generated context. One relevant study with typically developing pupils and children with dyslexia in grades 3-4 and 7 (Protopapas et al., 2013) has employed a single word and an orally dictated passage spelling task. Results of both dictation tasks are discussed alongside suggesting significant differences in the performance of children with dyslexia and typically developing children matched in age.

With respect to connections between text writing and spelling development, experience with reading/writing and morphological knowledge have been proposed to causally interact (Nunes et al., 2006). Additionally, phonological knowledge and literacy acquisition are closely linked, since the learner is involved in hearing the words, segmenting into phonemes and learning the corresponding symbol for the conventional orthographic system (Olson, 1996). If engagement with reading and writing tasks improves literacy skills, then correct spelling in a text writing condition would be expected to get less challenging as pupils grow older and acquire competence in narrative writing. Furthermore, writing for meaning provides a more naturalistic condition for spelling and it might result in a focused engagement with morphology, which would facilitate rather than impair spelling performance.

7.3 Aims of the present study

Spelling performance while creating texts may differ from spelling to dictation (Berninger et al., 1994; Pattison & Collier, 1992). Recently there is an increase in the interest of reserchers to discuss their findings in a combined view of different theoretical approaches (e.g., Ehri, 2014; Sharp, Sinatra, & Reynolds, 2008), which have the potential to provide a more inclusive account of spelling processes. There is, therefore, a need for parallel examination of spelling performance in both conditions. In addition, as shown by Sumner's study (2013), a free-writing task providing the freedom to avoid spelling challenging words might mask the actual spelling difficulties of the participants and reduce the opportunities for certain types of errors. Specifically as concerns research in atypical spelling, the findings of different studies might be due to the application of different measures of spelling across studies and sometimes across spelling tasks within the same study (e.g., Sumner, 2013).

Therefore, one aim of this research was to extend the findings of the analysis of the errors made by children with dyslexia on the single word spelling task (chapter 6) by employing two more spelling tasks involving text writing context. In particular, the current research aimed to further explore potential differences in the spelling performance of children with and without dyslexia supporting the developmental delay or deficit argument. In addition, it aimed to detect further evidence emphasising the role of the orthographic system (consistent-inconsistent, less inflected-more inflected) in the application of different types of knowledge (phonological, morphological, orthographic) when spelling within a written context. Furthermore, it aimed to identify any effect of written semantic and syntactic context on the spelling performance of typically and atypically developing learners in comparison to oral context as provided in the single word spelling task. More specifically the study aimed to:

1) Include one-to-one chronological age, reading and spelling ability matching for the dyslexic-profile pupils, in order to detect any discrepancies in the spelling errors of children with and without dyslexia.

2) Employ a wide range of spelling features in various parts of speech for a detailed investigation of spelling errors mapping onto the application of different types of knowledge (i.e., phonological, morphological, orthographic).

3) Explore the spelling profiles of children who learn to write in an orthographically inconsistent language (English) and a more consistent language (Greek) in parallel, to investigate the role of the orthographic system in the manipulation of challenging spelling patterns.

4) Draw direct comparisons between spelling-to-dictation and text writing tasks while controlling to some extent for the word choices of the participants, to allow for a direct examination of the role of written semantic and syntactic context in spelling performance.

To achieve these goals, this chapter explores the following research questions:

A) Do children with dyslexia make similar misspellings to typically developing pupils when matched in chronological age, reading age and spelling age? Is there a specific misspelling profile that could characterise the dyslexic-profile group and distinguish it from their control groups?

This is an extension of the research question of chapter 6. To address it the spelling errors were analysed at two levels, as in the study analysing the data from the single word spelling (chapter 6); that is at the whole word level and at the morphemic level. The first level differentiated between phonologically misspelled words and orthographically misspelled words, to permit direct investigation of the phonological deficit hypothesis, according to which individuals with dyslexia often exhibit persisting phonological difficulties (Snowling, 1995). The second level of analysis aimed to reveal any prominent difficulties with the application of morphological and orthographic skills when spelling morphologically complex words.

B) What is the role of oral and written context in facilitating or restricting spelling achievement of children in primary school? Does semantic and syntactic context affect the application of different types of knowledge? Are children with dyslexia affected in the same manner as their typically developing peers?

To address this question the same target words were distributed across the experimental measures of spelling to ensure that direct comparisons could be drawn between different spelling conditions (spelling-to-dictation and text composition). Potential differences between error categories within the same group of children per spelling task were explored in order to appreciate the effect of task on the application of different types of knowledge (i.e., phonological, morphological, orthographic). Comparisons between groups of children were drawn per spelling task to estimate the extent to which their spelling profiles were affected by oral and written context.

C) Do linguistic properties of the orthographic system affect the magnitude of the impact of semantic and syntactic context on spelling performance? Is this effect different for pupils with dyslexia and for typically developing children writing in each language?

The extent to which children with dyslexia employ specific spelling skills (i.e., phonological, morphological, orthographic), as a consequence of writing in a more inconsistent orthographic system (English), or a more consistent and highly inflected system (Greek), was investigated by examining their performance at a whole word and a morphemic level of analysis. The spelling profiles of the two dyslexic groups (English and Greek) and their controls were delineated by investigating the spelling errors within the same language sample and observing differences and commonalities.

7.4 Method

7.4.1 Participants, experimental spelling tasks and stimuli

The participants in this study were selected from the same schools as the pupils participating in the cross-linguistic study of with pupils with and without dyslexia, which was discussed in chapter 6. In England the dyslexic-profile group consisted of 18 native-speaking pupils, who were matched in chronological-age with 21 typically developing children, in reading ability with 18 pupils and in spelling ability with 18 pupils. In Greece the dyslexic-profile group consisted of 17 native-speaking pupils, who were matched in chronological age with 19 pupils, in reading ability with 18 pupils and in spelling ability with 17 pupils. The selection criteria and characteristics of the two language samples are thoroughly presented in chapter 4, sections 4.3.2.3 - 4.3.2.4.

To answer the research questions of this study semantic context was employed in different manners in three spelling tasks. One was the single word spelling (SWS) task, which was discussed in chapter 6. In this task single words were dictated in the context of an oral sentence. Additionally, a printed paragraph was presented to the children for the passage completion (PC) task. There were gaps which the participants were asked to complete with target words, which were dictated to them. Thirdly, in the text composition (TC) task the participants were required to produce a self-generated written narrative using the target words provided. The spelling tasks, the properties of the test stimuli and procedure of task administration are described in detail in chapter 4, sections 4.3.3 - 4.3.4.

7.4.2 Statistical analysis

In the single word spelling and the passage completion task the number of target words remained constant for all participants. An essential feature of the text composition task was that it allowed for a unique amount of opportunities for errors to be produced by each participant, since each pupil could use different numbers of target-words in their story. Since the single word spelling task provided the most detailed list of words of the three, it was employed as the basis of item-to-item comparisons. More specifically, the performance of the participants was analysed in pairs of tasks, namely passage completion versus single word spelling and text composition versus single word spelling. When the number of stimuli was constant across tasks, integers representing the misspelled words were used in the analyses. When the number of stimuli varied between participants or across tasks, the data were normalised by calculating the ratio of misspelled words or morphemes to the total number of words or morphemes used (opportunities for error). The target words used in the passage completion and the text composition were directly compared with the corresponding target words in the single word spelling task. If none of the target words was used in the text composition of a child, this participant was excluded from the analysis of text composition versus single word spelling. The classification of errors, levels of analysis, scoring and statistical methods employed are thoroughly presented in chapter 4, section 4.4. In similar vein to the study discussed in chapter 6 the examination of phonological and orthographic errors included three error categories, phonologically misspelled words, phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words. The analysis of affixed versus non-affixed words was not included in this study because the number of stimuli under the second category did not permit direct whole-word comparisons. In addition, the derivational suffixes included in the passage completion and the text composition task did not provide enough opportunities for comparisons with the stems and inflectional suffixes, and thus were not included in the analyses. Examples of the errors subsumed under each error category are displayed in Table 6.1-Table 6.2, pp. 185-186.

To enable comparisons across tasks the data were analysed with repeated-measures design or mixed design Analyses of Variance (ANOVA). The skewed data were transformed to approximate a normal distribution but most transformations did not correct the distortions. Nevertheless, all observations were retained to investigate possible differences between groups and tasks and parametric methods were preferred to allow for the examination of any interaction effect between variables. The possibility of inflation of Type I errors due to multiple comparisons was controlled for using Sidak corrections. All the results generated from skewed data were confirmed with Mann-Whitney U and Wilcoxon Signed Rank non-parametric tests. The results are presented in the following section. Means and standard deviations are displayed to indicate central tendencies in the data.

7.5 Results

The extent to which pupils employ semantic and syntactic context to derive correct spelling of the target words may vary depending on different levels of familiarity with print and the level of difficulty of the examined error categories. Additionally, the manner in which context is provided, as well as the demands of the task (e.g., memory load, writing for meaning) were expected to affect spelling performance. This hypothesis had two directions: either that less demanding tasks, such as the single word spelling, would enhance focusing on spelling of the dictated words, thus resulting in lower error rates or that the more engaging the context becomes, such as in the passage completion and text composition, the more attention would the children direct to spelling the target words. To explore the effect of context on the spelling profiles of the participants, the results of the comparisons between the spelling-to-dictation tasks are presented in the following section. Subsequently, the results of the text-composition versus the single word spelling task are presented. To preserve clarity, separate analyses for the English and the Greek data are exhibited in the following sections.

7.5.1 Examination of the performance of children with dyslexia and typically developing control groups in the spelling-to-dictation tasks

7.5.1.1 Comparisons between the English single word spelling and the passage completion task

A. Examination of overall misspelled words

In order to evaluate the overall spelling performance of each group of children, the total number of misspelled words was recorded for each participant. The total number of words was not equal across tasks (see chapter 4, section 4.3.3). Hence, for each pair of spelling tasks only the words that appeared in both tasks under examination were audited. Pupils received one point for each misspelled word. Descriptive statistics are presented in Table 7.1, p. 230. The total number of misspelled words obtained from each spelling task was subjected to a two-way mixed design Analysis of Variance (ANOVA). Task was entered as a within-participants variable with two levels (single word spelling and passage completion). Group membership (dyslexic-profile group, reading ability-matched, spelling ability-matched and chronological age-matched control groups) was entered as a between-participants variable. The data obtained from all control groups in the passage completion task and from the chronological-age and the reading-age group in the single word spelling task were positively skewed. Transformations did not correct the skewness, hence, raw data were entered in the analysis. The results were verified with non-parametric tests. Sidak corrections were applied to control for inflation of Type I errors due to multiple comparisons.

The analysis showed a significant main effect of group membership (F (3, 71) = 11.72, $p <$ .001, η_p^2=.33). However, the main effect of task (F (1, 71) = 1.04, p = .311, η_p^2=.01) and the interaction effect between task and group were not significant (F (3, 71) = 2.68, p = .053, η_p^2=.10). To explore the differences between the performance of the dyslexic-profile participants and their control groups, Sidak corrected post hoc pairwise comparisons were conducted. The results showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls ($p < .001$). In contrast, the dyslexic-profile children did not differ significantly from their younger reading and spelling ability-matched control groups in overall misspelled words (both p values > .05).

B. <u>Comparisons between phonologically misspelled and orthographically misspelled words</u>

One aim of the current study was to examine whether pupils with dyslexia would encounter more difficulties in applying different types of knowledge, i.e., phonological, morphological and orthographic, when spelling in comparison to typically developing children. In addition, the effect of context on the application of such knowledge by dyslexic-profile and typical spellers was of interest. For this purpose, misspelled words were categorised in three groups, as outlined in chapter 4, section 4.4.2.

A first category contained the words where at least one phoneme was phonologically misspelled. All misspelled words where a combination of phonological mistakes and phonologically plausible orthographic errors occurred were subsumed under the phonologically-orthographically misspelled category. When the word was spelled with alternative graphemes preserving the phonological identity of all phonemes, it was classified under the phonologically plausible-orthographically misspelled category. Examples of the misspelled words under each error category are presented in Table 6.1, p. 185. In the passage completion task the data obtained from all the control groups for phonologically misspelled words, from all participants for phonologically-orthographically misspelled words and from the chronological-age group for phonologically plausible-orthographically misspelled words were skewed. A skewness was also detected for the data obtained from the single word spelling task as concerns the phonologically misspelled words produced by all the control groups, and the phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words produced by the chronological-age controls. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. The results of the parametric analyses were verified with non-parametric tests.

Table 7.1

Means and Standard Deviations of English Misspelled Words per Group of Participants in the Single Word Spelling and Passage Completion Task

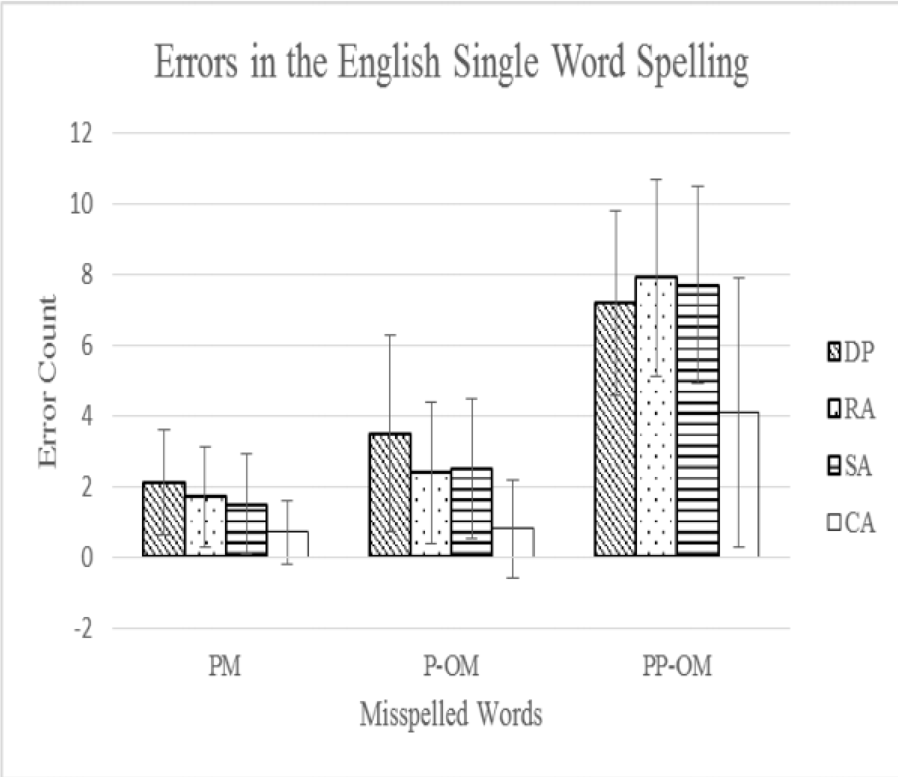
	Single Word Spelling								Passage Completion							
	DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)		DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	12.8	(3.1)	12.1	(4.4)	11.8	(4.2)	5.7	(4.8)	14.0	(3.0)	11.3	(5.8)	10.4	(5.9)	5.4	(4.9)
Phonologically Misspelled Words	2.1	(1.5)	1.7	(1.4)	1.5	(1.4)	0.7	(0.9)	1.8	(1.5)	1.6	(1.8)	1.2	(1.6)	0.9	(0.9)
Phonologically-Orthographically Misspelled Words	3.5	(2.8)	2.4	(2.0)	2.5	(2.0)	0.8	(1.4)	3.7	(3.3)	3.2	(2.8)	2.7	(2.7)	0.9	(1.9)
PP-Orthographically Misspelled Words	7.2	(2.6)	7.9	(2.8)	7.7	(2.8)	4.1	(3.8)	8.4	(2.7)	6.4	(3.8)	6.5	(3.9)	3.5	(3.3)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Maximum number of Misspelled Words = 19; PP-=Phonologically Plausible

To investigate differences between dyslexic-profile and control groups and compare their spelling performance in the three error categories and the two spelling tasks, a three-way mixed design ANOVA was performed. Since all participants were required to spell a constant number of target words and comparisons were drawn between the same items across spelling tasks, integers representing the total number of phonologically misspelled words, phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words were entered as one within-subjects variable (error category). A second within-subjects variable represented the spelling tasks and comprised of two levels (single word spelling and passage completion). Finally, group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. Descriptive statistics are presented in Table 7.1, p. 230.

A Mauchly's test revealed that the assumption of sphericity for error category and task by error category interaction had been violated ($\chi^2(2) = 31.44$, $p < .001$ and $\chi^2(2) = 15.12$, $p = .001$ respectively). Hence, for the main effect of error category and the task by error category interaction degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .778$ and $\varepsilon = .891$ respectively). The analysis showed that the main effect of task was not significant ($F\ (1, 71) = 1.13$, $p = .291$, η_p^2=.01). A significant main effect of error category ($F\ (1.55, 110.42) = 107.58$, $p < .001$, η_p^2=.60), as well as a significant main effect of group membership ($F\ (3, 71) = 11.74$, $p < .001$, η_p^2=.33) were revealed. The results also showed a significant task by error category by group interaction ($F\ (5.34, 126.58) = 3.44$, $p = .005$, η_p^2=.12) as well as a significant interaction between task and error category ($F\ (1.78, 126.58) = 4.14$, $p = .022$, η_p^2=.05). However, the interaction between task and group was not significant ($F\ (3, 71) = 2.56$, $p = .061$, η_p^2=.09) implying that there was no significant difference between spelling tasks at all levels of the group variable. Similarly, the error category by group interaction was not significant ($F\ (4.66, 110.42) = 1.88$, $p = .108$, η_p^2=.07) indicating that the difference between phonologically and orthographically misspelled words were comparable at all levels of the group variable. Sidak corrected post hoc pairwise comparisons between error categories showed that the phonologically misspelled words were significantly fewer than the phonologically-orthographically misspelled words and the phonologically plausible-orthographically misspelled words. In addition, the phonologically-orthographically misspelled words were significantly fewer than the phonologically plausible-orthographically misspelled words (all p values < .001).

To explore the error category by task by group interaction a two-way mixed design ANOVA was performed at each level of error category. The number of misspelled words in each task was entered as a within-subjects variable with two levels (single word spelling and passage completion task). Group membership was entered as a between-subjects variable (DP, RA, SA and CA). The results of the analysis of phonologically misspelled words showed that the effect of task was not significant (F (1, 71) = 0.69, p = .406, η_p^2=.01). The effect of group was significant (F (3, 71) = 3.25, p = .027, η_p^2=.12) but the interaction between task and group was not significant (F (3, 71) = 0.65, p = .580, η_p^2=.02) indicating that group membership consistently affected spelling performance across tasks (Figure 7.1, p. 233). Possible differences between groups were explored with post hoc pairwise comparisons. The results showed that the dyslexic-profile group produced significantly more phonologically misspelled words than their chronological-age controls (p = .024) but performed at the same level as their reading and spelling-age controls (both p values > .05). The analysis of phonologically-orthographically misspelled words showed that the effect of task was not significant (F (1, 71) = 3.66, p = .060, η_p^2=.05). A significant effect of group was detected (F (3, 71) = 4.82, p = .004, η_p^2=.16). However, the interaction between task and group was not significant (F (3, 71) = 0.78, p = .509, η_p^2=.03; Figure 7.1, p. 233).



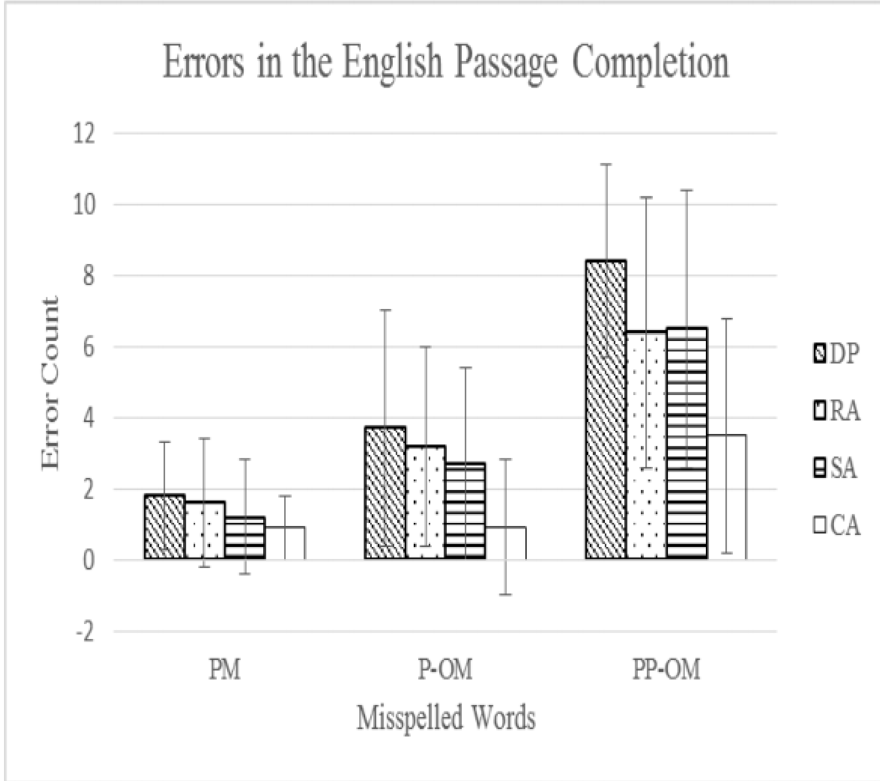


Figure 7.1

Means and Standard Deviations of English Misspelled Words per Group and per Spelling Task (Single Word Spelling, Passage Completion).

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

Post hoc pairwise comparisons showed that, along similar lines with the phonologically misspelled words, the dyslexic-profile group produced significantly more phonologically-orthographically misspelled words than their chronological-age controls (p = .003) but performed at the same level as their reading and spelling-age controls (both p values > .05).

Finally, the ANOVA on phonologically plausible-orthographically misspelled words detected significant effects of task and group as well as a significant interaction effect between these two variables (F (1, 71) = 4.07, p = .047, η_p^2=.05; F (3, 71) = 6.87, p < .001, η_p^2=.22 and F (3, 71) = 5.07, p = .003, η_p^2=.17 respectively). The simple effect of task on each level of group membership was examined by subjecting the phonologically plausible-orthographically misspelled words to a one-way repeated-measures ANOVA. Spelling task was entered as a within-subjects variable comprising of two levels (SWS and PC). The results of the analysis of the errors of the dyslexic-profile group showed a significant effect of task (F (1, 17) = 6.81, p = .018, η_p^2=.28) implying that more PP-OM words were misspelled in the passage completion than in the single word spelling (Figure 7.1, p. 233). On the other hand, all three control groups showed the opposite pattern making fewer phonologically plausible-orthographic misspellings in the passage completion task, but the difference between tasks was significant only for the reading-age controls (CA: F (1, 20) = 4.13, p = .056, η_p^2=.17; RA: F (1, 71) = 6.71, p = .019, η_p^2=.28; SA: F (1, 17) = 2.84, p = .110, η_p^2=.14; Figure 7.1, p. 233). The simple effect of group on each level of the task variable was investigated by subjecting the phonologically plausible-orthographically misspelled words to separate one-way univariate ANOVAs. Both ANOVAs produced a significant effect of group membership on the number of misspelled words (SWS: F (3, 71) = 6.55, p = .001, η_p^2=.21 and PC: F (3, 71) = 6.73, p < .001, η_p^2=.22; Figure 7.1, p. 233). Post hoc pairwise comparisons showed that similarly to the previously examined error categories, the dyslexic-profile group produced significantly more phonologically-orthographically misspelled words than their chronological-age controls in both tasks (SWS: p = .018 and PC: p < .001) but performed at the same level as their reading and spelling-age controls (both p values > .05).

Therefore, the source of the error category by task by group interaction seems to lie in that the effect of spelling task was prominent only as concerns the phonologically plausible-orthographically misspelled words. Specifically the dyslexic-profile participants appeared to make significantly more of such errors in the passage completion task. In contrast, all other groups seemed to make fewer mistakes in the passage completion task but the difference between tasks was significant only for the reading-age control group.

C. Comparisons of errors occurring in the component morphemes of polymorphemic words

In order to investigate the effect of context on the spelling of morphologically complex words by dyslexic-profile and typically developing children, the component morphemes of the target words were examined. For this purpose the analysis focused on the stems and the inflectional suffixes of the affixed words. Only phonologically plausible misspellings were included in the analysis to allow for a direct examination of the impact of semantic and syntactic context on orthographic and morphological spelling. Examples of errors are displayed in Table 6.1, p. 185. Because the number of morphemes was not equal across categories, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Dictated\ Stems}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Dictated\ Inflections}$. The data in most error groups were normally distributed, with the exception of the errors produced by the chronological-age and the reading-age controls, who produced positively skewed data in the stems examined in the passage completion task as well as the dyslexic-profile and the reading-age controls, who produced positively skewed data in the inflectional suffixes examined in the passage completion task. Skewed data were also produced in the stem category by the chronological-age controls and by the dyslexic-profile, the chronological-age and the reading-age controls in the inflectional suffixes category of the single word spelling task. Transformations did not correct the skewness, hence raw data were entered in the analysis.

Table 7.2

Means and Standard Deviations of Percentages of Misspellings in English Morphemes per Group of Participants in the Single Word Spelling and the Passage Completion Task

	Single Word Spelling								Passage Completion							
	DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)		DP (N=18)		RA (N=18)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	50.8	(16.1)	48.2	(24.4)	47.3	(23.2)	22.8	(23.8)	64.6	(15.9)	51.4	(27.8)	48.8	(28.4)	23.8	(25.3)
Inflectional Suffixes	22.2	(17.4)	21.5	(10.3)	20.8	(12.8)	11.3	(13.6)	27.7	(17.4)	22.9	(14.3)	23.6	(17.6)	12.5	(14.2)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of misspelled morphemes are presented for ease of interpretation.

Percentage of misspelled morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Used Morphemes}}$ x 100

Proportions of errors under the stem and the inflectional suffix category were subjected to a three-way mixed design ANOVA as a within-subjects variable with two levels (morphemes). Task was entered as a second within-subjects variable with two levels (SWS and PC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. The results were verified with non-parametric tests. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions are presented in Table 7.2, p. 236.

The analysis showed a significant main effect of task (F (1, 71) = 9.27, p = .003, η_p^2=.11) indicating that the passage completion task attracted more errors than the single word spelling task. In addition, the main effect of morphemes was significant (F (1, 71) = 130.40, p < .001, η_p^2=.59) implying that stems were more frequently misspelled than inflections. The main effect of group membership (F (3, 71) = 9.20, p < .001, η_p^2=.28) was also significant. The task by morpheme by group interaction was not significant (F (3, 71) = 0.95, p = .421, η_p^2=.04). In addition, the interaction between task and group as well as the interaction between task and morphemes were not significant (F (3, 71) = 2.47, p = .069, η_p^2=.07 and F (1, 71) = 0.97, p = .327, η_p^2=.01 respectively). In contrast, the morphemes by group interaction was significant (F (3, 71) = 3.88, p = .013, η_p^2 = .14) indicating that a) the differences between groups were not consistent across morphemes or b) the difference between morphemes was not consistent across groups.

The simple effect of group membership on the error rates at each level of the morpheme variable was further explored with separate one-way multivariate ANOVAs. MANOVAs were initially employed to control for an inflation of Type I errors (Field, 2013) and allow for a more condensed investigation of a potential effect of group on error rates. Only when the MANOVAs produced significant results was the effect explored further with separate ANOVAs for each task. Errors in stems were subjected to a MANOVA with group as the independent variable (DP, RA, SA and CA).

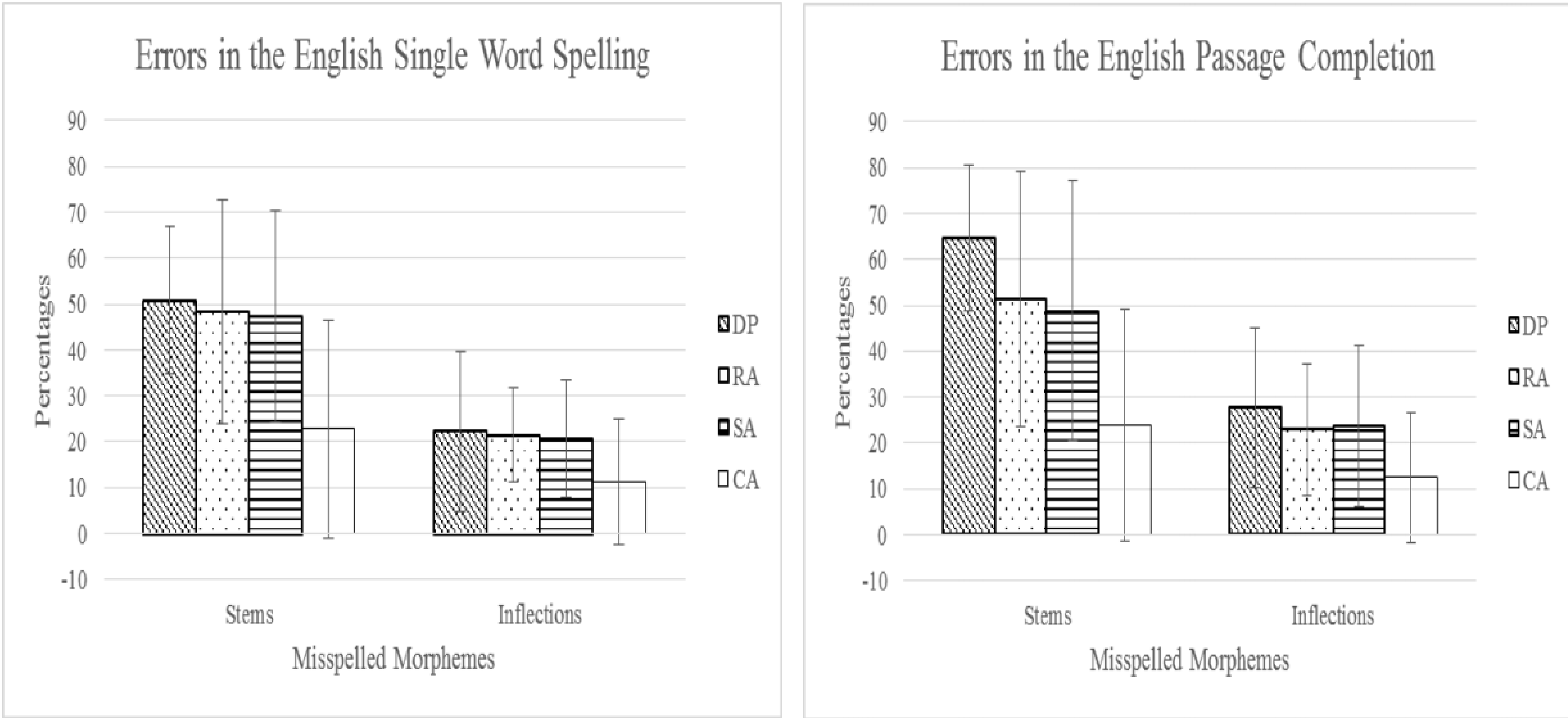


Figure 7.2

Means and Standard Deviations of Percentages of English Misspelled Morphemes per Group and per Spelling Task (Single Word Spelling, Passage Completion)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age

Using Pillai's trace the results produced a significant effect of group ($V = 0.35$, F (6, 142) = 5.07, $p < .001$, η_p^2=.17). The effect was further explored with separate univariate ANOVAs on each level of task. As concerns the single word spelling task, the analysis showed a significant effect of group (F (3, 71) = 6.97, $p < .001$, η_p^2=.22; Figure 7.2, p. 238). With regard to the passage completion task, the analysis of the errors in the stems revealed a significant effect of group (F (3, 71) = 9.26, $p < .001$, η_p^2=.28; Figure *7.2*, p. 238). Post hoc pairwise comparisons showed that the dyslexic-profile group produced significantly higher error rates when spelling the stems of the words than the chronological-age controls in both tasks (both $p < .001$), but their error rates were not significantly different from those of their younger reading and spelling-age controls (all p values > .05). The results of the MANOVA on the inflectional suffixes using Pillai's trace did not produce a significant effect of group membership ($V = 0.15$, F (6, 142) = 1.93, p = .080, η_p^2=.07; Figure 7.2, p. 238). Hence, the effect of group was not further explored for each task separately.

To explore the simple effect of morphemes on each level of group membership, one-way repeated-measures ANOVAs were performed for each group of participants. The results of the analyses on the data obtained from the dyslexic-profile and all control groups in the single word spelling task showed a significant effect of morphemes (DP: F (1, 17) = 31.13, $p < .001$, η_p^2 = .64; CA: F (1, 20) = 7.14, p = .015, η_p^2 = .26; RA: F (1, 17) = 17.82, p = .001, η_p^2 = .51; SA: F (1, 17) = 18.76, $p < .001$, η_p^2 = .52) implying that stems were more frequently misspelled than inflections by all the participants (Figure 7.2, p. 238). Along similar lines, a significant effect of morphemes was revealed for data obtained from all groups in the passage completion task (DP: F (1, 17) = 59.34, $p < .001$, η_p^2 = .77; CA: F (1, 20) = 6.34, p = .020, η_p^2 = .24; RA: F (1, 17) = 22.33, $p < .001$, η_p^2 = .56; SA: F (1, 17) = 26.94, $p < .001$, η_p^2 = .61) indicating that errors in the stems were significantly more frequent than in the inflections (Figure 7.2, p. 238). Therefore, it seems that inflectional suffixes were consistently more accurately spelled than the stems in both tasks by all groups of children. An inspection of the effect sizes shows that this difference was stronger for the dyslexic-profile group and the ability matched groups in both tasks than it was for the chronological-age controls, which might be a source of the morphemes by group interaction. The interaction might also lie in that the dyslexic-profile group made significantly more errors than the chronological-age controls in all examined morphemes with the exception of the inflectional suffixes in the single word spelling task where the difference was not statistically significant.

To summarise, as illustrated by the analyses of the English data the effect of task (SWS vs PC) was not significant when whole misspelled words were examined. However, the dyslexic-profile participants produced significantly more phonologically plausible-orthographically misspelled words in the passage completion task than in the single word spelling task. A similar effect was detected for all the participants with regard to the misspelling of morphemes. In contrast, significantly fewer phonologically plausible-orthographically misspelled words in the passage completion task than in the single word spelling task were produced by the reading-age control group. Overall, the dyslexic-profile group produced significantly more errors than the chronological-age group but performed at the same level as the reading and spelling-age controls. The only exception was the spelling of inflections of the target words examined in the single word spelling, where the effect of group was not significant. Finally, as concerns the differences between error categories, all the participants seemed to produce significantly more phonologically plausible-orthographically misspelled words than phonologically and phonologically-orthographically misspelled words. In addition, the combination of a phonological and an orthographic error in the same word (P-OM) occurred more frequently than phonological misspellings alone (PM). Moreover, inflectional suffixes were consistently more accurately spelled than the stems in both tasks by all groups of children.

7.5.1.2 Comparisons between the Greek single word spelling and the passage completion task

A. Examination of overall misspelled words

The total number of misspelled words obtained from each spelling task was subjected to a two-way mixed design ANOVA. Task was entered as a within-participants variable with two levels (SWS and PC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Descriptive statistics are presented in Table 7.3, p. 241. The data obtained from the dyslexic-profile group in the passage completion and the single word spelling task, as well as the spelling-age group in the single word spelling were positively skewed. Transformations did not correct the skewness, hence, raw data were entered in the analysis. The results were verified with non-parametric tests.

Table 7.3

Means and Standard Deviations of Greek Misspelled Words per Group of Participants in the Single Word Spelling and Passage Completion Task

	Single Word Spelling								Passage Completion							
	DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)		DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	11.3	(2.0)	9.7	(2.6)	10.7	(1.7)	5.2	(2.4)	10.3	(2.1)	8.2	(3.5)	9.1	(3.4)	4.0	(2.6)
Phonologically Misspelled Words	0.5	(0.5)	0.5	(0.8)	0.6	(0.8)	0.1	(0.3)	0.3	(0.4)	0.2	(0.6)	0.5	(0.8)	0.0	(0.2)
Phonologically-Orthographically Misspelled Words	0.4	(0.6)	0.3	(0.6)	0.4	(0.8)	0.1	(0.3)	0.3	(0.5)	0.3	(0.4)	0.2	(0.5)	0.0	(0.2)
PP-Orthographically Misspelled Words	10.3	(1.9)	8.9	(2.4)	9.7	(1.6)	5.0	(2.3)	9.7	(1.9)	7.7	(3.2)	8.4	(3.2)	3.8	(2.5)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Maximum number of Misspelled Words = 16; PP-=Phonologically Plausible

The analysis showed a significant main effect of task (F (1, 67) = 20.31, p < .001, η_p^2=.23) implying that overall fewer target words were misspelled in the passage completion task than in the single word spelling task. In addition, there was a significant main effect of group membership (F (3, 67) = 25.49, p < .001, η_p^2=.53). However, the interaction effect between task and group was not significant (F (3, 67) = 0.27, p = .844, η_p^2=.01) indicating that the effect of group was consistent across tasks. Sidak corrected post hoc pairwise comparisons showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls (p < .001) but not than their younger reading and spelling ability-matched control groups (both p values > .05).

B. <u>Comparisons between phonologically misspelled and orthographically misspelled words</u>

To investigate differences between dyslexic-profile and control groups and compare within-group spelling performance in the three error categories and the two spelling tasks, a three-way mixed design ANOVA was performed. Since the comparisons were drawn only between same items across pairs of spelling tasks, integers representing the total number of phonologically misspelled words, phonologically-orthographically misspelled words and phonologically plausible-orthographically misspelled words were entered as one within-subjects variable (error category). Spelling task was entered as a second within-subjects variable comprising of two levels (SWS and PC). Group membership was entered as a between-participants variable (DP, RA, SA and CA). All the data corresponding to the phonologically and the phonologically-orthographically misspelled words obtained from all four groups of children in both spelling tasks were positively skewed. In addition, the dyslexic-profile and the spelling-age group produced skewed data for the phonologically plausible-orthographically misspelled words in both tasks. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. The results of the parametric analyses were verified with non-parametric tests. Examples of the misspelled words under each error category are presented in Table 6.2, p. 186 and descriptive statistics in Table 7.3, p. 241.

A Mauchly's test revealed that the assumption of sphericity for error category and task by error category interaction had been violated ($\chi^2(2)$ = 98.28, p < .001 and $\chi^2(2)$ = 84.86, p < .001 respectively). Hence, for the effects of error category and the task by error category interaction degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .592 and ε = .610 respectively). The analysis showed a significant main effect of task (F (1, 67) = 20.31, p < .001, η_p^2=.23), a significant main effect of error category (F (1.18, 79.36) = 809.84, p < .001, η_p^2=.92) and a significant main effect of group membership (F (3, 67) = 25.49, p < .001, η_p^2=.53). The task by error category by group interaction as well as the task by group interaction were not significant (F (3.66, 81.80) = 0.35, p = .826, η_p^2=.01 and F (3, 67) = 0.27, p = .844, η_p^2=.01 respectively). However, the interaction between task and error category as well as between error category and group were significant (F (1.22, 81.80) = 9.27, p = .002, η_p^2=.12 and F (3.55, 79.36) = 18.71, p < .001, η_p^2=.45 respectively). Sidak corrected post hoc pairwise comparisons between error categories showed that the difference between phonologically misspelled and phonologically-orthographically misspelled words was not significant (p = .731). On the other hand, phonologically plausible-orthographically misspelled words were significantly more frequent than both the phonologically misspelled words and the phonologically-orthographically misspelled words (both p values < .001).

To explore the simple effect of task on each level of error category a one-way repeated-measures ANOVA was performed at each level of error category. The number of misspelled words in each task were entered as a within-subjects variable with two levels (SWS and PC). The results of the analysis of phonologically misspelled words showed that the effect of task was significant (F (1, 70) = 5.07, p = .027, η_p^2=.07; Figure 7.3, p. 244) indicating that children misspelled significantly fewer words in the passage completion task than in the single word spelling task. The analysis of phonologically-orthographically misspelled words showed that the difference between tasks was not statistically significant (F (1, 70) = 3.30, p = .073, η_p^2=.04; Figure 7.3, p. 244). The ANOVA on phonologically plausible-orthographically misspelled words detected a significant effect of task (F (1, 70) = 14.50, p < .001, η_p^2=.17; Figure 7.3, p. 244) indicating that children made significantly fewer such misspellings in the passage completion task than in the single word spelling task.

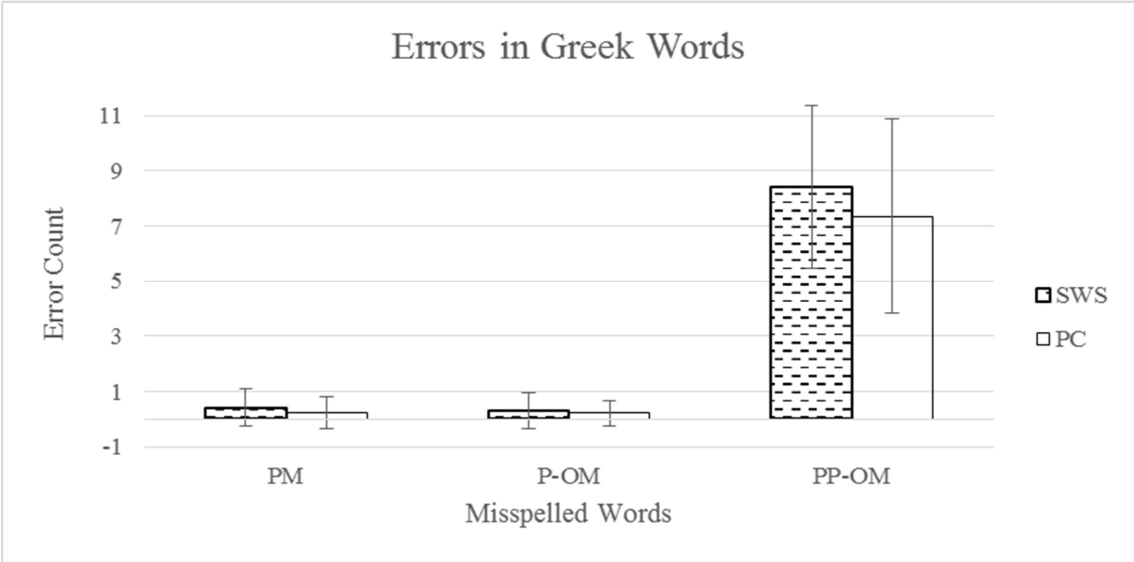


Figure 7.3

Means and Standard Deviations of Marginal Means of Greek Misspelled Words per Spelling Task (Single Word Spelling, Passage Completion).

Note. SWS = Single Word Spelling; PC = Passage Completion; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

Hence, the source of the task by error category interaction appears to lie in that target words were less frequently misspelled in the passage completion task in comparison with the single word spelling task, with the exception of the phonologically-orthographically misspelled words where a significant discrepancy between tasks was not detected.

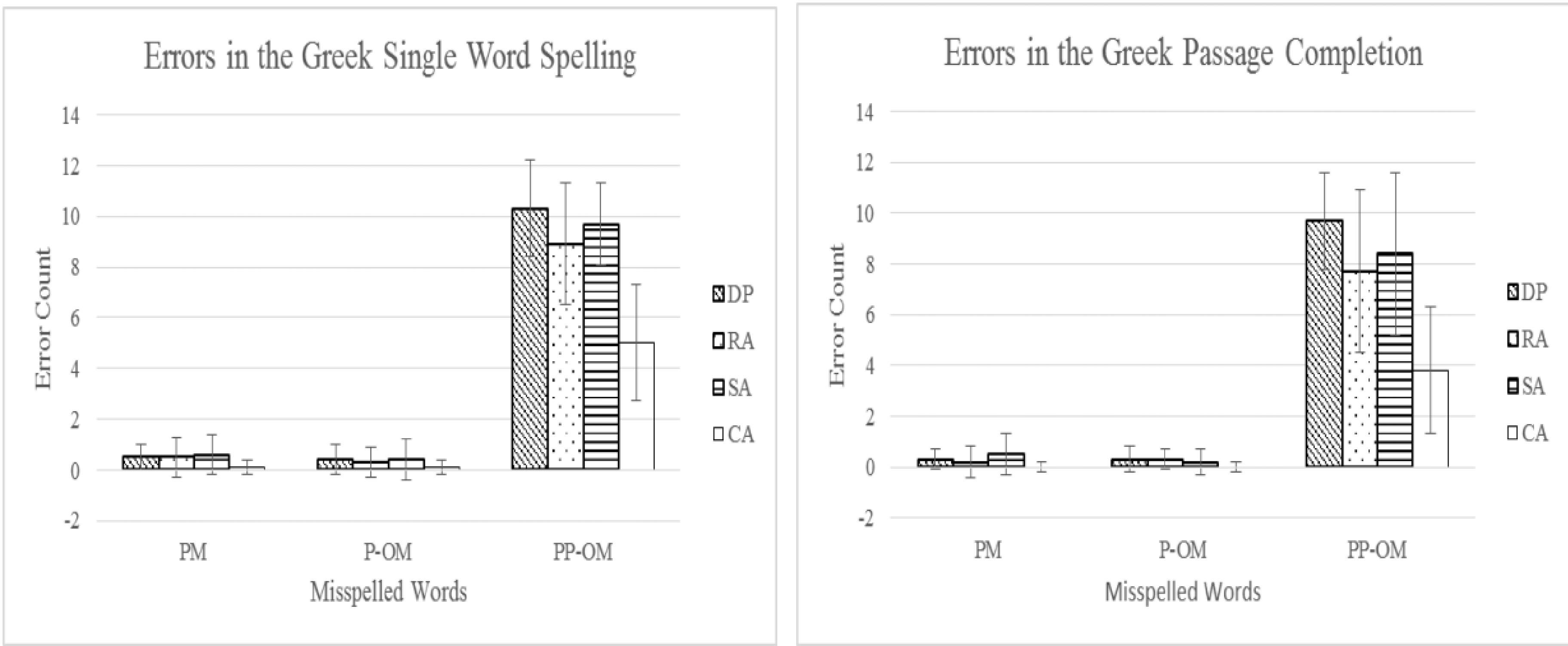


Figure 7.4

Means and Standard Deviations of Greek Misspelled Words per Group and per Spelling Task (Single Word Spelling, Passage Completion).

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

To explore the simple effect of group on each level of error category separate one-way multivariate ANOVAs were conducted. The analysis of the phonologically misspelled words in the single word spelling and the passage completion task using Pillai's trace showed that the effect of group membership was not significant (V = 0.11, F (6, 134) = 1.30, p = .260, η_p^2=.05). Similar results were produced by the analysis of phonologically-orthographically misspelled words (V = 0.06, F (6, 134) = 0.78, p = .583, η_p^2=.03). On the other hand, a significant effect of group was revealed for the phonologically plausible-orthographically misspelled words (V = 0.54, F (6, 134) = 8.32, p < .001, η_p^2=.27). The significant effect of group was further explored with separate univariate ANOVAs for the phonologically plausible-orthographically misspelled words occurring in each spelling task. The results showed that the effect of group was significant in both the single word spelling (F (3, 67) = 23.43, p < .001, η_p^2=.51; Figure 7.4, p. 245) and the passage completion task (F (3, 67) = 14.74, p < .001, η_p^2=.39; Figure 7.4, p. 245). Sidak corrected post hoc pairwise comparisons illustrated that the dyslexic-profile group produced significantly more phonologically plausible-orthographically misspelled words than their chronological-age controls in both tasks (both p values < .001) but performed at the same level as their reading and spelling-age controls (all p values > .05). Therefore, the source of the error category by group interaction seems to lie in that the dyslexic group did not differ significantly from the control groups in the phonological and phonological-orthographic error rates but produced significantly more phonologically plausible-orthographic misspellings than the chronological-age control group.

C. Comparisons of errors occurring in the component morphemes of polymorphemic words

The spelling performance of dyslexic-profile and typically developing children in the component morphemes of the affixed target words were examined to reveal any effect of context on the spelling of morphologically complex words. Phonologically plausible misspellings of the stems and the inflectional suffixes were compared across tasks to allow for a direct examination of the impact of semantic and morphological context on orthographic and morphological spelling.

Table 7.4

Means and Standard Deviations of Percentages of Misspellings in Greek Morphemes per Group of Participants in the Single Word Spelling and the Passage Completion Task

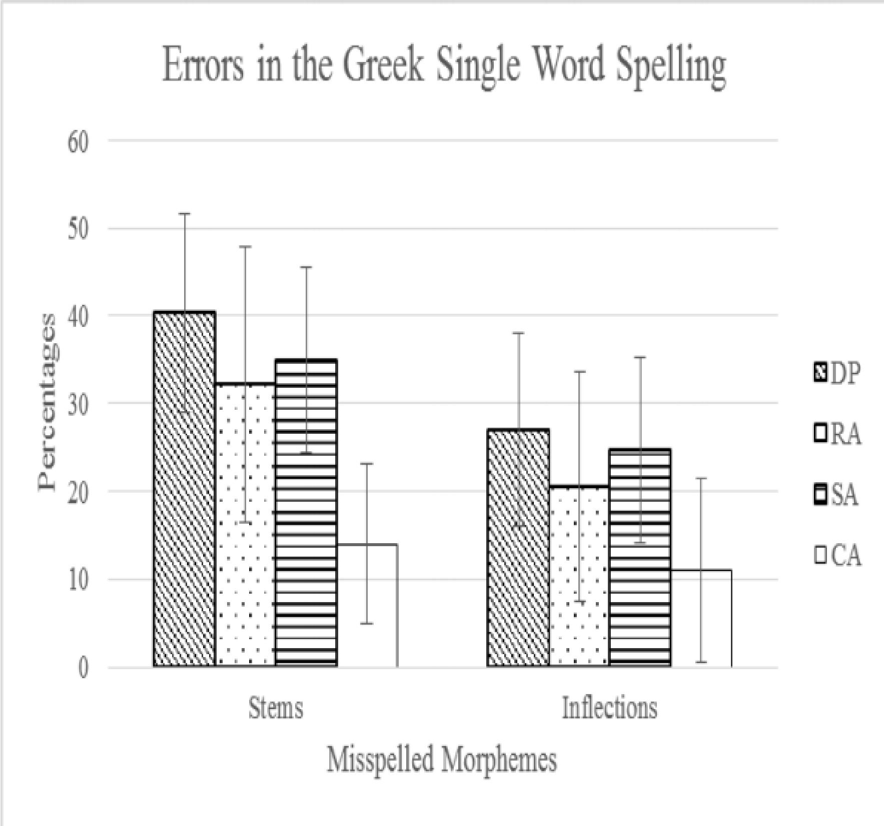
	Single Word Spelling								Passage Completion							
	DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)		DP (N=17)		RA (N=18)		SA (N=17)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	40.3	(11.4)	32.2	(15.7)	34.9	(10.6)	14.0	(9.1)	46.2	(13.0)	35.2	(17.9)	38.4	(16.2)	16.8	(12.2)
Inflectional Suffixes	27.0	(11.0)	20.5	(13.0)	24.7	(10.6)	11.0	(10.5)	21.2	(11.1)	15.5	(11.5)	19.4	(12.9)	8.4	(8.3)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of misspelled morphemes are presented for ease of interpretation.

Percentage of misspelled morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Used Morphemes}}$ x 100

Examples of errors are displayed in Table 6.2, p. 186. Because the number of morphemes was not equal across categories, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Dictated\ Stems}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Dictated\ Inflections}$. The data corresponding to the stem category were normally distributed in both spelling tasks, with the exception of the errors produced by the dyslexic-profile group in the single word spelling task. As concerns the inflections, the chronological-age group produced positively skewed data in both tasks, while the dyslexic-profile and the spelling-age group produced skewed data only in the single word spelling task. Transformations did not correct the skewness, hence raw data were entered in the analysis. Proportions of errors were subjected to a three-way mixed design ANOVA as a within-subjects variable comprising of two levels (errors in stems and in inflections). Task was entered as a second within-subjects variable with two levels (SWS and PC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. The results were verified with non-parametric tests. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions are presented in Table 7.4, p. 247.

The analysis showed that the main effect of morphemes was significant (F (1, 67) = 77.66, $p < .001$, η_p^2=.53). The main effect of group membership (F (3, 67) = 19.91, $p < .001$, η_p^2=.47) was also significant. However, the main effect of task was not significant (F (1, 67) = 0.16, $p = .690$, η_p^2=.00). The task by morpheme by group interaction was not significant (F (3, 67) = 0.59, $p = .619$, η_p^2=.02). In addition, the interaction between task and group was not significant (F (3, 67) = 0.06, $p = .978$, η_p^2=.00). In contrast, there was a significant interaction between task and morpheme (F (1, 67) = 25.10, $p < .001$, $\eta_p^2 = .27$) implying that the effect of task was not consistent across morphemes. In addition, there was a significant interaction between morpheme and group membership (F (3, 67) = 3.48, $p = .020$, $\eta_p^2 = .13$) indicating that a) the differences between groups were not consistent across morphemes or b) the difference between morphemes was not consistent across groups.



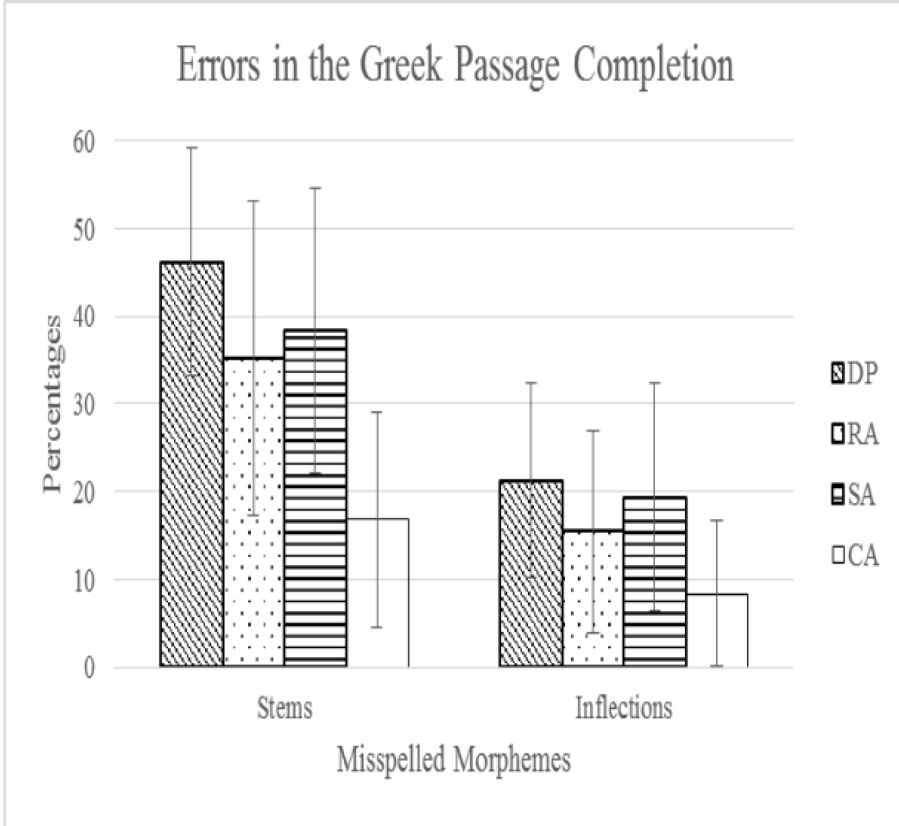


Figure 7.5

Means and Standard Deviations of Percentages of Greek Misspelled Morphemes per Group per Spelling Task (Single Word Spelling, Passage Completion)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age

To explore the task by morpheme interaction, the simple effect of task on each level of morphemes was investigated with separate one-way repeated-measures ANOVAs on stems and inflections. Spelling task was entered as a within-subjects variable with two levels (SWS and PC). The analysis of the error rates occurring in the stems of the words revealed a significant effect of task (F (1, 70) = 6.37, p = .014, η_p^2=.08; Figure *7.5*, p. 249) indicating that overall children misspelled significantly more stems in the passage completion task than in the single word spelling task. The results of the analysis of inflections showed a significant effect of task (F (1, 70) = 13.14, p = .001, η_p^2=.15; Figure *7.5*, p. 249), although following the opposite direction, i.e., fewer inflections were misspelled in the passage completion task than in the single word spelling task.

The simple effect of group membership on the error rates at each level of morphemes was investigated with separate one-way multivariate ANOVAs. The analysis of the stems using Pillai's trace showed that the effect of group membership was significant (V = 0.46, F (6, 134) = 6.70, p < .001, η_p^2=.23). The results were followed up with separate univariate ANOVAs for each task. As concerns the single word spelling task, the analysis showed a significant effect of group (F (3, 67) = 16.67, p < .001, η_p^2=.42; Figure *7.5*, p. 249). The results of the analysis of data obtained from the passage completion task showed a significant effect of group (F (3, 67) = 12.56, p < .001, η_p^2=.36; Figure *7.5*, p. 249). Sidak corrected post hoc pairwise comparisons between groups showed that in both tasks the dyslexic-profile group produced significantly higher error rates when spelling the stems of the words than the chronological-age controls (both p values < .001), but their error rates were not significantly different from those of their younger reading and spelling-age controls (all p values > .05). With regard to the inflectional suffixes the analysis of the MANOVA illustrated a significant effect of group (V = 0.26, F (6, 134) = 3.37, p = .004, η_p^2=.13). The effect was further explored with univariate ANOVAs for each task. The results of the analysis of the errors occurring in the single word spelling revealed a significant effect of group (F (3, 67) = 7.04, p < .001, η_p^2=.24; Figure *7.5*, p. 249). The analysis of the passage completion task also showed a significant effect of group (F (3, 67) = 4.77, p = .004, η_p^2=.17; Figure *7.5*, p. 249). Post hoc pairwise comparisons showed that the dyslexic-profile group misspelled significantly more inflections than the chronological age-matched children in both tasks (SWS: p < .001 and PC: p = .006), but that the performances of the dyslexic group, the reading and the spelling-age controls were not significantly different (all p values > .05).

To explore the simple effect of morphemes on each level of group membership, one-way repeated-measures ANOVAs were performed for each group of participants. The results of the analyses on the data obtained from the dyslexic-profile and the reading-age and spelling-age controls in the single word spelling task showed a significant main effect of morphemes (DP: F (1, 16) = 17.27, p = .001, η_p^2 = .52; RA: F (1, 17) = 6.50, p = .021, η_p^2 = .27; SA: F (1, 16) = 10.47, p = .005, η_p^2 = .39; Figure *7.5*, p. 249) implying that stems were more frequently misspelled than inflections. However the difference was not significant for the chronological-age control group (F (1, 18) = 0.80, p = .381, η_p^2 = .04; Figure *7.5*, p. 249). With regard to the passage completion task, a significant effect of morphemes was revealed for data obtained from all groups (DP: F (1, 16) = 51.36, p < .001, η_p^2 = .76; CA: F (1, 18) = 7.88, p = .012, η_p^2 = .30; RA: F (1, 17) = 24.02, p < .001, η_p^2 = .58; SA: F (1, 16) = 31.90, p < .001, η_p^2 = .66; Figure *7.5*, p. 249) indicating that errors in the stems were significantly more frequent than in the inflections of polymorphemic words. Therefore, it seems that inflectional suffixes were consistently more accurately spelled than the stems in both tasks by most of the participants. The only exception was the performance of the chronological-age controls in the single word spelling, where the difference between stems and inflections was not statistically significant. An inspection of the effect sizes of the effect of group on separate morphemes indicates that another source of the morpheme by group interaction might lie in a stronger effect of group on the errors occurring in the stems than in the inflections.

In summary, overall fewer misspellings occurred in the Greek passage completion than in the single word spelling task. This finding was consistent at all levels of analysis. One exception was the phonologically-orthographically misspelled words, in which a significant discrepancy between tasks was not detected, and the stems, which were more frequently misspelled in the passage completion task than in the single word spelling. In general, the dyslexic-profile group produced significantly more errors than the chronological-age group but performed at the same level as the reading and spelling-age controls. The only exceptions were the phonological and phonological-orthographic errors, in which the dyslexic group did not differ significantly from the control groups. Finally, as concerns the differences between error categories, all the participants seemed to produce significantly more phonologically plausible-orthographically misspelled words than phonologically and phonologically-orthographically misspelled words. The difference between phonologically and phonologically-orthographically misspelled words was not significant. In addition, inflectional suffixes were consistently more accurately spelled than the stems in both tasks, except the chronological-age controls whose errors in the stems and the inflections in the single word spelling were not significantly different.

7.5.2 Examination of the performance of children with dyslexia and typically developing control groups when spelling-to-dictation and spelling in self-generated context

7.5.2.1 Comparisons between the English single word spelling and the text composition task

A. Examination of overall misspelled words

In order to evaluate the overall spelling performance of each group of children, the total number of misspelled words in the text composition task as well as the total number of target words used were recorded for each participant. Because the number of target words used in the texts was not equal for all participants, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Target\ Words}{Total\ Number\ of\ Used\ Target\ Words}$. In order to compare the spelling performance of the participants in the text composition and the single word spelling tasks, the spelling accuracy of the corresponding target words in the SWS was also recorded in the form of proportions of errors ($\frac{Number\ of\ Misspelled\ Target\ Words}{Total\ Number\ of\ Used\ Target\ Words}$). This constituted the basis for comparing only the target words used in the text of each participant across spelling tasks. Descriptive statistics are presented in Table 7.5, p. 253. The proportions of errors obtained from each spelling task were subjected to a two-way mixed design ANOVA. Task was entered as a within-participants variable with two levels (single word spelling and text composition). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. The data obtained from the chronological-age group in both tasks as well as from the spelling-age controls in the text composition task were positively skewed. Transformations did not correct the skewness, hence, raw data were entered in the analysis. The results were verified with non-parametric tests.

Table 7.5

Means and Standard Deviations of Percentages of English Misspelled Words per Group of Participants in the Single Word Spelling and the Text Composition Task

	Single Word Spelling								Text Composition							
	DP (N=18)		RA (N=17)		SA (N=18)		CA (N=21)		DP (N=18)		RA (N=17)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	77.2	(27.7)	65.0	(29.6)	81.8	(43.0)	32.0	(28.7)	71.6	(23.6)	58.9	(32.9)	70.6	(33.3)	34.8	(29.5)
Phonologically Misspelled Words	12.3	(14.5)	13.6	(17.8)	6.8	(13.0)	2.5	(5.4)	10.5	(13.9)	8.6	(14.7)	8.3	(15.1)	4.4	(10.4)
Phonologically-Orthographically Misspelled Words	24.6	(18.7)	8.7	(18.9)	12.1	(18.5)	6.0	(11.7)	22.7	(21.6)	11.2	(18.7)	15.6	(26.1)	4.9	(9.3)
PP-Orthographically Misspelled Words	40.1	(29.0)	42.6	(26.9)	62.9	(43.7)	23.5	(23.2)	44.6	(28.6)	33.8	(29.2)	45.9	(31.0)	26.9	(22.5)

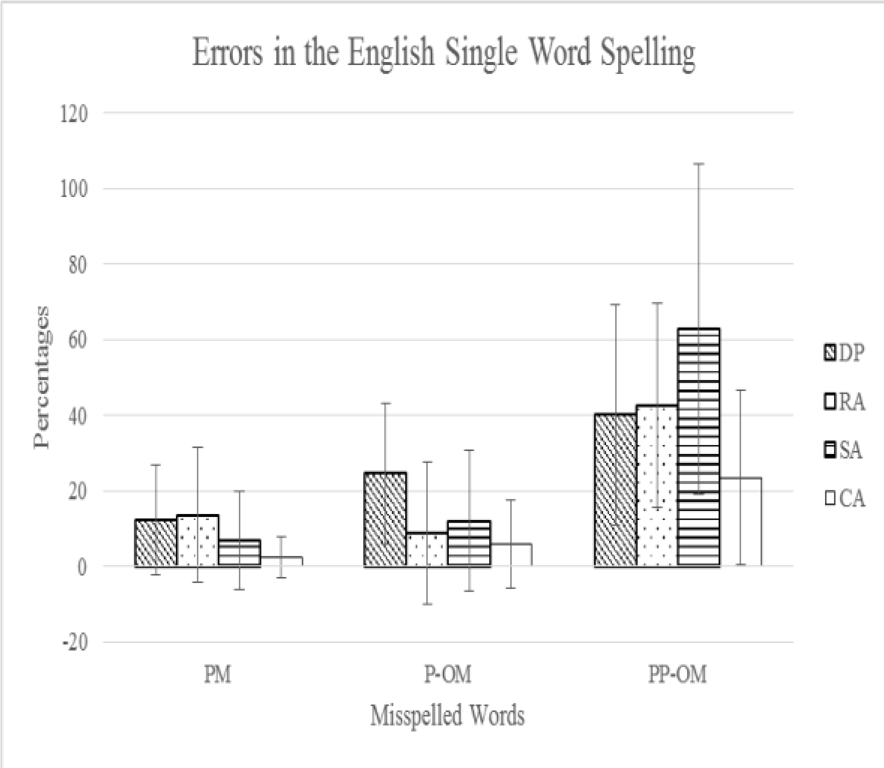
Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. PP-=Phonologically Plausible. Percentage of misspelled words = $\frac{\text{Misspelled Words}}{\text{Total Used Words}}$ x 100

The analysis showed that the main effect of task was not significant (F (1, 70) = 3.56, p = .063, η_p^2=.05). Thus, despite the fact that a higher proportion of target words was misspelled in the single word spelling task, the difference between tasks was not statistically significant. A significant main effect of group membership was evident (F (3, 70) = 9.04, p < .001, η_p^2=.28) but the interaction effect between task and group was not significant (F (3, 70) = 1.29, p = .283, η_p^2=.05). To explore the differences between the performance of the dyslexic-profile participants and their control groups, post hoc pairwise comparisons were conducted. The results showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls (p < .001) but not than the reading and spelling ability-matched control groups (both p values > .05).

B. Comparisons between phonologically misspelled and orthographically misspelled words

In order to explore the differences between the dyslexic-profile group and the control groups as well as the effect of semantic and syntactic context on employing different types of knowledge, proportions of errors corresponding to the phonologically misspelled, orthographically-phonologically misspelled and phonologically plausible-orthographically misspelled target words used in the text composition and the corresponding words in the single word spelling were recorded. Examples of the misspelled words under each error category are presented in Table 6.1, p. 185, and descriptive statistics in Table 7.5, p. 253. The data corresponding to phonologically misspelled words obtained from all four groups in both tasks were positively skewed. As concerns the phonologically-orthographically misspelled words, the data obtained from all groups in the text composition task and from all typically developing children in the single word spelling task were positively skewed. Regarding phonologically plausible-orthographically misspelled words, only the data obtained from the single word spelling task from the typically developing participants were skewed. Transformations did not correct the skewness. Hence, the raw proportions of errors under the three error categories were subjected to a three-way mixed design ANOVA with three levels (PM-P-OM, PP-OM). Spelling task was entered as a within-subjects variable comprising of two levels (SWS and TC) and group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. The results of the parametric analyses were verified with non-parametric tests.

A Mauchly's test revealed that the assumption of sphericity for error category and task by error category interaction had been violated ($\chi^2(2) = 31.17$, $p < .001$ and $\chi^2(2) = 9.31$, $p = .010$ respectively). Hence, for the effects of error category and the task by error category interaction degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .777$ and $\varepsilon = .948$ respectively). The analysis showed that the main effect of task was not significant (F (1, 70) = 3.40, $p = .069$, η_p^2=.05). However, a significant main effect of error category (F (1.55, 108.82) = 53.45, $p < .001$, η_p^2=.43), as well as a significant main effect of group membership (F (3, 70) = 8.64, $p < .001$, η_p^2=.27) were revealed. The results showed that the task by error category by group interaction was not significant (F (5.69, 132.78) = 1.81, $p = .104$, η_p^2=.07), but that there was a significant interaction between task and group (F (3, 70) = 2.89, $p = .041$, η_p^2=.11). However, the interaction between task and error category was not significant (F (1.89, 132.78) = 1.00, $p = .364$, η_p^2=.01) implying that the effect of task was consistent across error categories. Similarly, the error category by group interaction was not significant (F (4.66, 108.82) = 1.95, $p = .097$, η_p^2=.07) indicating that the differences between phonologically and orthographically misspelled words were comparable at all levels of the group variable. Sidak corrected post hoc pairwise comparisons between error categories showed that the proportions of phonologically misspelled words did not differ significantly from those of the phonologically-orthographically misspelled words ($p = .077$). On the other hand, the proportions of phonologically plausible-orthographically misspelled words were significantly higher than those of both error categories containing phonological mistakes (both p values < .001).



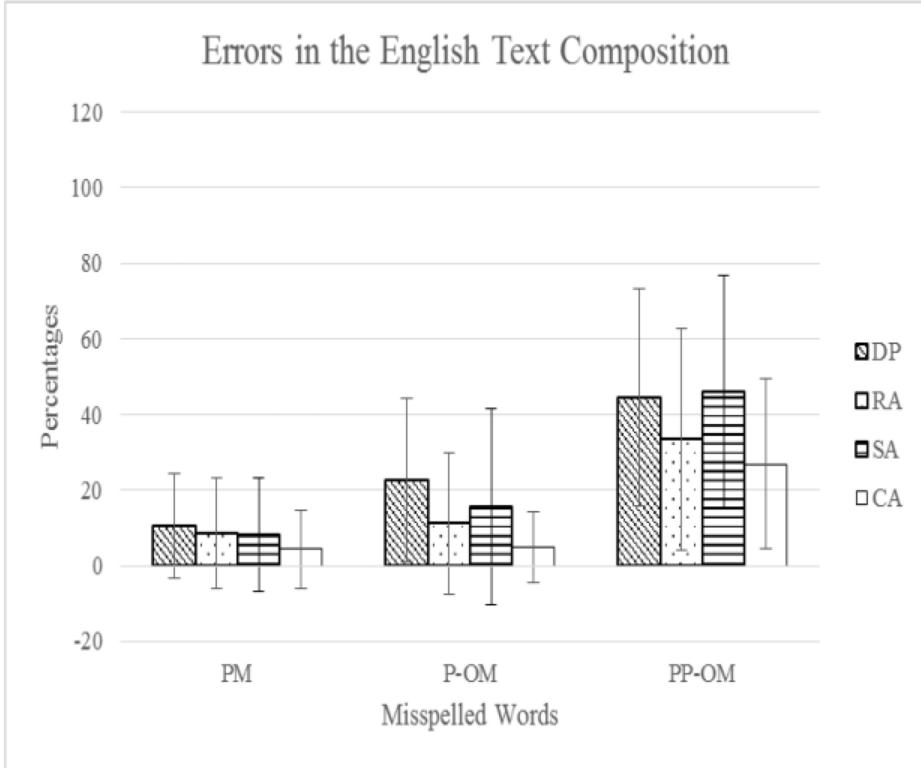


Figure 7.6

Means and Standard Deviations of English Misspelled Words per Group per Spelling Task (Single Word Spelling, Text Composition).

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

To explore the task by group interaction the simple effect of group membership on each level of the task variable was explored with a one-way multivariate ANOVA. Proportions of misspelled words under the three error categories in each task were entered as the dependent variable. Group membership was entered as an independent variable (DP, RA, SA and CA). The results of the analysis of the data obtained from the single word spelling task using Pillai's trace showed that the effect of group was significant ($V = 0.47$, F (9, 210) = 4.40, $p < .001$, η_p^2=.16). The result was followed up with separate univariate ANOVAs on each error category. The analysis of phonologically misspelled words revealed a significant effect of group (F (3, 70) = 2.92, $p = .040$, η_p^2=.11; Figure *7.6*, p. 256). Similar results were produced for the phonologically-orthographically misspelled words (F (3, 70) = 4.31, $p = .008$, η_p^2=.15; Figure *7.6*, p. 256) and the phonologically plausible-orthographically misspelled words (F (3, 70) = 5.08, $p = .003$, η_p^2=.17; Figure *7.6*, p. 256). Post hoc pairwise comparisons showed that the dyslexic-profile group did not differ significantly from any control group in the proportions of phonologically misspelled and phonologically plausible-orthographically misspelled words (all p values > .05; but Bonferroni corrected Mann-Whitney U at $\alpha = .016$ showed that in PP-OM in SWS: DP>CA; $U = 110.50$, z = -2.57, $p = .009$). However, they produced significantly more phonologically-orthographically misspelled words than the chronological-age controls (p = .007) and the reading-age controls ($p = .044$) but performed at the same level as their spelling-age controls ($p > .05$; but Bonferroni corrected Mann-Whitney U at $\alpha = .016$ showed that in SWS DP>SA; $U = 92.00$, z = -2.25, $p = .012$). The ANOVA on text composition also illustrated a significant effect of group ($V = 0.24$, F (9, 210) = 2.10, p = .030, η_p^2=.08). The univariate ANOVAs further exploring this effect of group produced significant results only for the phonologically-orthographically misspelled words (PM: F (3, 70) = 0.70, $p = .551$, η_p^2=.03; P-OM: F (3, 70) = 2.78, $p = .047$, η_p^2=.10; PP-OM: F (3, 70) = 2.05, $p = .113$, η_p^2=.08; Figure *7.6*, p. 256). Post hoc pairwise comparisons showed that the dyslexic-profile pupils made significantly higher phonological-orthographic error rates only in comparison with the chronological-age controls ($p = .038$) but not with the reading and spelling-age control groups (both p values > .05).

To investigate the simple effect of task on each level of group one-way repeated-measures ANOVAs were employed for each error category. Spelling task was entered as the within-subjects variable comprising of two levels (SWS and TC). The analyses on proportions of phonologically misspelled words showed that children in all groups did not produce significantly different error rates across the two tasks (DP: F (1, 17) = 0.16, p = .691, η_p^2=.01; CA: F (1, 20) = 0.59, p = .450, η_p^2=.03; RA: F (1, 16) = 1.32, p = .267, η_p^2=.07; SA: F (1, 17) = 0.20, p = .654, η_p^2=.01; Figure *7.6*, p. 256). Similar results were obtained from the analyses on phonologically-orthographically misspelled words (DP: F (1, 17) = 0.24, p = .626, η_p^2=.01; CA: F (1, 20) = 0.44, p = .511, η_p^2=.02; RA: F (1, 16) = 0.40, p = .536, η_p^2=.02; SA: F (1, 17) = 0.31, p = .581, η_p^2=.02; Figure *7.6*, p. 256). Finally, the ANOVAs on the proportions of phonologically plausible-orthographically misspelled words did not produce significant results concerning the error rates of the dyslexic-profile, the chronological-age and the reading-age participants (DP: F (1, 17) = 0.46, p = .505, η_p^2=.03; CA: F (1, 20) = 1.18, p = .289, η_p^2=.06; RA: F (1, 16) = 3.62, p = .075, η_p^2=.18; Figure *7.6*, p. 256). The analysis detected a significant effect of task only for the younger spelling-age controls, although the p value was close to the maximum threshold indicating significance (F (1, 17) = 4.60, p = .047, η_p^2=.21; Figure *7.6*, p. 256), showing that lower error rates occurred in the text composition than in the single word spelling task.

Therefore, the source of the task by group interaction appears to lie in that the effect of spelling task was prominent only as concerns the phonologically plausible-orthographically misspelled words and only for the younger spelling-age controls. Another source might be that the dyslexic-profile participants appeared to make significantly more phonological-orthographic errors than the chronological-age controls in the target words examined in the single word spelling and the text composition task as well as than both the chronological-age and the reading-age controls in the first task, but they did not seem to differ significantly from the spelling control group.

Table 7.6

Means and Standard Deviations of Percentages of Misspellings in English Morphemes per Group of Participants in the Single Word Spelling and the Text Composition Task

	Single Word Spelling								Text Composition							
	DP (N=18)		RA (N=17)		SA (N=18)		CA (N=21)		DP (N=18)		RA (N=17)		SA (N=18)		CA (N=21)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	30.0	(19.4)	27.3	(25.5)	39.0	(47.6)	13.7	(16.7)	41.2	(24.7)	24.9	(22.0)	37.4	(28.6)	20.8	(18.7)
Inflectional Suffixes	18.1	(24.9)	9.3	(14.4)	7.9	(11.5)	9.2	(23.8)	12.8	(19.9)	16.2	(30.1)	9.5	(26.7)	7.2	(22.2)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of misspelled morphemes are presented for ease of interpretation.

Percentage of misspelled morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Used Morphemes}}$ x 100

C. Comparisons of errors occurring in the component morphemes of polymorphemic words

All phonologically plausible misspellings in stems and inflectional suffixes of the affixed words used by each participant in the text composition task were recorded. The corresponding morphemes from the single word spelling task were also examined to investigate potential impact of semantic and syntactic context on orthographic and morphological spelling of pupils with and without dyslexia. Examples of errors are displayed in Table 6.1, p. 185. Because the number of morphemes was not equal across categories and each participant used a unique number of target words in their text, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Used\ Stems}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Used\ Inflections}$. As concerns the data corresponding to errors in the stems, the errors of most groups were normally distributed, with the exception of those produced by the chronological-age control group in both tasks and by the spelling-age controls in the single word spelling task. As concerns the inflections, the data obtained from all four groups in both tasks were positively skewed. Transformations did not correct the skewness, hence raw data were entered in the analysis. Sidak corrections controlled for inflation of Type I errors. The results were verified with non-parametric tests. Because the proportions of errors in some instances were very low, for ease of interpretation percentages of errors, rather than proportions are presented in Table 7.6, p. 259.

Proportions of errors under the stem and the inflectional suffix category were subjected to a three-way mixed design ANOVA as a within-subjects variable with two levels (morphemes). Task was entered as a second within-subjects variable with two levels (SWS and TC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. The analysis showed that the main effect of task was not significant (F (1, 62) = 0.40, p = .525, η_p^2=.00). However, the main effect of group was significant (F (3, 62) = 3.57, p = .019, η_p^2=.15). In addition, the main effect of morphemes was significant (F (1, 62) = 32.01, p < .001, η_p^2=.34) implying that stems were more frequently misspelled than inflections. Nevertheless, most of the interactions between variables were not significant, namely the task by morpheme by group interaction (F (3, 62) = 1.77, p = .161, η_p^2=.08), the task by group (F (3, 62) = 0.17, p = .916, η_p^2=.00) and the task by morpheme interaction (F

(1, 62) = 0.24, p = .626, η_p^2=.00). Only the morpheme by group interaction was significant, although the p value was close to the maximum threshold indicating significance (F (3, 62) = 2.77, p = .049, η_p^2 = .11).

To explore the simple effect of group on each level of morpheme separate one-way multivariate ANOVAs were performed for stems and inflections separately. Group membership (DP, RA, SA and CA) was entered as an independent variable. The analysis of proportions of misspelled stems using Pillai's trace indicated that the effect of group was significant (V = 0.18, F (6, 140) = 2.41, p = .030, η_p^2=.09). The effect was further explored with separate univariate ANOVAs on the proportions of errors in the stems for each spelling task. The results were significant only for the text composition task (F (3, 70) = 3.22, p = .028, η_p^2=.12). However, post hoc pairwise comparisons showed that the difference between the errors made by the dyslexic-profile group and the chronological-age controls was only marginally significant (p = .053; but Bonferroni corrected Mann-Whitney U at α = .016 showed that in TC DP>CA; U = 84.50, z = -2.95, p = .003), while the difference with the reading and spelling-age controls was not significant (p > .05). The analysis of error rates in stems in the single word spelling task did not produce significant results as concerns the effect of group (F (3, 70) = 2.47, p = .069, η_p^2=.09). The MANOVA on error rates in the inflectional suffixes using Pillai's trace showed that the effect of group was not significant (V = 0.06, F (6, 124) = 0.65, p = .684, η_p^2=.03). Hence, the effect of group on inflections was not explored further.

To summarise, most analyses of the English data showed that the effect of task (SWS vs TC) was not significant. The only exception were the phonologically plausible-orthographic misspellings of the younger spelling-age controls that were fewer in the text composition than in the single word task. Overall, the dyslexic-profile group produced significantly more errors than the chronological-age group but performed at the same level as the reading and spelling-age controls. This finding was consistent in the analysis of whole misspelled words, the phonological-orthographic errors in both tasks and the stems of polymorphemic words used in the text composition. In addition, the dyslexic group made significantly more phonological-orthographic errors than the reading-age controls in the single word spelling task. In all other error categories and morphemes the dyslexic group did not differ significantly from the control groups. Finally, all the participants produced significantly more phonologically plausible-orthographically misspelled words than phonologically and phonologically-orthographically misspelled words. The difference between the two error categories containing phonological errors (PM and P-OM) was not significant. Moreover, inflectional suffixes were consistently more accurately spelled than the stems in both tasks.

7.5.2.2 Comparisons between the Greek single word spelling and the text composition task

A. Examination of overall misspelled words

The proportion of misspelled target words in the text composition task was recorded for each participant using the ratio of $\frac{Number\ of\ Misspelled\ Target\ Words}{Total\ Number\ of\ Used\ Target\ Words}$. The corresponding error proportions from the single word spelling task were also recorded to enable direct comparisons between tasks, error types and groups. The data obtained from the chronological-age controls in the single word spelling task and from the reading-age control group in both tasks were positively skewed. Transformations did not correct the skewness, hence, raw data were entered in the analysis. Descriptive statistics are presented in Table 7.7, p. 263.

The proportions were subjected to a two-way mixed design ANOVA. Spelling task was entered as a within-participants variable comprising of two levels (SWS and TC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections were applied to control for inflation of Type I errors due to multiple comparisons. The results were verified with non-parametric tests.

According to the results, the main effect of task was not significant (F (1, 65) = 0.24, p = .621, η_p^2=.00). There was a significant main effect of group membership (F (3, 65) = 12.43, p < .001, η_p^2=.36) but the interaction effect between task and group was not significant (F (3, 65) = 2.27, p = .088, η_p^2=.09) indicating that the effect of group was consistent across tasks. Sidak corrected post hoc pairwise comparisons showed that the dyslexic-profile participants misspelled significantly more words than the chronological-age controls (p < .001) but not than the younger reading and spelling ability-matched controls (both p values > .05).

Table 7.7

Means and Standard Deviations of Percentages of Greek Misspelled Words per Group of Participants in the Single Word Spelling and Text Composition Task

	Single Word Spelling								Text Composition							
	DP (N=17)		RA (N=18)		SA (N=15)		CA (N=19)		DP (N=17)		RA (N=18)		SA (N=15)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Total Misspelled Words	61.0	(19.2)	61.5	(31.3)	58.8	(26.8)	24.4	(24.0)	77.8	(20.4)	56.8	(34.0)	53.8	(36.4)	24.4	(22.6)
Phonologically Misspelled Words	2.9	(12.1)	0.9	(3.9)	3.3	(12.9)	0.7	(3.2)	3.0	(9.9)	1.8	(7.8)	2.2	(8.6)	1.3	(3.8)
Phonologically-Orthographically Misspelled Words	6.0	(9.9)	1.8	(7.8)	3.0	(8.9)	0.0	(0.0)	8.6	(11.3)	7.6	(15.5)	5.2	(11.8)	0.7	(3.2)
PP-Orthographically Misspelled Words	65.6	(26.8)	62.5	(33.2)	58.6	(32.7)	23.7	(23.2)	64.5	(20.4)	48.1	(29.7)	48.6	(33.9)	23.5	(21.5)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. PP-=Phonologically Plausible. Percentage of misspelled words = $\frac{\text{Misspelled Words}}{\text{Total Used Words}}$ x 100

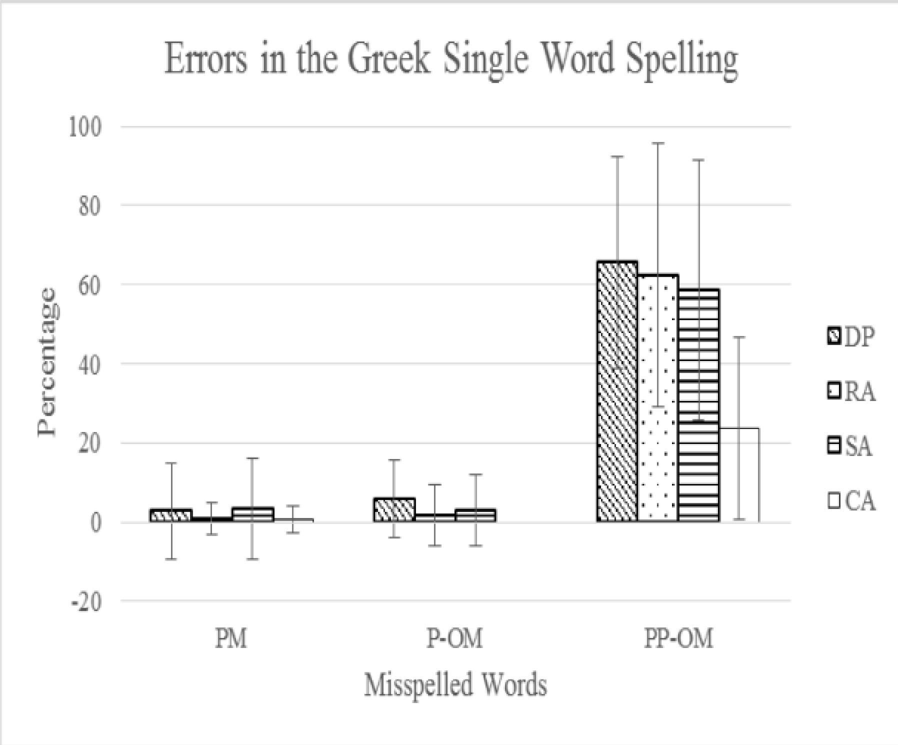
B. Comparisons between phonologically misspelled and orthographically misspelled words

Proportions representing the phonologically misspelled, phonologically-orthographically misspelled and phonologically plausible-orthographically misspelled target words over the total number of used target words in the text composition task were calculated. The proportions of errors obtained from the corresponding target words in the single word spelling task were also recorded. For the phonological and the phonological-orthographic error category, the data obtained from all four groups of children in both tasks were positively skewed. For the phonologically plausible-orthographic errors, the data obtained from the chronological-age controls were skewed in both tasks, while the reading-age controls produced skewed data only in the single word spelling task. Transformations did not correct the skewness. Hence, the raw data were subjected to the analysis. Error rates from both tasks were subjected to a three-way mixed design ANOVA investigating differences between tasks, error types and groups of children. One within-subjects variable was named error category and comprised of three levels (PM, P-OM and PP-OM words). Spelling task was entered as a second within-subjects variable comprising of two levels (SWS and TC). Group membership was entered as a between-participants variable (DP, RA, SA and CA). Sidak corrections were employed to control for inflation of Type I errors due to multiple comparisons. The results of the parametric analyses were verified with non-parametric tests. Examples of the misspelled words under each error category are presented in Table 6.2, p. 186, and descriptive statistics in percentages in Table 7.7, p. 263.

A Mauchly's test showed that the assumption of sphericity for error category and task by error category interaction had been violated ($\chi^2(2) = 83.45$, $p < .001$ and $\chi^2(2) = 26.78$, $p < .001$ respectively). Hence, for the effects of error category and the task by error category interaction degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .610$ and $\varepsilon = .794$ respectively). The analysis showed that the main effect of task was not significant (F (1, 65) = 1.16, $p = .284$, η_p^2=.02). There was, however, a significant main effect of error category (F (1.21, 79.24) = 242.49, $p < .001$, η_p^2=.79) and a significant main effect of group membership (F (3, 65) = 11.72, $p < .001$, η_p^2=.35). The task by error category by group interaction was not significant (F (4.76, 103.20) = 0.79, $p = .548$, η_p^2=.03). The error category by group interaction was significant F (3.65, 79.24) = 7.99, $p < .001$, η_p^2=.27) but the task by group interaction was not significant (F (3, 65) = 0.76, p =

.519, η_p^2=. 03). In addition, the interaction between task and error category was not significant, although the p value was close to the maximum threshold (F (1.58, 103.20) = 3.23, p = .055, η_p^2=.05). Sidak corrected post hoc pairwise comparisons between error categories showed that the difference between phonologically misspelled and phonologically-orthographically misspelled words was not significant (p = .129). On the other hand, phonologically plausible-orthographically misspelled words were significantly more frequent than both the phonologically misspelled words and the phonologically-orthographically misspelled words (both p values < .001).

To explore the simple effect of group on each level of error category separate one-way multivariate ANOVAs were conducted for each of the three error categories. The analysis of the phonologically misspelled words using Pillai's trace showed that the effect of group membership was not significant (V = 0.02, F (6, 130) = 0.28, p = .946, η_p^2=.01). Similar results were produced by the analysis of phonologically-orthographically misspelled words (V = 0.14, F (6, 130) = 1.72, p = .121, η_p^2=.07). On the other hand, a significant effect of group was detected for the phonologically plausible-orthographically misspelled words (V = 0.36, F (6, 130) = 4.79, p < .001, η_p^2=.18). The significant effect of group was further explored with separate univariate ANOVAs for the phonologically plausible-orthographically misspelled words occurring in each spelling task. The results showed that the effect of group was significant in both the single word spelling (F (3, 65) = 8.25, p < .001, η_p^2=.27; Figure 7.7, p. 266) and the text composition task (F (3, 65) = 7.31, p < .001, η_p^2=.25; Figure 7.7, p. 266). Sidak corrected post hoc pairwise comparisons revealed that the dyslexic-profile group produced significantly more phonologically plausible-orthographically misspelled words than their chronological-age controls in both tasks (p values < .001) but performed at the same level as the reading and spelling-age controls (all p values > .05)



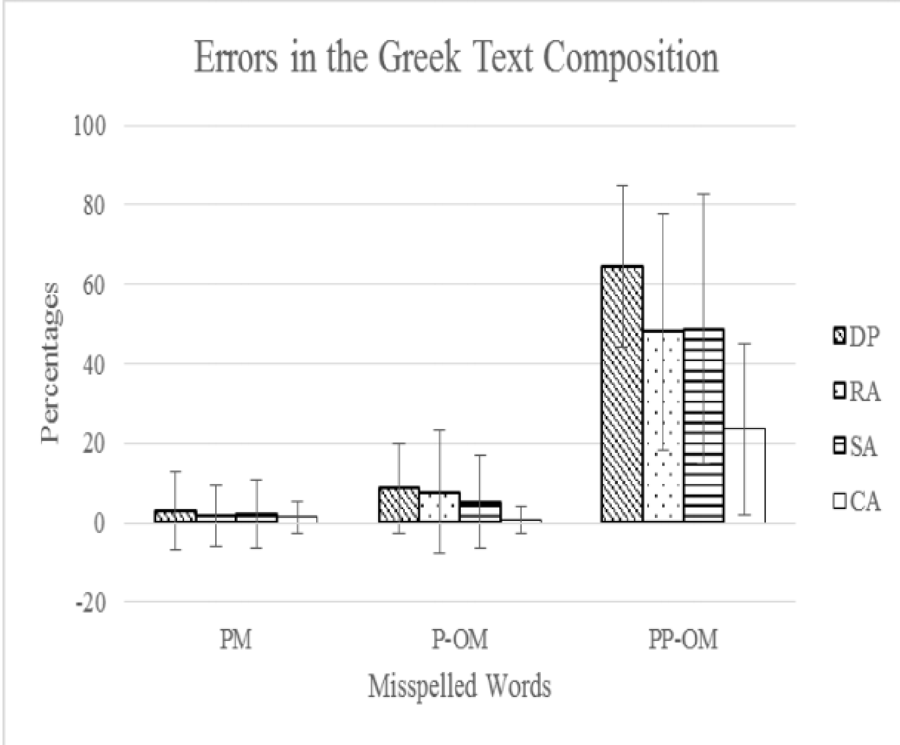


Figure 7.7

Means and Standard Deviations of Greek Misspelled Words per Group per Spelling Task (Single Word Spelling, Text Composition).

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age; PM = Phonologically Misspelled; P-OM = Phonologically-Orthographically Misspelled; PP-OM = Phonologically Plausible-Orthographically Misspelled

Therefore, the source of the error category by group interaction seems to lie in that the dyslexic group did not differ significantly from the control groups in the phonological and phonological-orthographic error rates but produced significantly more phonologically plausible-orthographic misspellings than the chronological-age control group in both tasks.

C. Comparisons of errors occurring in the component morphemes of polymorphemic words

The phonologically plausible misspellings occurring in the stems and the inflectional suffixes of affixed words were compared across tasks (SWS and TC) to allow for a direct examination of the impact of semantic and syntactic context on orthographic and morphological spelling of the dyslexic-profile children and their control groups. Examples of errors are displayed in Table 6.2, p. 186. Because the number of morphemes was not equal across categories and each participant used a unique number of target words in their text, the errors were normalised by calculating the ratio of $\frac{Number\ of\ Misspelled\ Stems}{Total\ Number\ of\ Used\ Stems}$ and $\frac{Number\ of\ Misspelled\ Inflections}{Total\ Number\ of\ Used\ Inflections}$. The data corresponding to errors in the stems as produced by the chronological-age and the reading-age controls in both tasks were positively skewed. In addition, positively skewed data were produced in both tasks by all the participants in the inflectional suffixes category. Transformations did not correct the skewness, hence raw data were entered in the analysis. Proportions of errors were subjected to a three-way mixed design ANOVA as a within-subjects variable comprising of two levels (errors in stems and in inflections). Task was entered as a second within-subjects variable with two levels (SWS and TC). Group membership (DP, RA, SA and CA) was entered as a between-participants variable. Sidak corrections controlled for inflation of Type I errors. The results were verified with non-parametric tests. Percentages of errors are presented in Table 7.8, p. 268.

Table 7.8

Means and Standard Deviations of Percentages of Misspellings in Greek Morphemes per Group of Participants in the Single Word Spelling and the Text Composition Task

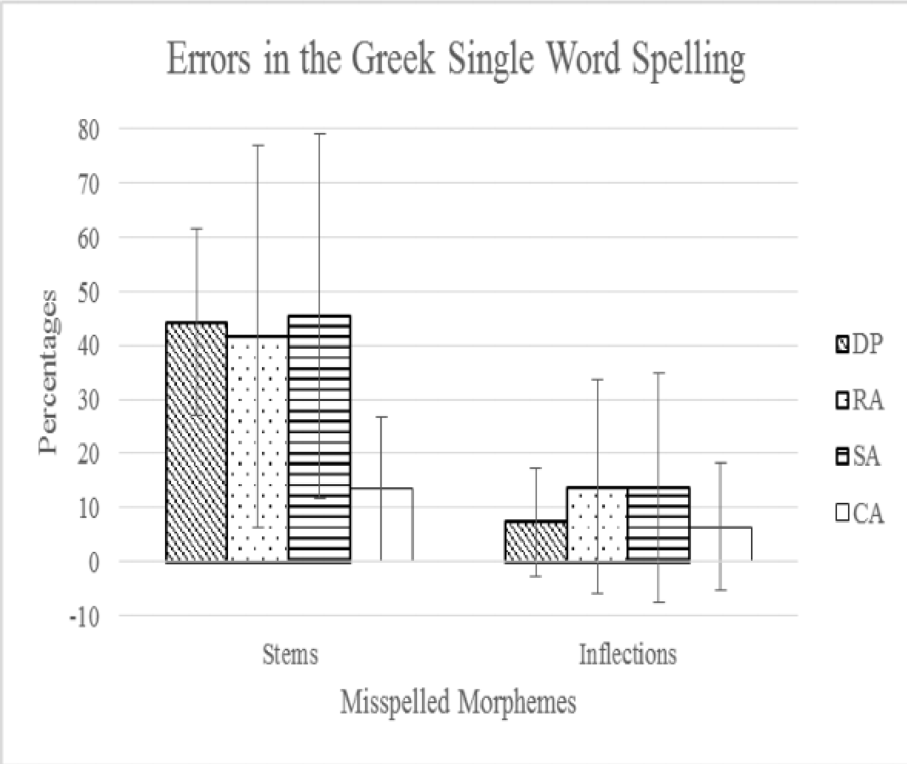
	Single Word Spelling								Text Composition							
	DP (N=17)		RA (N=18)		SA (N=15)		CA (N=19)		DP (N=17)		RA (N=18)		SA (N=15)		CA (N=19)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Stems	44.3	(17.3)	41.7	(35.3)	45.5	(33.7)	13.4	(13.3)	38.7	(16.8)	33.4	(31.8)	43.6	(32.6)	17.6	(19.3)
Inflectional Suffixes	7.3	(10.1)	13.8	(19.7)	13.8	(21.2)	6.4	(11.8)	2.2	(6.3)	4.0	(9.7)	0.0	(0.0)	3.9	(9.7)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age. Percentages of misspelled morphemes are presented for ease of interpretation.

Percentage of misspelled morphemes = $\frac{\text{Misspelled Morphemes}}{\text{Total Used Morphemes}}$ x 100

The analysis showed that the main effect of task was significant (F (1, 64) = 8.00, p = .006, η_p^2=.11) indicating that overall the error rates occurring in the text composition task were lower than those occurring in the single word spelling task. The main effect of morphemes (F (1, 64) = 88.99, p < .001, η_p^2=.58) and of group (F (3, 64) = 5.16, p = .003, η_p^2=.19) were also significant. The task by morpheme by group interaction was not significant (F (3, 64) = 0.65, p = .583, η_p^2=.03). In addition, the interaction between task and group (F (3, 64) = 1.45, p = .234, η_p^2=.06) as well as between task and morpheme (F (1, 64) = 1.97, p = .165, η_p^2 = .27) were not significant. In contrast, there was a significant interaction between morpheme and group membership (F (3, 64) = 4.57, p = .006, η_p^2 = .17) indicating that a) the differences between groups were not consistent across morphemes or b) the difference between morphemes was not consistent across groups.

The simple effect of group membership on the error rates at each level of morphemes was investigated with separate one-way multivariate ANOVAs. The analysis of the stems using Pillai's trace showed that the effect of group membership was significant (V = 0.24, F (6, 130) = 2.98, p = .009, η_p^2=.12). The results were followed-up by separate univariate ANOVAs for each task. As concerns the single word spelling task, the analysis showed a significant effect of group (F (3, 65) = 6.14, p = .001, η_p^2=.22; Figure 7.8, p. 270). The results of the analysis of data obtained from the text composition task showed a significant effect of group (F (3, 65) = 3.36, p = .024, η_p^2=.13; Figure 7.8, p. 270). Sidak corrected post hoc pairwise comparisons between groups showed that only in the single word spelling task the dyslexic-profile group produced significantly higher error rates than the chronological-age controls when spelling the stems of the words (p = .005) but their error rates were not significantly different from those of their younger reading and spelling-age controls (both p values > .05). In addition, their performance in the stems did not differ significantly from the performance of all control groups in the text composition task (all p values > .05; but Bonferroni corrected Mann-Whitney U at α = .016 showed that in TC DP>CA; U = 62.00, z = -3.17, p = .001).



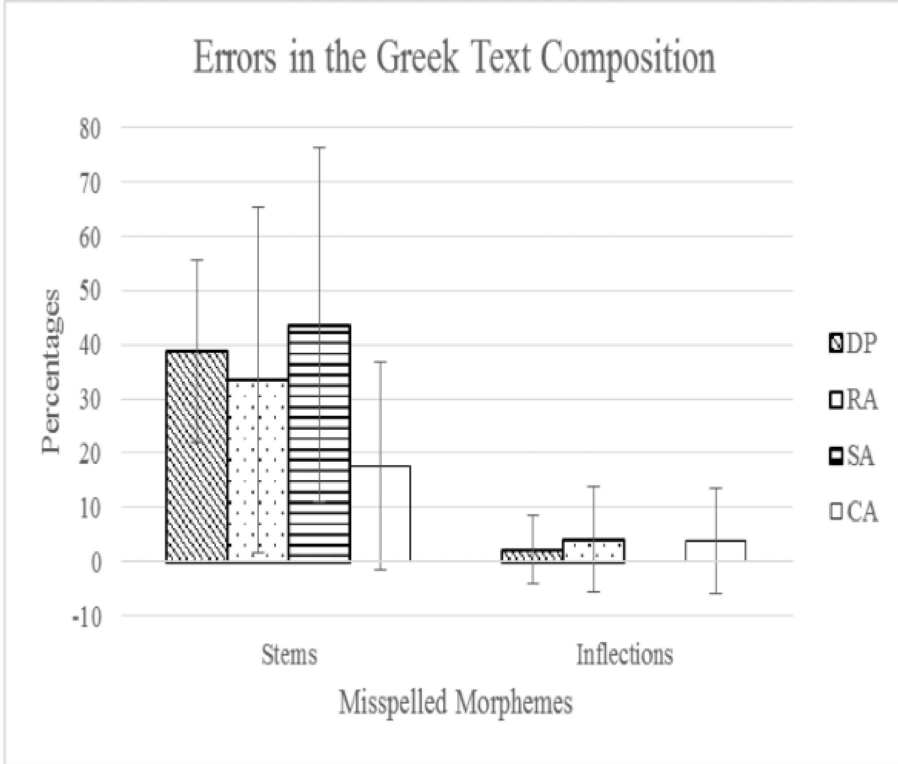


Figure 7.8

Means and Standard Deviations of Percentages of Greek Misspelled Morphemes per Group per Spelling Task (Single Word Spelling, Text Composition)

Note. DP= Dyslexic Profile; RA= Reading Age; SA= Spelling Age; CA= Chronological Age

With regard to the inflectional suffixes, the analysis of the MANOVA did not produce any significant results concerning the effect of group (V = 0.09, F (6, 128) = 1.10, p = .362, η_p^2=.05; Figure 7.8, p. 270). Thus, the effect of group was not further investigated.

To explore the simple effect of morphemes on each level of group membership, one-way repeated-measures ANOVAs were performed for each group of participants. The results of the analyses on the data obtained from the dyslexic-profile and the reading-age and spelling-age controls in the single word spelling task showed a significant main effect of morphemes (DP: F (1, 15) = 92.76, p = .001, η_p^2 = .86; RA: F (1, 17) = 9.49, p = .007, η_p^2 = .36; SA: F (1, 14) = 9.96, p = .007, η_p^2 = .42; Figure 7.8, p. 270) implying that stems were more frequently misspelled than inflections. However the difference was not significant for the chronological-age control group (F (1, 18) = 2.77, p = .113, η_p^2 = .13). With regard to the text composition task, a significant effect of morphemes was revealed for the data obtained from all groups (DP: F (1, 15) = 86.12, p < .001, η_p^2 = .85; CA: F (1, 18) = 7.10, p = .016, η_p^2 = .28; RA: F (1, 17) = 14.52, p < .001, η_p^2 = .46; SA: F (1, 14) = 26.82, p < .001, η_p^2 = .66; Figure 7.8, p. 270) indicating that errors in the stems were significantly more frequent than in the inflections of polymorphemic words. Therefore, it seems that inflectional suffixes were consistently more accurately spelled than the stems in both tasks by most of the participants. The only exception was the performance of the chronological-age controls in the single word spelling, where the difference between stems and inflections was not statistically significant. Another source of the group by morpheme interaction seems to lie in that the dyslexic-profile children appeared to misspell significantly more stems than the chronological-age controls, while their performance did not differ significantly from that of the reading and spelling-age controls as concerns the stems and from that of all three control groups as concerns the inflectional suffixes.

Although the significance of the task by morpheme interaction was only marginally significant, the simple effect of task on each level of morpheme was explored to address the specific interest of the present study in investigating the effect of semantic and syntactic context on the application of orthographic and morphological spelling. For this purpose, the proportions of errors in stems and in inflections were subjected to two separate one-way repeated-measures ANOVAs, where task was entered as a within-subjects variable (SWS and TC). The analysis of stems showed that the effect of task was not significant (F (1, 68) = 0.90, p = .345, η_p^2 = .01; Figure 7.8, p. 270). However, the

ANOVA on inflectional suffixes revealed a significant effect of task (F (1, 67) = 13.75, p < .001, η_p^2 = .17; Figure 7.8, p. 270) indicating that the errors in inflections were significantly lower in the text composition task in comparison to the single word spelling task.

In summary, most analyses of the Greek data obtained from the text composition and the single word spelling showed that the effect of task was not significant. The only exception were the error rates in inflections, which were significantly lower in the text composition than in the single word spelling task. Regarding the effect of group, the dyslexic-profile participants made significantly more errors than the chronological-age group but performed at the same level as the reading and spelling-age controls. However, the dyslexic group did not differ significantly from any control group in the proportion of phonological and phonological-orthographic errors and in the error rates in inflectional suffixes. Finally, all the participants produced significantly more phonologically plausible-orthographically misspelled words than phonologically and phonologically-orthographically misspelled words. Nonetheless, the difference between the two error categories containing phonological errors (PM and P-OM) was not significant. Finally, inflectional suffixes were consistently more accurately spelled than the stems in both tasks. Only for the chronological-age controls in the single word spelling the difference between the proportions of errors made in stems and inflections was not statistically significant.

7.5.3 Summary of results

To summarise, the examination of the spelling errors produced by English and Greek participants with and without dyslexia indicated commonalities as well as differences with regard to the magnitude of the effects of spelling task, group membership and error category on the children's spelling performance.

In more detail, the analysis of the English data obtained from the passage completion and the corresponding words in the single word spelling showed that the effect of task on the total number of misspelled words was not significant. Nonetheless, comparisons at a finer level produced some statistically significant results. Specifically, the proportions of misspelled words containing phonological mistakes (PM and P-OM) did not appear to differ across tasks. On the other hand, the English dyslexic-profile group made significantly more phonologically plausible-orthographic misspellings in the passage completion task, whereas all control groups produced fewer such errors in this task in comparison with the single word spelling task. Nevertheless, it is worth noting that the discrepancy was significant only for the reading-age controls. Another occasion where the passage completion task appeared to attract more errors than the single word spelling was revealed in the examination of the component morphemes of affixed words in both languages. In detail, English children seemed to produce higher error rates in stems and inflectional suffixes in the passage completion and Greek children misspelled significantly more stems in the passage completion than in the single word spelling.

In contrast, the passage completion task had the opposite effect on Greek inflections. The results illustrated that all Greek participants produced significantly lower error rates in this task than when writing the same words in the single word spelling. A similar effect was detected when examining the Greek phonologically misspelled words and phonologically plausible-orthographically misspelled words. The analysis demonstrated that significantly fewer such errors occurred in the passage completion task than in the single word spelling task, whereas there was no significant effect of task on the number of phonologically-orthographically misspelled words.

Finally, the effect of task was not significant for both the English and the Greek participants when the text composition and the single word spelling task were compared. One exception was the phonologically plausible-orthographically misspelled words produced by the younger English spelling-age controls, who made significantly fewer such errors in the text composition than in the single word spelling. In addition, the error rates of all the Greek participants in inflections were significantly lower in the text composition than in the single word spelling task.

As concerns the differences in the spelling performance of the dyslexic groups and their three control groups, the analyses showed that, overall, both the English and the Greek dyslexic-profile participants produced significantly higher error rates than the chronological-age control groups but did not differ significantly from the younger reading and spelling ability-matched controls. This was a common finding at all levels of analysis (i.e., overall misspelled words, PM, P-OM and PP-OM words, component morphemes of affixed words). An additional significant discrepancy between the English dyslexic-profile participants and the reading-age controls was revealed in the examination of the target words used in the text composition versus the corresponding words dictated in the single word spelling. Specifically, the results showed that in the latter task the dyslexic-profile group made significantly more phonological-orthographic errors than the chronological-age and the reading-age control group.

In contrast, there were error categories where the effect of group was not significant. In the English sample, the analysis of affixed words dictated in the passage completion versus the single word spelling demonstrated that the difference between the dyslexic-profile group and the chronological-age controls in inflectional spelling was not significant. When the text composition was examined in comparison with the single word spelling, no significant differences between dyslexic-profile and controls were detected as concerns the spelling of stems in the single word spelling and of inflectional suffixes in both tasks. Finally, with regard to the Greek sample, the examination of corresponding target words in the passage completion and the single word spelling illustrated that the discrepancy between the number of words containing phonological mistakes (PM and P-OM) of the dyslexic-profile and the chronological-age control group was not significant.

Concerning spelling performance in different error categories, there were common findings in the analyses of the phonologically misspelled, phonologically-orthographically misspelled and phonologically plausible-orthographically misspelled words of both language samples. More specifically, most pairwise comparisons showed that the difference between phonologically misspelled and phonologically-orthographically misspelled words was not statistically significant. One exception was revealed in the analysis of the target words dictated in the English passage completion task versus the corresponding words in the single word spelling task. The results showed that the pupils produced significantly fewer phonologically misspelled words than phonologically-orthographically misspelled words in both tasks. In contrast, all pairwise comparisons illustrated that phonologically plausible-orthographic errors occurred consistently more frequently than phonological and phonological-orthographic errors.

Finally, the investigation of the component morphemes of English and Greek affixed words showed that the inflectional suffixes were consistently more accurately spelled than the stems by children with and without dyslexia in all the examined tasks. The difference between stems and inflections was not statistically significant only as concerns the errors made by the Greek chronological-age controls in the affixed words examined in the single word spelling as compared to the text composition task.

7.6 Discussion

The present study was designed to explore the role of semantic and syntactic context in the spelling performance of children with dyslexia attending years 4-6 in England and grades 4-6 in Greece and their typically developing controls (Y3-Y6 and G3-G6 respectively). Spelling errors occurring in three experimental spelling conditions were analysed. The impact of context on spelling performance was investigated by comparing the passage completion and the text composition task with the single word spelling. Any differences between tasks within the same group of children, as well as between groups (dyslexic-profile and controls), and between error categories (whole words and component morphemes) were examined with the intention to understand how context might have influenced the performance of typical and atypical spellers writing in two languages of different levels of orthographic transparency. The role of language as illustrated by cross-linguistic similarities and differences in the spelling profiles of the participants is also discussed.

The comparisons between the spelling performance of the participants with a dyslexic profile in the single word spelling, where semantic context was orally provided, and in the two tasks, where it was either printed or self-generated, did not always produce significant results. This was demonstrated when the total number of misspelled words were compared across tasks. However, when errors were examined at a finer level of analysis some indications for a significant effect of task were revealed. Under circumstances there were commonalities in the manner that children with a dyslexic profile approached spelling. On the other hand, the findings obtained from each language group bore differences indicating that the orthographic system might play a significant role in the way that spelling weaknesses are manifested in different writing contexts.

Phonological errors. The results of the within-groups analyses in all three spelling tasks demonstrated that, regardless of the orthographic system in which they were writing, both typically and atypically developing spellers of this age had developed their phonological spelling skills to a level so that significant differences between phonologically misspelled and phonologically-orthographically misspelled words could not be detected. As an exception, the phonologically misspelled words were significantly fewer than the phonologically-orthographically misspelled words in the English passage completion and the corresponding words of the single word spelling. This finding might be due to the grapho-phonemic complexity of the items, since it would be expected that phonological and phonologically plausible-orthographic errors would be more likely to co-occur in a longer word containing various combinations of graphemes. By contrast, grapho-phonemically simple and short words would provide fewer opportunities for orthographic errors. The fact that such target words were outnumbered by more complex words in the English passage completion task, could explain why combinations of phonological and orthographic errors in the same word occurred more frequently than pure phonological misspellings.

As concerns the effect of context on the words containing phonological errors (PM and P-OM) produced by the English dyslexic-profile group and the typically developing children, the analysis showed that the error rates in these categories were not significantly different across the passage completion and the single word spelling task. This result possibly indicates that printed context was not exploited sufficiently as to impact on phonological spelling, in accord with general results from previous studies (Treiman & Cassar, 1996). The finding that the number of phonologically misspelled words produced by the Greek participants was significantly reduced in the passage completion in comparison with the single word spelling might suggest an advantage of typically and atypically developing pupils writing in a more consistent orthography to exploit the externally provided context in order to better apply phonological information when spelling. If printed context can be exploited to remove some of the load imposed on memory when writing-to-dictation and, thus, enhance concentration on the spelling of the target words, then writing in a more consistent orthographic system, such as Greek, might explain why Greek children appeared to benefit from the passage spelling condition while no strong effect of task was detected for the English participants. Previous research suggesting that pupils with dyslexia writing in more opaque orthographic systems are confronted with persistent phonological difficulties, while children writing in more consistent orthographic systems tend to overcome such weaknesses relatively early (Landerl & Wimmer, 2000; Nikolopoulos et al., 2003) would endorse this notion that it is easier for Greek children to make use of the printed context for more accurate spelling than it is for English children of corresponding age and years of schooling.

The results of within-groups comparisons between the phonological errors in the target words used in the text composition and the corresponding words dictated in the single word spelling did not show any significant differences between tasks. This might be an indication that the high demands of the writing task possibly directed the attention of the participants to different aspects of writing for meaning. Such demands might have been composing grammatically correct and well-structured sentences to embed as many as possible of the given target words in a meaningful self-generated semantic context combined with the need for a well presented handwriting. This might be an explanation of why the participants in both language samples did not take advantage of the semantic and syntactic self-generated context to reduce their phonological error rates in the text composition task.

The common finding that in both language samples and in all examined tasks children with a dyslexic profile produced significantly more phonologically and phonologically-orthographically misspelled words than only the chronological-age controls but not than the control groups matched in reading and spelling ability further supports the notion for a delay in the acquisition of phonological spelling rather than a deviance. This is in accord with the results of chapter 6 and with previous studies (e.g., Diamanti, et al., 2013; Egan & Tainturier, 2011; Nikolopoulos et al., 2003; Protopapas et al., 2013; Tsesmeli & Seymour, 2006). The exception of the Greek dyslexic-profile group, who did not appear to differ from any of the control groups in phonological misspellings (PM and P-OM), as demonstrated by the results of the passage completion and single word spelling comparisons, is possibly due to the orthographic consistency of the language. As illustrated by the findings in chapter 6 in the more consistent Greek language all the participants of this age appear to have reached a comparable level of ability to apply phonological information to spelling. The results of the current chapter verify these findings and provide further evidence from another spelling-to-dictation task, i.e., the passage completion, to support that children with dyslexia writing in more consistent orthographic systems manage to acquire some competence in phonological spelling relatively early (Angelelli et al., 2004; Nikolopoulos et al., 2003; Protopapas et al., 2013; Wimmer & Schurz, 2010). The fact that a significant discrepancy between the phonological errors of the Greek dyslexic group and the chronological-age controls was detected in the text composition task further supports the notion that highly demanding writing tasks may trigger the underlying causes of phonological difficulties specifically linked to dyslexia.

Phonologically plausible-orthographic errors. The morpho-phonemic structure of the English and the Greek writing system appeared to have contributed in a similar manner to the children's approach to orthographic and morphological spelling. The fact that all pairwise comparisons demonstrated a preponderance of phonologically plausible-orthographic errors over phonological and phonological-orthographic errors provides further evidence to support similar findings from chapters 5 and 6. Furthermore, previous research has emphasised the difficulties occurring when spelling orthographically dependent patterns (e.g., Berninger, et al., 2008; Bourassa et al., 2006; Cassar et al., 2005; Coleman, et al., 2009; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Sterling, et al., 1998; Sumner, 2013). The present results stemming from analyses of data obtained from all three spelling conditions strengthen the notion that application of morphological and orthographic knowledge is more difficult to acquire for children with and without dyslexia regardless of spelling task and transparency of the orthographic system.

On the other hand, the argument highlighting the role of language in the way children with dyslexia approach spelling in different writing conditions could be further reinforced by the comparisons of rates of phonologically plausible-orthographically misspelled words across spelling tasks. In this error category the English dyslexic-profile group appeared to produce significantly higher error rates in the passage completion than in the single word spelling. This is in contrast with the findings of the analysis of the Greek data, which demonstrated a decrease in the phonologically plausible-orthographic errors of the dyslexic-profile group in the passage completion in comparison with the single word spelling. Previous research suggests that phonological spelling is the basis on which orthographic skills develop, as for instance in Ehri's orthographic mapping theory (Ehri, 2014), Share's self-teaching hypothesis (Share, 2008) and the lexical quality hypothesis (Perfetti, 1997; Perfetti & Hart, 2002). This is also supported by the results of the studies with typical spellers and children with dyslexia detailed in chapters 5 and 6 of the current thesis. In the present study the difference in the effect of task on the errors of English and Greek children with dyslexia furthers the notion that the level of orthographic consistency plays a significant role in the extent to which these pupils may surpass phonological spelling so as to exploit the surrounding semantic and syntactic information to enhance orthographic and morphological spelling. The more opaque English system might have increased the demands of the task employing printed context by intensifying the effort required for reading the passage and digesting the semantic information. This process might have imposed additional load on the dyslexic children's working memory, thus taking their attention away from the target words. On the contrary, reading in a more consistent language might have not been as problematic for the Greek children with a dyslexic profile, thus providing them the opportunity to extract semantic and syntactic information from the printed context to aid their orthographic and morphological spelling.

The findings stemming from typically developing spellers in both language samples promote the claim that the results of the English dyslexic-profile group are consequent to weaknesses specifically linked with dyslexia. In contrast, all English and Greek control groups produced fewer phonologically plausible-orthographic errors in the passage completion than in the single word spelling. The discrepancy was statistically significant for the English reading-age controls and all the Greek control groups. This is an indication that typically developing children had developed their skills adequately to make some use of the semantic and syntactic context provided to aid the spelling of the most challenging parts of the words, regardless of the consistency of the orthographic system in which they were writing. It appears that only when pupils start feeling more comfortable with spelling orthographically consistent patterns, concentration in the writing task can further affect their orthographic spelling. Nonetheless, not all English typically developing participants managed to make use of the context to the extent required so as to drop their error rates significantly.

The present findings appear to differ from those of previous studies. In more detail, Walker and Hauerwas (2006) employed a single word and a sentence dictation task with a sample of English speaking pupils in grades 1-3 and reported stability of past tense <-ed> spelling across tasks. Protopapas and colleagues (2013), who used a single word and a passage dictation task with Greek grade 3-4 and 7 pupils, reported the results for both tasks in parallel implying that no difference between tasks was observed. One possible reason resulting in the different findings of the present study might be the older age of the English participants as compared to the sample of the study of Walker and Hauerwas (2006), which might imply a higher competence of the first in employing contextual information to enhance their spelling. Another factor might be the research design. In the present study the context was printed, whereas in the studies of Walker and Hauerwas (2006) and Protopapas and colleagues (2013) it was dictated. Hence, there is a possibility that this difference in the research design might have triggered different processes, which might have facilitated or hindered effective employment of contextual information when spelling.

Along similar lines with the words containing phonological errors (PM and P-OM) the effect of task on phonologically plausible-orthographically misspelled words did not appear to be significant when the text composition and the single word spelling were compared. The exception of the English spelling-age controls, who made significantly fewer such errors in the text composition might be due to their younger age and their general spelling ability. These children composed simpler texts possibly employing a more familiar vocabulary. Therefore, a more careful selection of the target words would potentially provide them with the opportunity to reflect on the semantic and syntactic role of the specific words in the text and thus correct some of their orthographic errors.

The effect of group membership on the proportions of phonologically plausible-orthographically misspelled words in both language groups and all spelling tasks verified the notion of a developmental delay in applying orthographic and morphological information when spelling. In accord with the results of the analysis of phonological error categories and with findings of previous studies (e.g., Diamanti, Goulandris, Stuart, & Campbell, 2013; Egan & Tainturier, 2011; Nikolopoulos et al., 2003; Protopapas et al., 2013; Treiman, 1997; Tsesmeli & Seymour, 2006) the dyslexic-profile participants made significantly more errors than their chronological-age controls but did not perform differently from reading and spelling-age controls. Apparently, different spelling conditions did not affect the performance of the participants to an extent that would alter these relations between groups.

Morphemes of affixed words. A more in depth analysis of phonologically plausible errors in stems and inflectional suffixes of polymorphemic words showed that the latter were consistently more accurately spelled than the first by children with and without dyslexia in all the examined tasks in both language samples. This finding extends similar results of chapters 5 and 6. In the current study further evidence is provided from writing tasks involving printed or self-generated context to support the notion that inflectional spelling may be enhanced by combined application of morphological rules and orthographic knowledge as previous research has suggested (Chliounaki & Bryant, 2007; Ehri, 2014; Nunes et al., 1997). Engagement with the semantic and syntactic context aided inflectional spelling in comparison to stem spelling, which relies entirely on the application of orthographic knowledge via retrieval of the specific morpheme from memory. Thus, stem spelling depends largely on frequency levels and familiarity of the speller with the specific morpheme. The difference between stems and inflections was not statistically significant for the Greek chronological-age controls in the affixed words dictated in the single word spelling. This might indicate the significant role that the manner in which the context is presented might play in spelling. If engagement with the syntactic context enhances inflectional spelling by triggering the application of morphological knowledge in a more inflected language, such as Greek, then this finding signifies that mere oral context as presented in the single word spelling task, did not have a comparable effect on inflectional spelling for the most competent spellers of the sample as had the printed context provided in the passage completion task and the self-generated context in the text composition task. Previous research in English provided similar results (Sumner, 2013), even though comparisons were not drawn on comparable stimuli across tasks. Sumner (2013) suggested that the drop in error rates was due to the freedom provided to the writer to choose less challenging vocabulary. The controlled writing task employed in the current study did not allow for such freedom, since only the target-words used in the texts were examined. A possible explanation for these findings might be that engagement with narrative writing contributes to better concentration on the task, thorough selection of the words and maybe better use of semantic and syntactic information, which would finally link to proportionally better spelling of some orthographic features.

Semantic information as provided by printed or self-generated context could be exploited to activate retrieval of the orthographic form of familiar morphemes, if statistical morpheme-specific learning is the basis for accurate spelling of stems and inflections (Deacon, Conrad, & Pacton, 2008; Nunes & Bryant, 2009). In addition, syntactic information could be sourced from written context to help children appreciate the grammatical status of the target morpheme (Nunes et al., 1997). There is evidence to suggest that both the passage completion and the text composition task had such an effect on inflectional spelling of all Greek participants. The significantly reduced error rates of the dyslexic-profile group and the typically developing children in those two tasks in comparison to the single word spelling task could imply that participants writing in a more inflected language, such as Greek, make use of the semantic cues provided by written context to retrieve morpheme-specific information from memory. The fact that retrieval of stems was not as efficient as was retrieval of inflections reinforces previous findings claiming that orthographic errors are extremely persistent (e.g., Berninger, et al., 2008; Bourassa et al., 2006; Cassar et al., 2005; Coleman, et al., 2009; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Sterling, et al., 1998; Sumner, 2013) providing evidence from different spelling conditions. One possible explanation might lie in the frequency levels of the morphemes under examination. If statistical learning contributes to accurate spelling of morphemes, then in a highly inflected language it would be expected that the statistical properties of inflectional suffixes are an advantageous feature as compared to stems. On the other hand, if inflectional spelling is enhanced by the application of morphological rules (Bryant & Nunes, 2008), then the findings of the present study support the notion that familiarity with a highly inflected orthographic system may provide Greek children with the advantage to engage more thoroughly with the syntactic information stemming from written context. In other words, having to reflect on the role of the target word in a sentence externally provided as in the passage completion or self-generated as in the text composition might have enabled better application of morphological knowledge on inflectional spelling.

The absence of a comparable effect on the error rates of the children with and without dyslexia writing in a less inflected system, such as English, further highlights the important role of the orthographic system in enabling a beneficial use of the context for spelling. It is worth noting that Greek and English children used approximately the same number of inflected words in their texts (English: M = 3.22, SD = 2.21, min = 0, max = 9; Greek: M = 3.64, SD = 1.62, min = 0, max = 7), which strengthens the argument about a strong effect of language on the extent to which children make use of context. Especially the comparisons between passage completion and single word spelling produced results indicating a negative effect of printed context on the spelling of both the examined stems and inflections. The fact that similar results stemmed from the analysis of Greek stems possibly signifies that printed context as presented in the passage completion task might have increased the effort of reading for comprehension and imposed additional load on the children's memory, thus taking attention away from the target morpheme. A similar effect on Greek inflections was not detected potentially because Greek is a highly inflected language, which led to the aforementioned results.

Previous research by Treiman and Cassar (1996) compared a single word spelling group with a sentence-creating group of English speaking grade 2 children and did not find any significant difference between the performance of the two groups in morphological spelling of final consonant clusters. The results of the present study extend this finding with data obtained from older English speaking pupils with and without dyslexia assessed in both a single word spelling and a text composition task, which enabled for direct within-group comparisons. Conversely, the analyses on the Greek data have shown a positive effect of the text writing condition on inflectional spelling of typical and atypical spellers. This difference in findings might be due to the effect of writing in a more consistent orthographic system (Greek) or the older age of the participants of the present study and, hence, their greater ability to make use of morphological aid, as provided by the self-generated semantic and syntactic context. In addition, research design might have played a significant role, since in Treiman and Cassar's study each spelling condition was assigned to a different group of children, whereas in the present study the same children were assessed in spelling the same target words in both the spelling-to-dictation and the text composition task. Nevertheless, Treiman and Cassar emphasise the possible positive effect of greater amount of time dedicated to spelling in the sentence condition. A possible explanation for the present findings might be that engagement with writing a longer narrative contributes to better concentration on the task, thorough selection of the words and maybe better use of semantic and syntactic information, which would finally link to proportionally better spelling. Further evidence to support this notion is derived from studies using narratives for orthographic learning purposes, as in Wang, Castles, Nickels and Nation (2011). In their study, English speaking grade 2 children appeared to be better at learning spellings of novel irregular words in a story context condition than when the words were presented in isolation.

Finally, regarding the effect of group membership, most of the comparisons complied with the general pattern revealed in the whole-word levels of analysis supporting the notion of developmental delay rather than deviance in the acquisition of morphemes. One exception was the absence of significant differences in the performance of the English dyslexic group and all their control groups in the inflections of affixed words in all three examined tasks. An inspection of proportions of misspellings indicated a large variance in the error rates of both typical and atypical spellers. This large variability in the ability of all the participants to apply orthographic and morphological information to inflectional spelling might be attributable to the morphological characteristics of English, which is a less inflected language and, thus, might provide fewer opportunities for practice in inflectional spelling for children with and without dyslexia. Another explanation stems from a study with typically developing pupils in grades 3-6 (Puranik et al., 2008), in which 120 story retelling texts were collected. The researchers observed considerable variability in the spelling performance of pupils attending the same grade, which they attributed to the vocabulary constrains of the task. Taking into account that in the current study the analyses were based on the target words used in the passage completion and the text composition task, the variability in errors in inflectional suffixes might be due to the selection of the specific target words. If complete morphological spelling requires synchronisation of both morphological and morpheme-specific (orthographic) knowledge, the recorded difference in the effects of task and group on children's inflectional error rates provides further evidence to support that pupils progress from using simpler to more sophisticated spelling strategies depending on the complexity of the target-item and the demands of the spelling task (e.g., overlapping waves theory: Rittle-Johnson & Siegler, 1999).

Overall, the results of the present study suggest that, if adequately used, semantic and syntactic context may contribute positively to the spelling performance of typically and atypically developing pupils in the final four years of primary education in England and Greece. A possible reason might be that the process of understanding a given context, as in the passage completion task, or creating a written narrative, as in the text composition task, results in a more thorough engagement with spelling the target words than when stimuli are orally dictated. Nevertheless, the passage completion task did not prove to be as useful in some error categories implying that externally provided context is not always easy to manipulate in order to inform spelling performance. As illustrated by the findings from different language samples, the role of language is very important in determining the extent to which children make use of the context to enhance their spelling. It appears that spelling in context may enhance the performance of pupils with and without dyslexia with regard to morphologically dependent patterns when writing in a language with fewer phonological challenges, such as Greek. This further implies that only when children have conquered phonological spelling they manage to overcome possible challenges stemming from the demands of the writing task and make use of self-generated context to apply their knowledge of morphology more successfully than when the words are presented in isolation. As concerns the effect of group membership, the findings support the notion for a developmental delay in the acquisition of spelling skills for children with dyslexia in comparison with typically developing children. The fact that the difference in the spelling performance of the dyslexic group and the chronological-age controls was not statistically significant for some error types in the context-employing tasks is in accordance with the results from chapters 5 and 6 demonstrating that despite differences in the pace of acquisition, progress in spelling the phonological, morphological and orthographic sub-components of the words is incremental and consistent throughout primary education.

7.7 Conclusions

The current research embraced combined approaches to spelling processes by contrasting more technical (i.e., spelling-to-dictation) and more natural writing conditions (i.e., text composition) to allow for a wider examination of the spelling ability of typically and atypically developing primary school pupils. In particular, it contributed to the investigation of the extent to which pupils with and without dyslexia use semantic and syntactic context to facilitate spelling. The findings suggest that written semantic context may contribute to better spelling of phonological and orthographic categories and for morphologically dependent patterns (i.e., inflections) for pupils writing in Greek. On the contrary, English children were not as successful in making use of the context as presented in both context-employing tasks. It, therefore, seems that the properties of the orthographic system also play a role regarding the extent to which pupils with dyslexia exploit semantic and syntactic context to spell. This finding complies with the notion that writers of a more orthographically consistent language, such as Greek, often reduce their phonological misspellings earlier than spellers of a more opaque orthography, such as English (Landerl & Wimmer, 2000; Nikolopoulos et al., 2003). Overcoming their difficulties with one challenging area seems to allow children with dyslexia writing in the former orthographic system to progress towards correct morphological spelling with the aid of context. This is in agreement with previous research exploring the pace with which spelling skills develop in orthographic systems with different properties (Bryant et al., 1999; Joshi & Aaron, 2006). Of all examined error categories, the orthographic mistakes were found to be the most frequently produced by both language groups. This is in accord with previous research suggesting that orthographic spelling of inconsistent patterns is most challenging for pupils with and without dyslexia (e.g., Bourassa et al., 2006; Cassar et al., 2005; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Protopapas et al., 2013).

Chapter 8

General Discussion and Conclusions

8.1 Summary of the goals of the present thesis

The present study aimed to contribute further evidence to the approach to investigating spelling processes. In particular, the general goal was to specify how typically and atypically developing learners of primary school age writing in two languages of different level of orthographic consistency acquire spelling skills. Adequacy and viability of a theoretical model depends on its ability to account for both the invariant characteristics among different writing systems as well as their unique properties, which dictate the learner's journey to mastering spelling skills in their conventional system (Olson & Caramazza, 1994; Frost, 2011). To date research findings imply that the developmental trajectories of literacy skills might be dependent on the characteristics of the writing system (Alegria & Mousty, 1996; Bryant et al., 1999; Goswami et al., 2003; Landerl & Wimmer, 2000; Nikolopoulos et al., 2003; Wimmer & Goswami, 1994; Ziegler et al., 2001). They might also be attributable to the differential approaches that typical and atypical learners adopt (i.e., exhibiting a developmental delay or a deficit) (Alegria & Mousty, 1996; Bourassa & Treiman, 2003; Carlisle, 1987; Diamanti et al., 2013; Egan & Tainturier, 2011; Nikolopoulos et al., 2003; Protopapas et al., 2013; Tsesmeli & Seymour, 2006). Analysis of different error categories may provide an informative insight into processing various types of information (i.e., phonological, morphological and orthographic) when spelling. Therefore, by investigating different error types made by children with and without dyslexia, this study also aimed to capture any similarities or distinguishing characteristics of the way that these children applied different types of knowledge when spelling. Direct cross-linguistic comparisons intended to reveal any universal features of typical and atypical spelling as well as the differentiating role of the writing system or of the manner in which these information are processed by children with and without dyslexia.

A final aim of the present study was to add to the limited research evidence on spelling processes when writing for meaning. Specifically, the interest of this research was directed to exploring a potential effect of semantic and syntactic context on the spelling errors of children with dyslexia writing in two languages with different levels of orthographic consistency. Previous findings of intervention studies suggest that semantic context and spelling performance interact (Ouellette & Fraser, 2009; Ouellette, 2010). According to the simple view of writing model (Berninger & Swanson, 1994), in text composition tasks memory resources are allocated to the three different components of writing processes aiming to coordinate lower and higher level skills. In addition, research has shown that children with dyslexia often are confronted with significant weaknesses in handwriting and memory (Berninger et al., 2008; Rose, 2009; Singleton, 2002). Based on this evidence, this study intended to explore further the extent to which the employment of written semantic and syntactic context would impact on the error rates of children with dyslexia. Another goal was to investigate the degree to which the writing system would impact on their use of context to facilitate their spelling performance. These goals were addressed by employing three spelling tasks, which provided semantic and syntactic context in different manners (i.e., oral versus written), and by a parallel examination of the phonological, morphological and orthographic error rates of English and Greek native speaking children with and without dyslexia. The aims of the study resulted in formulating the research questions as detailed in the empirical chapters 5, 6 and 7. The following section summarises the results of the present research in relation to these questions.

8.2 Summary of the results of the present thesis

8.2.1 Spelling development and the role of language

The results presented in chapter 5 suggested that the orthographic properties of the two languages mainly affected the pace with which phonological, morphological and orthographic spelling skills are mastered by typical spellers (Joshi & Aaron, 2006) rather than the developmental trajectories followed (Bryant et al., 1999). For example, Greek children appeared to have mastered phonological spelling skills since G3, reached a plateau of morphological/orthographic errors in affixed words and suffixes by G4 and in stems and derivations by G5. On the other hand, the error rates of English pupils continued decreasing significantly from Y4 to Y6, with the exception of errors in affixed words and their component morphemes, which did not differ significantly. As concerns children with dyslexia (chapter 6), both the English and the Greek participants produced significantly higher error rates than the chronological-age control groups but did not differ significantly from the younger reading and spelling ability-matched controls. This is in agreement with the notion of a delay rather than a specific deficit in the development of spelling skills, as is frequently reported for dyslexic participants (e.g., Treiman, 1997). The results obtained from the analyses of the data in the passage completion and the text composition task verified these findings.

With regard to the developmental trajectories that distinct spelling skills follow, the analysis between error types showed that typically developing spellers in both language groups consistently made fewer phonological-orthographic errors than phonologically plausible-orthographic errors. Overall the findings suggested that all pupils found polymorphemic words more challenging than monomorphemic words and that within the latter the application of orthographic knowledge (i.e., in stems) was more challenging than that of orthographic information in combination with morphological cues (i.e., in suffixes). This is in agreement with the notion that phonological spelling skills are mastered earlier than morphological and orthographic skills, regardless of the writing system (e.g., Bryant et al., 1999; Porpodas, 1989, 1999; Stainthorp & Hughes, 1999; Waters et al., 1985), and may constitute the base for orthographic learning (Share, 2008). On the other hand, the cross-linguistic comparisons showed that the magnitude of phonological error rates may be attributable to the level of orthographic consistency of the two languages, since Greek pupils made significantly fewer such mistakes than their English peers. In contrast, English children were better than their Greek peers in morphological/orthographic spelling of whole words, non-affixed and affixed words. These findings support the view that children writing in more consistent orthographies tend to over-rely on their phonological skills, thus, overlooking morphological rules and making less extended use of their stored orthographic representations, while children learning opaque orthographies substitute GPC rules with whole word processing (Nikolopoulos et al., 2003; Wimmer & Goswami, 1994; Ziegler et al., 2001). The aforementioned results were confirmed by the findings of the studies examining the spelling performance of children with dyslexia in the single word spelling task and the two tasks employing written context, in agreement with previous findings suggesting that morphological/orthographic spelling is most challenging for pupils whether they have dyslexia or are typically developing (e.g., Bourassa et al., 2006; Cassar et al., 2005; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Protopapas et al., 2013) and that the properties of the language impact on the children's phonological and orthographic error rates.

8.2.2 The effect of semantic context and the role of language

The results discussed in chapter 7 indicated that writing system plays a role in the manner that children with dyslexia and their typically developing control groups approach spelling in a text writing context. More specifically, the distinction between English and Greek children was more profound when the passage completion task was examined in comparison with the single word spelling task. On one hand, the English participants with dyslexia produced significantly more phonologically plausible-orthographic misspellings in the passage completion task, while typically developing children produced fewer such errors in this task. Additionally, both children with and without dyslexia made significantly more errors in the inflectional suffixes in the passage completion. On the other hand, all the Greek children made significantly fewer phonological and phonologically plausible-orthographic errors in the passage completion task. In addition, their errors in the inflectional suffixes were significantly reduced in that task. Conversely, both English and Greek pupils with and without dyslexia produced significantly higher error rates in the stems of the target-words in the passage completion task in comparison with the single word spelling task. These findings suggested an advantage for typically and atypically developing pupils writing in a more consistent orthography, such as Greek, in exploiting the externally provided context in order to aid their phonological and morphological spelling. However, it appeared that printed context was not exploited sufficiently to facilitate the spelling of patterns that were entirely dependent on orthographic knowledge (i.e., stems) regardless of the orthographic system in which the children were writing.

Along similar lines, both language samples did not appear to make adequate use of self-generated context as employed in the text composition task to facilitate their spelling. This is indicated by the lack of significant difference between most error rates produced in the text composition and the single word spelling task. However, it is important to note that the inflectional error rates of Greek participants with and without dyslexia were significantly reduced in the first task, which signifies a clear interaction between self-generated syntactic context and application of morphological information when spelling. Furthermore, a significant drop was detected in the phonologically plausible-orthographic errors of the English spelling-age controls. Without further indications for an analogous decrease in the mistakes of any other group of English children, it is difficult to support a generalised beneficial use of self-generated context for more accurate spelling.

Between-groups comparisons offered additional evidence of the magnitude of the effect of self-generated context on the spelling performance of the participants. Specifically, it was found that the only occasion where the difference between the dyslexic-profile groups and their chronological-age controls was not significant occurred when the English stems and inflectional suffixes and the Greek phonological errors were examined. The high error rates of the English participants in both components of polymorphemic words indicated that the demands of the text composition task produced considerable challenges for the children with dyslexia and their chronological-age controls, thus resulting in the absence of significant differences between them. On the other hand, the phonological error rates of the Greek children were so low that the lack of a significant difference between dyslexic children and same age peers might be explained by the higher level of orthographic consistency of the Greek language, from which all participants appeared to have benefited. Hence, the findings indicate that the orthographic system as well as the demands of the task and of the spelling pattern (i.e., phonological, morphological, orthographic) play a significant role in the extent to which pupils with and without dyslexia exploit semantic and syntactic context to spell.

8.3 Linking the present results with theories of spelling development

The evidence provided by the three spelling tasks is in agreement with processes described both in the phase theory as discussed by Ehri (2014) and with accumulative models, such as the self-teaching hypothesis (Share, 2008), lexical quality hypothesis (Perfetti, 1997; Perfetti & Hart, 2002), dual-route and connectionist models of skilled spelling (e.g., Brown & Ellis, 1994; Houghton & Zorzi, 2003) and overlapping waves theory (Rittle-Johnson & Siegler, 1999). Spelling progress is evident in children's error rates throughout the four year groups examined. As examination proceeds from younger to older year groups' performance, spellings become more accurate in a wider range of orthographic features, indicating that pupils gradually enrich their knowledge about spelling components with more precise information and adapt their spelling strategies to the demands of the task and the stimuli.

Nunes and Bryant (2009) refer to orthographic learning of younger pupils as incorporating new knowledge of conditional rules (i.e., conventional rules constraining orthography to preserve pronunciation, as doubling the <-p> in DROP-DROPPED) in a broader system, where phoneme-to-grapheme correspondences are already established. Such a perspective acknowledges that, as children grow older and more confident with phonological spelling, they become able to expand their orthographic knowledge and widen its application. In line with this view, constant decrease in phonological, morphological and orthographic error rates across year groups was detected in the present study. This finding indicates that pupils gradually conquer phonological skills, which possibly facilitates application of morphological and orthographic strategies. As concerns the magnitude of improvement, phonological error rates were always found to be significantly lower than the other two error categories. Nevertheless, pupils showed some progress in phonological spelling too, as indicated by significant differences across younger and older children. This was more profound for the English sample than for their Greek peers. The fact that after conquering phonological spelling all pupils continued dropping their morphological and orthographic error rates until the final two years of primary school is in line with Share's (2008) self-teaching hypothesis postulating that children use phonological recoding to retain pronunciation, orthographic representation and meaning of the words in their memory. Another finding which complies with this view is the advantage that Greek children with dyslexia appeared to have in making use of the printed context provided in the passage completion task to reduce their phonological and their orthographic error rates as well as their mistakes in inflections. This is in agreement with the notion that writers of a more orthographically consistent language, such as Greek, often reduce their phonological misspellings earlier than spellers of a more opaque orthography, such as English (Landerl & Wimmer, 2000; Nikolopoulos et al., 2003). Overcoming their difficulties with one challenging area may have allowed Greek children with dyslexia to progress towards correct morphological spelling with the aid of printed context. The present findings are in agreement with Keuning and Verhoeven's (2008) results in Dutch. They reported that pupils in grades 2-6 appeared to master spelling of phonetic items first, before they could incrementally grasp orthographic rules and word-specific spelling. The findings are also in accord with the results of Sprenger-Charolles et al. (2003) in French, showing that children in grades 1-4 continued applying phonological procedures when already using orthographic strategies for spelling.

Analyses at a whole-word and a morphemic level showed that as children grow older their spelling errors change in quantity rather than in type. This is in line with the lexical quality hypothesis (Perfetti & Hart, 2002) suggesting that better spellers hold more accurate representations of the words in their memory. According to Perfetti and Hart, these representations consist of three well-bonded constituents, namely orthographic, phonological and semantic. Gradual improvement in spelling the phonological, morphological and orthographic patterns across year groups, as demonstrated by the results of the present study, signifies constant reinforcement of the quality of pupils' lexical representations. Treiman and Bourassa (2000) suggested that improvement in spelling is a product of the bidirectional relationship between vocabulary acquisition and accumulation of morphological – orthographic knowledge. In that view, it is reasonable to assume that differences in the spellings of younger and older participants would be influenced by the vocabulary acquired via print exposure throughout primary education, as suggested by Wise, Sevcik, Morris, Lovett and Wolf (2007). Weaknesses in retaining a large vocabulary could also explain the significant differences between the error rates of children with dyslexia and their chronological-age controls.

Some comparisons did not show significant differences in spelling between consecutive year groups e.g., year 3 and year 4 in England or grade 5 and grade 6 in Greece. Nation's (1997) study showed comparable results regarding rime frequency effect on year 3-4 children's spellings and proposed including a wider age range of participants in future studies to reveal possible differences between younger and older children. This view is in line with the approach embraced by connectionist models that statistical relationships between phonological input and orthographic output play a significant role for skilled spelling. As children grow older, wider and repeated exposure to the statistical links between the sound and the spelling of more words would broaden their spelling repertoire. Indeed spelling improvement is clearly evident in the results of this study when examining children of a wider age range e.g., Y3-Y4 in comparison to Y5-Y6. In addition, inspection of the misspellings provided indications that children are better in spelling words which contain more common and orthographically consistent patterns. This finding supports further the connectionist view that statistical relationships are detected by the human brain and facilitate learning (Frost, 2011). Furthermore, pairwise comparisons showed that most of the children with and without dyslexia spelled the morphemes that combined application of orthographic and morphological knowledge more accurately than those requiring only morpheme-specific knowledge (i.e., inflections versus stems). This result supports the notion that spelling becomes more accurate as connections between the phonological, orthographic and semantic components of the language are strengthened and lexical representations of the words become more precise (Perfetti & Hart, 2002). Indeed, the differences in the pace with which English and Greek spellers increased the application of phonological, morphological and orthographic information to their spelling might also be interpreted by differences in the statistical properties of the two orthographic systems (i.e., orthographic consistency) influencing the development of connections and the quality of representations in the spellers' lexicon.

Finally, the findings of the present study are also in line with Ehri's (2014) description of orthographic learning. Phase theory is combined with the aforementioned approaches to suggest that grapheme-phoneme units and morphemic spelling units (e.g., stems-suffixes) accumulate in memory as children acquire deeper knowledge about them. She also suggests that different units can be learnt in different pace within the same phase of development. Decreasing error rates in the present study signify that all relevant skills are in use. Although this was not directly pronounced by participants, significant differences across pairs or blocks of year groups imply that phonological, morphological and orthographic strategies are incrementally activated to a larger extent so as to address the demands of spelling. There were similarities in the way that children in both language groups approached spelling. For instance, they all made more morphological and orthographic errors than phonological mistakes. They spelled unfamiliar irregular patterns employing a phonetic strategy. The phonological error rates of the typically developing children decreased significantly as the spellings of older year groups were examined. Similarly, the phonological mistakes of children with dyslexia were significantly more than those of their chronological-age controls yet not than their reading and spelling ability-matched controls. Additionally, in the single word spelling task the phonological error rates of the Greek dyslexic-profile pupils did not differ significantly from those of any of the control groups. With the exception of two participants who produced substantially high phonological error rates, the results indicate that the majority of dyslexic and typically developing participants had a good understanding of the alphabetic principle, which would position them in Ehri's full and consolidated alphabetic phases.

However, there was ample variability in their levels of morphological and orthographic spelling as indicated by the differences detected when the component morphemes of affixed words were examined. This is in line with Ehri's suggestion that units continuously accumulate in children's memory and multiple ways of processing information are in use in any phase of development. Ehri also highlights the contribution of the overlapping waves theory (Rittle-Johnson & Siegler, 1999) to that concept. Indeed, results from pairwise comparisons between spelling tasks employing semantic and syntactic context in a different manner demonstrated that the extent to which children with and without dyslexia manage or fail to skilfully manipulate different types of knowledge and spelling strategies depends on the demands of the stimulus (e.g., stem versus inflection) and the spelling task (e.g., passage completion versus single word spelling) in line with the aforementioned theories. This is also in agreement with the simple view of writing (Berninger & Swanson, 1994) implying that allocation of memory resources depends on the interactions between lower level skills, such as spelling and handwriting, and higher level skills, such as concentrating attention. Hence, although memory or attention skills were not directly assessed in this study, it might be reasonable to assume that performance in all three components of writing may adjust to the demands of the task.

8.4 Linking the present results with theories of dyslexia

Although the present study was not designed to examine the underlying factors of dyslexia, thorough analysis of the spelling errors of the children in comparison with their typically developing controls may indicate possible weaknesses contributing to the observed spelling weaknesses. Overall, the results postulate that the manifestation of dyslexia depends on the properties of the orthographic system in which the children are writing. This might explain the finding stemming from the examination of the single word spelling task that Greek children with dyslexia made significantly fewer phonological mistakes than their English peers. In contrast, English children were better than their Greek peers in morphological/orthographic spelling in this task in agreement with the suggestion that general levels of consistency of a writing system affect the strategies that children with dyslexia employ to access written language (whole-word strategies over PGC rules) (Nikolopoulos et al., 2003; Wimmer & Goswami, 1994; Ziegler et al., 2001).

The strong effect of language was also evident in the manipulation of syntactic context. Greek pupils with dyslexia, writing in a more orthographically consistent and highly inflected system, appeared to make sufficient use of the printed context in the passage completion task to reduce their phonological mistakes and their errors in inflections as compared with the corresponding stimuli in the single word spelling task. On the other hand, English participants with dyslexia generally produced more orthographic misspellings in the first than in the second task in contrast with English typically developing controls whose error rates followed the opposite direction. Furthermore, both children with and without dyslexia made significantly more errors in the inflectional suffixes in the first than in the second task, which postulated that writing in a less inflected system impacts on the extent to which pupils exploit context to spell the specific morphemes. Both these findings support the view of the self-teaching hypothesis (Share, 2008), Ehri's theory (e.g., 1987, 2014) and the lexical quality hypothesis (Perfetti, 1997; Perfetti & Hart, 2002) that impaired phonological skills may hinder the development of orthographic skills. In addition, these results indicate a significant role of orthographic consistency of the writing system in spelling performance. The role of language is supported further by the finding that inflectional error rates of the Greek children with dyslexia were significantly reduced in the text composition task in comparison with the single word spelling task. Such an effect was not detected for the English children writing in a less inflected system. This is a clear indication that the properties of the orthographic system impact on the manifestation of dyslexia as mapped by the interaction between self-generated syntactic context and application of morphological information when spelling (lower level skills of the simple view of writing model by Berninger & Swanson, 1994).

Overall, the findings stemming from all English tasks complied with the phonological deficit hypothesis (e.g., Ramus et al., 2003; Snowling, 1995; Stanovich & Siegel, 1994) regarded as a developmental delay rather than a deviance. This was supported by the result that children with dyslexia were poorer in phonological spelling only in comparison with typically developing same-age peers but not with the reading and spelling ability-matched children. Extensive phonics teaching implemented in schools in the framework of the National Literacy Strategy (1998) and explicit phonics training received by all English participants with dyslexia might explain their ability to perform at the same levels as younger children. On the other hand, the results stemming from the examination of the single word spelling task showed that the phonological errors of the Greek dyslexic-profile group did not differ significantly from any of the three control groups, while in the two tasks employing written context the difference with same-age peers was statistically significant. These are all further indications that manifestation of dyslexia in spelling may depend not only on the orthographic system but also on the training that pupils receive and on the demands of the task that they are required to complete.

Moreover, the pattern of developmental delay emerged from all comparisons of phonologically plausible-orthographic misspellings at all levels of analysis in all three tasks. This is in agreement with previous studies in English and in Greek showing that children with dyslexia performed no differently than reading and spelling ability-matched typically developing children (e.g., Diamanti et al., 2013; Nikolopoulos et al., 2003; Protopapas et al., 2013; Treiman, 1997; Tsesmeli & Seymour, 2006). A more detailed investigation of affixed versus non affixed words and of the component morphemes of the latter reinforced the findings of previous research suggesting that morphemic complexity affects spelling performance. In addition, the results supported further the notion that spelling patterns, which depend solely on orthographic knowledge (i.e., stems), are more difficult to acquire in comparison with patterns which require combination of orthographic and morphological information (i.e., inflections) (e.g., Berninger, et al., 2008; Bourassa et al., 2006; Cassar et al., 2005; Coleman, et al., 2009; Diamanti et al., 2013; Egan & Tainturier, 2011; Nelson, 1980; Sterling, et al., 1998; Sumner, 2013).

8.5 Theoretical and practical implications

The results of this study highlighted the significance of certain factors that research ought to take into account when assessing the acquisition of literacy skills in a cross-linguistic perspective. Firstly, it is important that orthographic consistency and morpho-phonemic complexity of the examined writing systems are considered. As demonstrated by the present findings, there are invariant features in the development of spelling skills in a more consistent and more inflected language, such as Greek, and a more opaque and less inflected system, such as English. It is these features that a model of spelling should be able to capture to approach spelling development from a more universal perspective. Nevertheless, the differences detected in the spelling profiles of children writing in these two languages also emphasise the need for research designs to be able to detect the distinguishing characteristics, which will inform theories of spelling so as to increase their capacity for explaining typical and atypical development in different writing systems. In line with this, the results of this study supported further the need for research to investigate the development of literacy skills beyond monosyllables, since considerable variability in the way that children learn how to spell is attributable to the morphological complexity of the words comprising a large part of the vocabulary of several alphabetic languages.

Secondly, it is important that research explores different indices of spelling performance to capture the variety of spelling strategies being employed in parallel depending on the spelling task, the complexity of the stimulus and the orthographic system. In the present study such a holistic approach was attempted by investigating different error categories at various levels of analysis and in three writing conditions. Emphasis was given on spelling accuracy, but future research might also benefit from investigating speed of orthographic processing, especially when writing systems with different levels of transparency and populations with various levels of spelling abilities are examined. Thirdly, as shown by the present findings, children may employ different strategies to a greater or lesser extent at different times. Thus, it is important that the performance of participants of a wide age range is examined to enable the detection of the milestones pinpointing the developmental trajectories of literacy skills. In that sense, the conclusions of studies conducted in limited developmental periods should be treated with caution.

Concerning practical implications, the findings of this study demonstrated that children with dyslexia may still exhibit phonological difficulties in highly demanding tasks even when writing in a more transparent system, such as Greek. It was also revealed that the use of semantic and syntactic context to facilitate spelling may depend on the properties of the orthographic system. Hence, it is essential that practitioners employ different writing conditions to diagnose dyslexia and to teach spelling in daily practice, so that significant spelling weaknesses of those children are not overlooked. The finding that semantic and syntactic context interact with spelling performance urges that improvement in one skill would result in development of the other. Hence, ample opportunities to practice spelling in written context ought to be offered to students as part of their regular spelling routine to enhance not only their spelling but also writing skills.

In addition, the present research underscored the significance of derivational and inflectional morphology in learning to spell for both typical and atypical learners, which ought to inform the systematic instruction of spelling in primary education. In line with this, another educational implication would relate to spelling assessment in schools. More specifically, scoring for phonological, morphological and orthographic errors could prove extremely helpful for teachers to identify specific problematic areas for individuals and groups of students and adapt spelling instruction according to the learning needs of their pupils. However useful phonics teaching may be, the need to teach beyond basic phonics to aid morphological and orthographic spelling is supported by the findings of the present study as well as by several previous studies in different orthographic systems.

8.6 Limitations of the present study

In order to evaluate the results of the present study it is important to consider some limitations. A general point relates to the testing situation, which might have altered the performance of the participants in comparison with their normal performance in the classroom. In order to diminish such consequences as much as possible, the study was conducted in the children's classrooms employing materials with which they were already familiar (i.e., pencils, lined pages, board) and the experimental tasks were not timed to relieve the stress stemming from time pressure. For the same reason, the experimental tasks were devised to resemble the tasks that children are asked to complete as part of their regular writing practice at school. Another point could be made about the nature of the controlled writing task. It is reasonable to argue that asking the participants to use certain target words in their narratives raised the demands of an already demanding task, thus impacting on the children's performance. Additionally, inclusion of the same target words across spelling conditions might raise concerns about the effect of repeated exposure to the stimuli on the children's spelling performance. However, this was dictated by the scope of the study, which was to compare spelling performances across tasks. Comparing the same target words was regarded as a more reliable method to detect any differences over comparing the total number of misspellings in all the words used across the three spelling tasks. To reduce test-retest effects as much as possible the administration of the tasks was semi-counterbalanced allowing for adequate time intervals between tasks.

In addition, the cross-sectional design bears the inherent limitation that one cannot assume that the characteristics detected in a younger group of children were present at an earlier developmental stage of an older group. Thus, a longitudinal design is regarded as preferable to investigate developmental trends. However, the latter design has several limitations related to time and cost, as outlined in chapter 4. These limitations combined with the interest in drawing cross-linguistic comparisons resulted in selecting the cross-sectional design as more appropriate for the scope of the present study. Despite the fact that the cross-language design is one of the main strengths of this study, it also led to a weakness related to the age difference between language groups. More specifically, the Greek participants were significantly older that their English peers. However, this was impossible to reconcile since children in the UK start formal education earlier than the children in Greece. The principle decision was made to compare performance relative to years of schooling because spelling has been found to depend on instruction. Nevertheless, in the present study cross-linguistic comparisons were also drawn after matching English and Greek children in age to control as much as possible for any effect of age. Finally, an issue stemming from the characteristics of the dyslexic participants recruited for this study might be that they had all received explicit phonics instruction at school as well as additional training to meet their learning needs, as detailed in chapter 4. It would be reasonable to argue that this might have influenced their spelling performance smoothing potential difficulties attributable to dyslexia. Nevertheless, the fact that all English and all Greek pupils had received such training provided a common ground to draw reliable conclusions between those two groups as well as between them and their control groups writing in the same language.

8.7 Conclusions and future directions

In conclusion, the results of the present study seem to conform to a variety of theoretical approaches not necessarily conflicting one another. This might be attributable to the research design including cross-sectional, cross-linguistic investigation with participants of a wide age range and spelling abilities being examined in a large variety of orthographic features in three spelling tasks with different demands. Examination of such a rich database under the prism of multiple theoretical frameworks shows that spelling development may be conceived as an accumulative process. Different theoretical models can account for the commonalities and discrepancies in spelling development. Embracing a variety of theoretical models is essential, especially when approaching spelling processes from a universal perspective, which examines a) orthographic systems with different statistical properties, b) stimuli within the same writing system with individual characteristics (e.g., orthographic consistency, frequency), and c) participants with various levels of literacy abilities. It is, therefore, suggested that, as research interest is directed to a more detailed and more inclusive studying of literacy acquisition, interactive approaches combining theoretical views are employed, since they are more appropriate to perceive and describe the dynamic processes under investigation.

Replication of the findings with larger samples would reinforce the conclusions of the present study. Future studies should also intensify parallel examination of distinct orthographic features in systems with various levels of orthographic consistency, and indeed in Greek, in which research on typical and atypical spelling is still very limited. In similar lines, research ought to further the investigation of spelling beyond the single word level in more complex literacy processes, such as writing, aiming to explore the interaction between semantic and syntactic context and spelling performance. There is still ample capacity for investigation of the interactions between the components of writing processes, especially as concerns their impact on the manifestation of dyslexia in spelling and writing. Further examination of spelling under the prism of the application of different types of knowledge is particularly necessary for languages with a higher level of orthographic consistency and morphophonemic complexity in which mastery of morphological and orthographic skills has been found to play a significant role. Finally, it is suggested that larger-scale, cross-linguistic, longitudinal studies will further the knowledge about the manifestation of dyslexia in line with the growing interest for universal theoretical approaches to the learning of spelling and writing.

REFERENCES

Aidinis, A., & Nunes, T. (2001). The role of different levels of phonological awareness in the development of reading and spelling in Greek. *Reading*, *14*(1-2), 145–177.

Alegria, J., & Mousty, P. (1996). The development of spelling procedures in French-speaking, normal and reading-disabled children: effects of frequency and lexicality. *Journal of Experimental Child Psychology*, *63*(2), 312–38. doi:10.1006/jecp.1996.0052

Angelelli, P., Judica, A., Spinelli, D., Zoccolotti, P., & Luzzatti, C. (2004). Characteristics of writing disorders in Italian dyslexic children. *Cognitive and Behavioral Neurology : Official Journal of the Society for Behavioral and Cognitive Neurology*, *17*(1), 18–31. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15209222

Apel, K., Wilson-Fowler, E. B., Brimo, D., & Perrin, N. (2011). Metalinguistic contributions to reading and spelling in second and third grade students. *Reading and Writing*, *25*(6), 1283–1305. doi:10.1007/s11145-011-9317-8

Aro, M., Aro, T., Ahonen, T., Rasanen, T., Hietala, a., & Lyytinen, H. (1999). The Development of Phonological Abilities and Their Relation to Reading Acquisition: Case Studies of Six Finnish Children. *Journal of Learning Disabilities*, *32*(5), 457–463. doi:10.1177/002221949903200511

Babayiğit, S., & Stainthorp, R. (2011). Modeling the relationships between cognitive–linguistic skills and literacy skills: New insights from a transparent orthography. *Journal of Educational Psychology*, *103*(1), 169–189. doi:10.1037/a0021671

Barker, K., Torgesen, J. K., & Wagner, R. K. (1992). The role of orthographic processing skills on five different reading tasks. *Reading Research Quarterly*, (27), 334–345.

Barry, C. (1994). Spelling Routes (or Roots or Rutes). In G. Brown & N. Ellis (Eds.), *Handbook of Spelling: Theory, Process and Intervention* (pp. 27–50). Chichester: John Wiley & Sons.

Barry, C., & Seymour, P. H. K. (1988). Lexical priming and sound-to-spelling contingency effects in nonword spelling. *The Quarterly Journal of Experimental Psychology Section A*, *40*(1), 5–40. doi:10.1080/14640748808402280

Bates, T. C., Castles, A., Luciano, M., Wright, M. J., Coltheart, M., & Martin, N. G. (2007). Genetic and environmental bases of reading and spelling: A unified genetic dual route model. *Reading and Writing*, *20*(1-2), 147–171. doi:10.1007/s11145-006-9022-1

Beers, C. S., & Beers, J. W. (1992). Children's spelling of English inflection morphology. In S. Templeton &D.R. Bear (Eds.),. In *Development of orthographic knowledge and the foundations of literacy: A memorial festchrift for Edmund H. Henderson* (pp. 231– 252). Hillsdale, NJ: Lawrence Erlbaum.

Berninger, V., & Amtmann, D. (2003). Preventing written expression disabilities through early and continuing assessment and intervention for handwriting and/or spelling problems: Research into practice. In H. Swanson, K. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 323– 344). New York: The Guilford Press.

Berninger, V. W., Abbot, R. D., Brooksher, R., Lemos, Z., Ogier, S., Zook, D., & Mostafapour, E. (2000). A connectionist approach to making the predictability of English orthography explicit to at-risk beginning readers: Evidence for alternative, effective strategies. *Developmental Neuropsychology*, (17(2)), 241–271.

Berninger, V. W., Fuller, F., & Whitaker, D. (1996). A Process Model of Writing Development Across the Life Span. *Educational Psychology Review*, (8 (3)), 193–218.

Berninger, V. W., Mizokawa, D. T., Bragg, R., Cartwright, A., & Yates, C. (1994). Intraindividual differences in levels of written language. *Reading Research Quartely*, *10*, 259–275.

Berninger, V. W., Nielsen, K. H., Abbott, R. D., Wijsman, E., & Raskind, W. (2008). Writing problems in developmental dyslexia: under-recognized and under-treated. *Journal of School Psychology*, *46*(1), 1–21. doi:10.1016/j.jsp.2006.11.008

Berninger, V. W., & Swanson, H. L. (1994). Modifying Hayes and Flower's Model of Skilled Writing. In E. Butterfield (Ed.), *Children's Writing; Toward a Process Theory of Development of Skilled Writing* (pp. 57–81). Greenwich: CT: JAI Press.

Berninger, V. W., Yates, C., Cartwright, A., Rutberg, J., Remy, E., & Abbott, R. (1992). Lower-level developmental skills in beginning writing. *Reading and Writing: An Interdisciplinary Journal*, (4), 257–280.

Bernstein, S. E. (2009). Phonology, decoding, and lexical compensation in vowel spelling errors made by children with dyslexia. *Reading and Writing*, *22*(1), 307 – 331.

Bonifacci, P., & Snowling, M. J. (2008). Speed of processing and reading disability: a cross-linguistic investigation of dyslexia and borderline intellectual functioning. *Cognition*, *107*(3), 999–1017. doi:10.1016/j.cognition.2007.12.006

Bonin, P., Barry, C., & Alain, M. (2004). The influence of age of acquisition in word reading and other tasks : A never ending story ? *Journal of Memory and Language*, *50*, 456–476. doi:10.1016/j.jml.2004.02.001

Bourassa, D. C., & Treiman, R. (2001). Spelling Development and Disability: The Importance of Linguistic Factors. *Language, Speech and Hearing Services in Schools*, *32*, 172–181.

Bourassa, D. C., & Treiman, R. (2008). Morphological constancy in spelling: A comparison of children with dyslexia and typically developing children. *Dyslexia: An International Journal of Research and Practice*, *14*(3), 155–169.

Bourassa, D. C., & Treiman, R. (2009). Linguistic Foundations of Spelling Development. In D. Wyse, R. Andrews, & J. Hoffman (Eds.), *Routledge international handbook of English, language and literacy teaching* (pp. 182–192). Routledge. Retrieved from http://pages.wustl.edu/files/pages/imce/readingandlanguagelab/Bourassa & Treiman (2009).pdf

Bourassa, D. C., Treiman, R., & Kessler, B. (2006). Use of morphology in spelling by children with dyslexia and typically developing children. *Memory & Cognition*, *34*(3), 703–14. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16933775

Bourassa, D., & Treiman, R. (2003). Spelling in Children With Dyslexia: Analyses From the Treiman-Bourassa Early Spelling Test. *Scientific Studies of Reading*, *7*(4), 309–333. doi:10.1207/S1532799XSSR0704_1

Bowers, P. G., & Wolf, M. (1993). Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *5*, 69–85.

Bowman, M., & Treiman, R. (2002). Relating print and speech: the effects of letter names and word position on reading and spelling performance. *Journal of Experimental Child Psychology*, *82*(4), 305–40. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12225758

British Dyslexia Association. (n.d.). Information for Parents: Help with Handwriting. Retrieved March 30, 2013, from http://www.bdadyslexia.org.uk/aboutdyslexia/parents/help-with-handwriting.html

Brown, G., & Ellis, N. (Eds.). (1994). *Handbook of spelling*. Chichester: John Wiley & Sons.

Brown, W., Eliez, S., Menon, V., Rumsey, J., White, C., & Reiss, A. (2001). Preliminary evidence of widespread morphological variations of the brain in dyslexia. *Neurology*, *56*, 781–783.

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: the case of initial consonant clusters. *Journal of Experimental Child Psychology*, *50*(1), 156–178. doi:10.1016/0022-0965(90)90037-9

Bruck, M., & Waters, G. (1988). An analysis of the spelling errors of children who differ in their reading and spelling skills. *Applied Psycholinguistics*, *9*, 77–92.

Bryant, P., & Nunes, T. (2008). Morphemes, spelling and development: Comments on “Timing and mechanisms of children’s use of morphological information in spelling” by S. Pacton and H. Deacon. *Cognitive Development*, *23*, 360–369.

Bryant, P., Nunes, T., & Aidinis, A. (1999). Different morphemes, same spelling problems: cross-linguistic developmental studies. In M. Harris & G. Hatano (Eds.), *Learning to read and write. A cross-linguistic perspective.* (pp. 112–133). Cambridge: Cambridge University Press.

Butterworth, B. (1983). Lexical Representation. In B. Butterworth (Ed.), *Language Production, Vol. 2: Development, Writing and Other Language Processes* (pp. 257–293). London: Academic Press.

Campbell, R. (1983). Writing nonwords to dictation. *Brain and Language*, *19*, 153–178.

Caramazza, A., Miceli, G., Silveri, M. C., & Laudanna, A. (1985). Reading mechanisms and the organization of the lexicon: Evidence from acquired dyslexia. *Cognitive Neuropsychology*, *2*, 81–114.

Caravolas, M. (2003). Similarities and differences between English and French poor spellers. In N. Goulandris (Ed.), *Dyslexia in different languages*. London: Whurr.

Caravolas, M. (2006). Learning to spell in different languages: How orthographic variables might affect early literacy. In R. M. Joshi & P. G. Aaron (Eds.), *Handbook of orthography and literacy* (pp. 497–511). Mahwah, NJ: Erlbaum.

Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness – A cross-linguistic study. *Journal of Experimental Child Psychology*, *55*(1), 1–30.

Caravolas, M., & Bruck, M. (1993). The effect of oral and written language input on children's phonological awareness: A cross-linguistic study. *Journal of Experimental Child Pschology*, (55), 1–30.

Caravolas, M., Bruck, M., & Genesee, F. (2003). Similarities and differences between English- and French- speaking poor spellers. In N. Goulandris (Ed.), *Dyslexia in different languages: Cross-linguistic comparisons* (pp. 157–180). London: Whurr.

Caravolas, M., Hulme, C., & Snowling, M. (2001). The Foundations of Spelling Ability: Evidence from a 3-Year Longitudinal Study. *Journal of Memory and Language*, *45*(4), 751–774. doi:10.1006/jmla.2000.2785

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavsky, M., Onochie-Quintanilla, E., … Hulme, C. (2012a). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological Science*, *23*(6), 678–86. doi:10.1177/0956797611434536

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavsky, M., Onochie-Quintanilla, E., … Hulme, C. (2012b). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological Science*, *23*(6), 678–86. doi:10.1177/0956797611434536

Caravolas, M., & Volín, J. (2001). Phonological spelling errors among dyslexic children learning a transparent orthography: the case of Czech. *Dyslexia (Chichester, England)*, *7*(4), 229–45. doi:10.1002/dys.206

Caravolas, M., Volín, J., & Hulme, C. (2005). Phoneme awareness is a key component of alphabetic literacy skills in consistent and inconsistent orthographies: evidence from Czech and English children. *Journal of Experimental Child Psychology*, *92*(2), 107–39. doi:10.1016/j.jecp.2005.04.003

Carlisle, J. (1987). The use of morphological knowledge in spelling derived forms by learning-disabled and normal students. *Annals of Dyslexia*, *37*, 90–108.

Carlisle, J. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, (9), 247–266.

Carlisle, J. F. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, *9*(03), 247. doi:10.1017/S0142716400007839

Casalis, S., Deacon, S. H., & Pacton, S. (2011). How specific is the connection between morphological awareness and spelling? A study of French children. *Applied Psycholinguistics*, *32*(03), 499–511. doi:10.1017/S014271641100018X

Cassar, M., & Treiman, R. (2006). Developmental variations in spelling: Comparing typical and poor spellers. In B. Shulman, K. Apel, B. Ehren, E. R. Silliman, & C. A. Stone (Eds.), *Handbook of language and literacy* (pp. 627–643). New York: Guildford.

Cassar, M., Treiman, R., Moats, L., Pollo, T. C., & Kessler, B. (2005). How do the spellings of children with dyslexia compare with those of nondyslexic children? *Reading and Writing*, *18*(1), 27–49. doi:10.1007/s11145-004-2345-x

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition*, *47*, 149–180.

Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition*, *91*(1), 77–111. doi:10.1016/S0010-0277(03)00164-1

Castles, A., Datta, H., Gayan, J., & Olson, R. K. (1999). Varieties of Developmental Reading Disorder: Genetic and Environmental Influences. *Journal of Experimental Child Psychology*, *72*(2), 73–94. doi:10.1006/jecp.1998.2482

Census. (2011). Retrieved from http://www.ons.gov.uk/ons/guide-method/census/2011/index.html

Chitiri, H. F., & Willows, D. M. (1994). Word recognition in two languages and orthographies: English and Greek. *Memory & Cognition*, (22), 313–325.

Chliounaki, K., & Bryant, P. (2007). How children learn about morphological spelling rules. *Child Development*, *78*(4), 1360–1373. doi:10.1111/j.1467-8624.2007.01070.x

Cholewa, J., Mantey, S., Heber, S., & Hollweg, W. (2010). Developmental surface and phonological dysgraphia in German 3rd graders. *Reading and Writing*, *23*, 97–127.

Clairis, C., & Babiniotis, G. (1996). *Γραμματική της Νέας Ελληνικής: Δομολειτουργική – Επικοινωνιακή [ModernGreekGrammar: Structural – Functional – Communicative]*. Athens: Ellinika Grammata.

Coleman, C., Gregg, N., McLain, L., & Bellair, L. W. (2009). A comparison of spelling performance across young adults with and without dyslexia. *Assessment for Effective Intervention*, *34*, 94–105.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of Reading Aloud: Dual-Route and Parallel-Distributed-Processing Approaches. *Psychological Review*, *100*(4), 589–608.

Coltheart, M., & Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual-route models of reading. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 1197–1211.

Connelly, V., Campbell, S., MacLean, M., & Barnes, J. (2006). Contribution of lower order skills to the written composition of college students with and without dyslexia. *Developmental Neuropsychology*, *29*, 175–196.

Coolican, H. (2014). *Research methods and statistics in psychology*. London: Hodder & Stoughton.

Cuetos, F. (1993). Writing processes in a shallow orthography. *Reading and Writing: An Interdisciplinary Journal*, (5), 17–28.

Cunningham, A., & Carroll, J. (2011). Age and schooling effects on early literacy and phoneme awareness. *Journal of Experimental Child Psychology*, *109*, 248–255. doi:10.1016/j.jecp.2010.12.005

Cunningham, A. E., & Stanovich, K. E. (1993). Children's literacy environments and early word recognition subskills. *Reading and Writing*, *5*(2), 193–204.

Davies, R. a. I., & Weekes, B. S. (2005). Effects of feedforward and feedback consistency on reading and spelling in dyslexia. *Dyslexia*, *11*(4), 233–252. doi:10.1002/dys.307

De Jong, P. F., & van der Leij, A. (2002). Effects of phonological abilities and linguistic comprehension on the development of reading. *Scientific Studies of Reading*, *6*, 51–77.

Deacon, H., Conrad, N., & Pacton, S. (2008). A statistical learning perspective on children's learning about graphotactic and morphological regularities in spelling. *Canadian Psychology/Psychologie Canadienne*, *49*(2), 118–124. doi:10.1037/0708-5591.49.2.118

Deacon, S. H., & Bryant, P. (2006). Getting to the root: young writers' sensitivity to the role of root morphemes in the spelling of inflected and derived words. *Journal of Child Language*, *33*(2), 401–417. doi:10.1017/S0305000906007409

Deacon, S. H., & Bryant, P. E. (2005). What young children do and do not know about the spelling of inflections and derivations. *Developmental Science*, (8), 583–594.

Deacon, S. H., Campbell, E., Tamminga, M., & Kirby, J. (2010). Seeing the harm in harmed and harmful: Morphological processing by children in Grades 4, 6, and 8. *Applied Psycholinguistics*, *31*(04), 759–775. doi:10.1017/S0142716410000238

Deacon, S., & Leung, D. (2013). Testing the statistical learning of spelling patterns by manipulating semantic and orthographic frequency. *Applied Psycholinguistics*, *34*(06), 1093–1108. doi:10.1017/S0142716412000173

Deacon, S., Whalen, R., & Kirby, J. R. (2011). Do children see the danger in dangerous? Grade 4, 6, and 8 children's reading of morphologically complex words. *Applied Psycholinguistics*, *32*(03), 467–481. doi:10.1017/S0142716411000166

Di Betta, A., & Romani, C. (2006). Lexical learning and dysgraphia in a group of adults with developmental dyslexia. *Cognitive Neuropsychology*, *23*(3), 376–400.

Diamanti, V. (2005). *Dyslexia and dysgraphia in Greek in relation to normal development: Cross- linguistic and longitudinal studies.* University College London.

Diamanti, V., Goulandris, N., Campbell, R., & Stuart, M. (2005). Spelling of derivational suffixes in Greek Children with and without dyslexia. In *Poster in Twelfth Annual Meeting of the Society for the Scientific Study of Reading*. Toronto.

Diamanti, V., Goulandris, N., Stuart, M., & Campbell, R. (2013a). Spelling of derivational and inflectional suffixes by Greek-speaking children with and without dyslexia. *Reading and Writing*, *27*(2), 337–358. doi:10.1007/s11145-013-9447-2

Diamanti, V., Goulandris, N., Stuart, M., & Campbell, R. (2013b). Spelling of derivational and inflectional suffixes by Greek-speaking children with and without dyslexia. *Reading and Writing*. doi:10.1007/s11145-013-9447-2

Dufva, M., Niemi, P., & Voeten, M. J. (2001). The role of phonological memory, word recognition, and comprehension skills in reading development: From preschool to grade 2. *Reading and Writing: An Interdisciplinary Journal*, *14*, 91–117.

Egan, J., & Tainturier, M. J. (2011a). Inflectional spelling deficits in developmental dyslexia. *Cortex*, *47*(10), 1179–1196. doi:10.1016/j.cortex.2011.05.013

Egan, J., & Tainturier, M.-J. (2011b). Inflectional spelling deficits in developmental dyslexia. *Cortex; a Journal Devoted to the Study of the Nervous System and Behavior*, *47*(10), 1179–96. doi:10.1016/j.cortex.2011.05.013

Ehri, L. C. (1986). Sources of difficulty in learning to spell and read. In M. L. Wolrach & D. Routh (Eds.), *Advances in developmental and behavioural pediatrics* (pp. 121–175). Greenwich: CT: JAI Press.

Ehri, L. C. (1987). Learning to Read and Spell Words. *Journal of Reading Behavior*, *XIX*(1), 5–31.

Ehri, L. C. (1997). Learning to read and learning to spell are one and the same, almost. In C. A. Perfetti (Ed.), *Learning to Spell: Research, Theory, and Precice Across Languages* (pp. 237–270). London: Lawrence Erlbaum Associates.

Ehri, L. C. (2014). Orthographic Mapping in the Acquisition of Sight Word Reading, Spelling Memory, and Vocabulary Learning. *Scientific Studies of Reading*, *18*, 5–21. doi:10.1080/10888438.2013.819356

Ehri, L. C., & Wilce, L. S. (1987). Does learning to spell help beginners learn to read words? *Reading Research Quarterly*, *22*, 47–65.

Elbeheri, G., & Everatt, J. (2007). Literacy ability and phonological processing skills amongst dyslexic and non-dyslexic speakers of Arabic. *Reading and Writing*, *20*(3), 273–294. doi:10.1007/s11145-006-9031-0

Elliott, C. D., Smith, P., & McCulloch, K. (1996). *British Abilities Scales II: Administration and scoring manual.* Berkshire: NFER-NELSON.

Ellis, N. (1994). Longitudinal Studies of Spelling Development. In G. Brown & N. Ellis (Eds.), *Handbook of Spelling: Theory, Process and Intervention* (pp. 155–178). Chichester: John Wiley & Sons.

Ellis, N. C., Natsume, M., Stavropoulou, K., Hoxhallari, L., Van Daal, V. H. P., Polyzoe, N., … Petalas, M. (2004). The effects of orthographic depth on learning to read alphabetic, syllabic, and logographic scripts. *Reading Research Quartely*, *39*(4), 438–468. doi:10.1598/RRQ.39.4.5

Fakou, A., Drakopoulou, S., Skaloumbakas, C., & Protopapas, A. (2010). Σύγκριση σχετικής συχνότητας ορθογραφικών λαθών μεταξύ μαθητών με και χωρίς δυσλεξία. In A. Mouzaki & P. A. (Eds.), *Ορθογραφία. Μάθηση και διαταραχές.* Athens: Gutenberg.

Field, A. (2013). *Discovering Statistics using IBM SPSS Statistics* (4th ed.). London: Sage.

Fowler, C. A., Treiman, R.., & Gross, J. (1993). The structure of English syllables and polysyllables. *Journal of Memory and Language*, *32*(115-140).

Frith, U. (1980). Unexpected spelling problems. Retrieved from http://www.icn.ucl.ac.uk/dev_group/ufrith/documents/Frith, Unexpected spelling problems copy.pdf

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. Patterson, J. Marshall, & M. Coltheart (Eds.), *Surface Dyslexia, Neuropsychological and Cognitive Studies of Phonological Reading* (pp. 301–330). London: Erlbaum.

Frith, U. (1986). A developmental framework for developmental dyslexia. *Annals of Dyslexia*, *36*, 69–81.

Frith, U. (1999). Paradoxes in the Definition of Dyslexia. *Dyslexia*, 192–214.

Frith, U., Wimmer, H., & Landerl, K. (1998). Differences in phonological recoding in German- and English- speaking children. *Scientific Studies of Reading*, (2), 31–54.

Frost, R. (2011). Towards a Universal Model of Reading. *Behavioral and Brain Sciences*, 1–49.

Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: a multilingual comparison. *Journal of Experimental Psychology. Human Perception and Performance*, *13*(1), 104–15. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2951484

Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences*, (21), 85–96.

Gathercole, S. E., & Baddeley, A. D. (1993). *Working Memory and Language.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gathercole, S. E. C., Willis, C. S., Emslie, H., & Baddeley, A. D. (1992). Phonological memory and vocabulary development during the early school years. *Developmental Psychology*, *28*, 887–898.

Gentry, J. R. (1982). An Analysis of Developmental Spelling in “GNYS AT WRK.” *The Reading Teacher*, *36*(2), 192–200. Retrieved from http://www.jstor.org/stable/20198182

Gentry, J. R. (1982). An analysis of developmental spelling in GNYS AT WRK. *The Reading Teacher*, *36*(2), 192–200.

Gentry, J. R. (2000). A Retrospective on Invented Spelling and a Look Forward. *The Reading Teacher*, *54*(3), 318–332.

Georgas, D. D., Paraskevopoulos, I. N., Mpezevengis, I. G., & Giannitsas, N. D. (1997). *Greek WISC-III: Wechsler intelligence scales for children.* Athens: Ellinika Grammata.

Georgiou, G. K., Parrila, R., & Papadopoulos, T. C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology*, *100*(3), 566–580. doi:10.1037/0022-0663.100.3.566

Georgiou, G. K., Torppa, M., Manolitsis, G., Lyytinen, H., & Parrila, R. (2010). Longitudinal predictors of reading and spelling across languages varying in orthographic consistency. *Reading and Writing*, *25*(2), 321–346. doi:10.1007/s11145-010-9271-x

Georgiou, G., Papadopoulos, T., Fella, A., & Parrila, R. (2012). Rapid naming speed components and reading development in a consistent orthography. *Journal of Experimental Child Psychology*, *112*(1), 1–17. doi:10.1016/j.jecp.2011.11.006

Goswami, U. (1999a). Causal connections in beginning reading: The importance of rhyme. *Journal of Research in Reading*, (22), 217–240.

Goswami, U. (1999b). The relationship between phonological awareness and orthographic representations in different orthographies. In M. Harris & G. Hatano (Eds.), *Learning to read and write: A cross-linguistic perspective* (pp. 134–156). Cambridge: Cambridge University Press.

Goswami, U. (2000). Phonological representations, reading development and dyslexia: Towards a cross-linguistic theoretical framework. *Dyslexia*, *6*, 133–151.

Goswami, U. (2002). Phonology, reading development, and dyslexia: A cross-linguistic perspective. *Annals of Dyslexia*, *52*, 139–163.

Goswami, U., & Bryant, E. P. (1990). *Phonological skills and learning to read*. Hove: LEA.

Goswami, U., Gombert, J. E., & de Barrera, L. F. (1998). Children's orthographic representations and linguistic transparency: Nonsense word reading in English, French, and Spanish. *Applied Psycholinguistics*, *19*, 19–52.

Goswami, U., Ziegler, J. C., Dalton, L., & Schneider, W. (2003). Nonword reading across orthographies: How flexible is the choice of reading units? *Applied Psycholinguistics*, *24*, 235–247.

Goswami, U., Ziegler, J. C., & Richardson, U. (2005). The effects of spelling consistency on phonological awareness: a comparison of English and German. *Journal of Experimental Child Psychology*, *92*(4), 345–65. doi:10.1016/j.jecp.2005.06.002

Goulandris, N. (2003). Introduction: developmental dyslexia, language and orthographies. In N. Goulandris (Ed.), *Dyslexia in different languages: Cross-linguistic comparisons* (pp. 1–14). London: Whurr.

Goulandris, N., & Snowling, M. J. (1991). Visual memory deficits: A plausible case of developmental dyslexia? Evidence from a single case study. *Cognitive Neuropsychology*, *8*, 127–154.

Grainger, J., & Ziegler, J. C. (2011). A dual-route approach to orthographic processing. *Frontiers in Psychology*, *2*, 13.

Green, L., McCutchen, D., Schwiebert, C., Quinlan, T., Eva-Wood, A., & Juelis, J. (2003). Morphological development in children's writing. *Journal of Educational Psychology*, (95), 752–761.

Harris, L. N., Perfetti, C. a, & Rickles, B. (2014). Error-related negativities during spelling judgments expose orthographic knowledge. *Neuropsychologia*, *54*, 112–28. doi:10.1016/j.neuropsychologia.2013.12.007

Harris, M., & Giannouli, V. (1999). Learning to read and spell in Greek: The importance of letter knowledge and morphological awareness. In M. Harris & G. Hatano (Eds.), *Learning to Read and Write: A Cross-Linguistic Perspective* (pp. 51 – 70). Cambridge, UK: Cambridge University Press.

Hatcher, J., & Snowling, M. J. (2002). The phonological representations hypothesis of dyslexia: from theory to practice. In G. Reid & J. Wearmouth (Eds.), *Dyslexia and Literacy*. Chichester: Wiley and Sons.

Hatcher, P. J., Goetz, K., Snowling, M., Hulme, C., Gibbs, S., & Smith, G. (2006). Evidence for the effectiveness of the Early Literacy Support programme. *The British Journal of Educational Psychology*, *76*, 351–367. doi:10.1348/000709905X39170

Hayes, J., & Flower, L. (1980). Identifying the organisation of writing processes. In L. W. Gregg & E. R. Steinberg (Eds.), *Cognitive processes in writing: An interdisciplinary approach* (pp. 3–30). Hillsdale, NJ: Lawrence Erlbaum.

Hecht, S. A., Burgess, S. R., Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (2000). Explaining social class differences in growth of reading skills from beginning kindergarten through fourth-grade : The role of phonological awareness , rate of access , and print knowledge. *Reading and Writing: An Interdisciplinary Journal*, *12*, 99–127.

Hoefflin, G., & Franck, J. (2005). Development of Spelling Skills in Children with and without Learning Disabilities. *L1-Educational Studies in Language and Literature*, *5*(2), 175–192. doi:10.1007/s10674-005-0917-6

Holton, D., Mackridge, P., & Philippaki-Warburton, I. (2002). *A Comprehensive Grammar of the Modern Language*. London & New York: Routledge.

Houghton, G., & Zorzi, M. (2003). Normal and impaired spelling in a connectionist dual-route architecture. *Cognitive Neuropsychology*, *20*(2), 115–62. doi:10.1080/02643290242000871

Hulme, C., Muter, V., & Snowling, M. (1998). Segmentation does predict early progress in learning to read better that rhyme: A reply to Bryant. *Journal of Experimental Child Psychology*, *71*, 39–44.

Hulme, C., & Roodenrys, S. (1995). Verbal working memory development and its disorders. *Journal of Child Psychology and Psychiatry*, *36*, 373–398.

Hutzler, F., Ziegler, J. C., Perry, C., Wimmer, H., & Zorzi, M. (2004). Do current connectionist learning models account for reading development in different languages? *Cognition*, *91*(3), 273–96. doi:10.1016/j.cognition.2003.09.006

Joshi, R. M., & Aaron, P. G. (Eds.). (2006). *Handbook of orthography and literacy*. London: Lawrence Erlbaum Associates.

Juel, C., Griffith, P., & Gough, P. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. *Journal of Educational Psychology*, *75*, 752–762.

Juel, C., Griffith, P. L., & Gough, P. B. (1985). Reading and spelling strategies of first grade children. In J. A. Niles & R. Lalik (Eds.), *Issues in literacy: A research perspective* (pp. 306–309). Rochester: NY: National Reading Conference.

Kail, R., Hall, L. K., & Caskey, B. J. (1999). Processing speed, exposure to print, and naming speed. *Applied Psycholinguistics*, *20*(2), 303–314.

Katidioti, I., Simpson, I. C., & Protopapas, A. (2009). Dual-route Connectionist Model of Greek Spelling, 315–316. Retrieved from http://users.uoa.gr/~aprotopapas/CV/pdf/Katidioti_etal_2012_ICCM.pdf

Katzir, T., Shaul, S., Breznitz, Z., & Wolf, M. (2004). The Universal and the unique in dyslexia: A cross-linguistic investigation of reading and reading fluency in Hebrew-and English-speaking children with reading disorders. *Reading and Writing*, *17*(7-8), 739–768. doi:10.1007/s11145-004-2655-z

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

Kessler, B., & Treiman, R. (2001). Relationships between Sounds and Letters in English Monosyllables. *Journal of Memory and Language*, *44*(4), 592–617. doi:10.1006/jmla.2000.2745

Keuning, J., & Verhoeven, L. (2008). Spelling development throughout the elementary grades: The Dutch case. *Learning and Individual Differences*, *18*(4), 459–470. doi:10.1016/j.lindif.2007.12.001

Kohnen, S., Nickels, L., Brunsdon, R., & Coltheart, M. (2008). Patterns of generalisation after treating sub-lexical spelling deficits in a child with mixed dysgraphia. *Journal of Research in Reading*, *31*(11), 157–177.

Kucera, H., & Francis, W. (1984). *Computational analysis of present-day American English*. Providence: RI: Brown University Press.

Landerl, K., & Wimmer, H. (2000). Deficits in phoneme segmentation are not the core problem of dyslexia: Evidence from German and English children. *Applied Psycholinguistics*, *21*(2), 243–262. doi:10.1017/S0142716400002058

Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology*, *100*(1), 150–161. doi:10.1037/0022-0663.100.1.150

Landerl, K., Wimmer, H., & Frith, U. (1997). The impact of orthographic consistency on dyslexia: a German-English comparison. *Cognition*, *63*(3), 315–34. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9265873

Lavery, P., Richmond-welty, E. D., & Tincoff, R. (1996). Effects of Morphology on Children ' s Spelling of Final Consonant Clusters. *Journal of Experimental Child Psychology*, *170*, 141–170.

Lete, B., Peereman, R., & Fayol, M. (2008). Consistency and word-frequency effects on spelling among first- to fifth-grade French children : A regression-based study. *Journal of Memory and Language*, *58*, 952–977. doi:10.1016/j.jml.2008.01.001

Loizidou-Ieridou, N., Masterson, J., & Hanley, J. R. (2010). Spelling development in 6-11-year-old Greek-speaking Cypriot children. *Journal of Research in Reading*, *33*(3), 247–262. doi:10.1111/j.1467-9817.2009.01411.x

Lonigan, C. J., Burgress, S. T., & Anthony, J. L. (2000). Development of emergent literacy and early reading skills in preschool children: Evidence from a latent-variable longitudinal study. *Developmental Psychology*, (36), 596–613.

Lyytinen, H., Aro, M., & Holopainen, L. (2004). Dyslexia in highly orthographically regular Finnish. In *International Book of Dyslexia. A cross language comparison and practice guide* (I. Smythe,.). Chichester: Wiley and Sons.

Marcel, T. (1980). Phonological awareness and phonological representation: Investigation of a specific spelling problem. In U. Frith (Ed.), *Cognitive Processes in Spelling* (pp. 373–403). London: Academic Press.

Marsh, G., Friedman, M., Welch, V., & Desberg, P. (1980). The development of strategies in spelling. In U. Frith (Ed.), *Cognitive Processes in Spelling* (pp. 339–354). London: Academic Press.

Mavrommati, T. D., & Miles, T. R. (2002). A picto-graphic method for teaching spelling to Greek dyslexic children. *Dyslexia*, *8*, 86–101.

Melissaropoulou, D., & Ralli, A. (2010). Greek derivational structures: restrictions and constraints. *Morphology*, 1–11.

Morton, J., & Frith, U. (1995). Causal modeling: A structural approach to developmental psychopathology copy.pdf. In D. Cicchetti & D. Cohen (Eds.), *Developmental psychopathology* (pp. 357–390). John Wiley & Sons. Retrieved from http://www.icn.ucl.ac.uk/dev_group/ufrith/documents/Morton and Frith, Causal modeling - A structural approach to developmental psychopathology copy.pdf

Mouzaki, A., Protopapas, A., Sideridis, G., & Simos, P. (2010). Μια δοκιμασία για την αξιολόγηση της ορθογραφίας. In Α. Μουζάκη & Α. Πρωτόπαπας (Eds.), *Ορθογραφία. Μάθηση και διαταραχές.* Αθήνα: Gutenberg.

Mouzaki, A., Sideridis, G., Protopapas, A., & Simos, P. (2007). Διερεύνηση των ψυχομετρικών χαρακτηριστικών μιας δοκιμασίας ορθογραφικής δεξιότητας μαθητών της Β', Γ', Δ, και Ε΄τάξης του δημοτικού σχολείου. *Επιστήμες Της Αγωγής*, *1*, 129–146.

Nagy, W., & Gentner, D. (1990). Semantic constraints on lexical categories. *Language and Cognitive Processes*, *5*(3), 169–201. doi:10.1080/01690969008402104

Nation, J. K., & Hulme, C. (1998). The role of analogy in early spelling development. In C. Hulme & R. M. Joshi (Eds.), *Reading and spelling: Development and disorders* (pp. pp. 433–445). London: Erlbaum.

Nation, K. (1997). Children' s sensitivity to rime unit frequency when spelling words and nonwords. *Reading and Writing: An Interdisciplinary Journal*, *9*, 321–338.

Nation, K., & Snowling, M. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. *Journal of Research in Reading*, *27*, 342–356.

Nelson, H. (1980). Analysis of spelling errors in normal and dyslexic children. In U. Frith (Ed.), *Cognitive processes in spelling* (pp. 475–493). London: Academic Press.

Nenopoulou, S. (2005). *Dyslexia versus English as an Additional Language: Literacy and Phonological Skills.* University of Surrey.

Nicolson, R. I., Fawcett, A. J., & Dean, P. (2001). A TINS debate – Hindbrain versus the forebrain : a case for cerebellar deficit dyslexia : the cerebellar deficit hypothesis. *TRENDS in Neuroscience*, *24*(9), 508–511.

Nikolopoulos, D. (1999). *Cognitive and linguistic predictors of literacy skills in the Greek Language. The manifestation of reading and spelling difficulties in a regular orthography*. University College London.

Nikolopoulos, D., Goulandris, N., Hulme, C., & Snowling, M. (2006). The cognitive bases of learning to read and spell in Greek: evidence from a longitudinal study. *Journal of Experimental Child Psychology*, *94*(1), 1–17. doi:10.1016/j.jecp.2005.11.006

Nikolopoulos, D., Goulandris, N., & Snowling, M. (2003). Developmental dyslexia in Greek. In N. Goulandris (Ed.), *Dyslexia in different languages* (pp. 53–67). London: Whurr.

Nunes, T., & Bryant, P. (2009). *Children's Reading And Spelling. Beyond the First Steps*. Chichester: Wiley-Blackwell.

Nunes, T., Bryant, P., & Bindman, M. (1997). Morphological spelling strategies: developmental stages and processes. *Developmental Psychology*, *33*(4), 637–49. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9232379

Nunes, T., Bryant, P., & Bindman, M. (2006). The e□ects of learning to spell on children's awareness of morphology. *Reading and Writing*, *19*, 767–787. doi:DOI 10.1007/s11145-006-9025-y

Nunes, T., Bryant, P., & Olsson, J. (2003). Learning morphological and phonological spelling rules: An intervention study. *Scientific Studies of Reading*, *7*, 289 – 307.

Olson, A., & Caramazza, A. (1994). Representations and connectionist models: The NETspell experience. In G. D. A. Brown & N. C. Ellis (Eds.), *Handbook of spelling: Theory, process and intervention.* Chichester: Wiley.

Olson, D. (1996). Towards a psychology of literacy: On the relations between speech and writing. *Cognition*, *60*, 83–104.

Oney, B., & Durgunoglou, A. Y. (1997). Beginning to read in Turkish: A phonologically transparent orthography. *Applied Psycholinguistics*, *18*, 1–15.

Ouellette, G. (2006). What's meaning got to do with it: The role of vocabulary in word reading and reading comprehension. *Journal of Educational Psychology*, *98*, 554–566.

Ouellette, G. (2010). Orthographic learning in learning to spell: The roles of semantics and type of practice. *Journal of Experimental Child Psychology*, *107*, 50–58.

Ouellette, G., & Fraser, J. (2009). What exactly is a Yait anyway: The role of semantics in orthographic learning. *Journal of Experimental Child Psychology*, *104*, 239– 251.

Pattison, H. M., & Collier, J. (1992). Methodological Issues in the Investigation of Spelling and Spelling Development. In C. M. Sterling & C. Robson (Eds.), *Psychology, Spelling & Education*. Bristol: Longdunn Press.

Paulesu, E., Démonet, J. F., Fazio, F., McCrory, E., Chanoine, V., Brunswick, N., … Frith, U. (2001). Dyslexia: cultural diversity and biological unity. *Science (New York, N.Y.)*, *291*(5511), 2165–7. doi:10.1126/science.1057179

Pennington, B. F. (2006). From single to multiple deficit models of developmental disorders. *Cognition*, *101*(2), 385–413. doi:10.1016/j.cognition.2006.04.008

Pennington, B. F., McCabe, L. L., Smith, S. D., Lefly, D. L., Bookman, M. O. Kimberling, W. J., & Lubs, H. A. (1986). Spelling errors in adults with a form of familial dyslexia. *Child Development*, *57*, 1001–1013.

Perfetti, C. A. (1997). *Learning to Spell : Research, Theory, and Practice Across Languages*. London: Lawrence Erlbaum Associates.

Perfetti, C. A., & Hart, L. (2002). The lexical quality hypothesis. In L. Vehoven, C. Elbro, & P. Reitsma (Eds.), *Precursors of functional literacy* (pp. 189–213). Amsterdam: John Benjamins.

Peters, A. M. (1997). Language typology, prosody, and the acquisition of grammatical morphemes. In D. I. Slobin (Ed.), *The cross-linguistic study of language acquisition*. (Vol. 5, pp. 135–197). Hillsdale, NJ: Erlbaum.

Plaut, D. C., McClelland, J. L., Seidenberg, M. S., & Patterson, K. (1996). Understanding normal and impaired word reading: Computational principles in quasi-regular domains. *Psychological Review*, *103*, 56–115.

Porpodas, C. (1992). The relation between phonemic awareness and reading and spelling of greek words in the first school years. In M. Carretero, M. Pope, R. Simons, & J. Poso (Eds.), *Learning and Instruction* (pp. 203–217). N. York: Pergamon Press.

Porpodas, C. D. (1989). The phonological factor in reading and spelling of Greek. In P. G. Joshi & R. M. Aaron (Eds.), *Reading and writing disorders in different orthographic systems* (pp. 177–190). The Netherlands: Kluwer Academic Publishers.

Porpodas, C. D. (1999). Patterns of Phonological and Memory Processing in Beginning Readers and Spellers of Greek. *Journal of Learning Disabilities*, *32*(5), 406–416. doi:10.1177/002221949903200506

Porpodas, C. D. (2006). Literacy acquisition in Greek: Research review of the role of phonological and cognitive factors. In R. M. Joshi & P. G. Aaron (Eds.), *Handbook of Orthography and Literacy* (pp. 189–199). Mahwah, NJ: Erlbaum.

Porpodas, C., Pantelis, S., & Hantziou, E. (1990). Phonological and lexical encoding processes in beginning readers: effects of age and word characteristics. *Reading and Writing: An Interdisciplinary Journal*, *2*(1-12).

Powell, D., Plaut, D., & Funnell, E. (2006). Does the PMSP connectionist model of single word reading learn to read in the same way as a child? *Journal of Research in Reading*, *29*(2), 229–250. doi:10.1111/j.1467-9817.2006.00300.x

Powell, D., Stainthorp, R., & Stuart, M. (2013). *Deficits in Orthographic Knowledge in Children Poor at Rapid Automatized Naming (RAN) Tasks? in press*.

Powell, D., Stainthorp, R., Stuart, M., Garwood, H., & Quinlan, P. (2007). An experimental comparison between rival theories of rapid automatized naming performance and its relationship to reading. *Journal of Experimental Child Psychology*, *98*(1), 46–68. doi:10.1016/j.jecp.2007.04.003

Protopapas, A. (2010). *Children's Textbook Database*. Shared after personal communication with the author.

Protopapas, A., Fakou, A., Drakopoulou, S., Skaloumbakas, C., & Mouzaki, A. (2013). What do spelling errors tell us? Classification and analysis of errors made by Greek schoolchildren with and without dyslexia. *Reading and Writing*, *26*(5), 615–646. doi:10.1007/s11145-012-9378-3

Protopapas, A., Tzakosta, M., Chalamandaris, A., & Tsiakoulis, P. (2012). IPLR: An online resource for Greek word-level and sublexical information. *Language Resources & Evaluation.*, *46*(3), 449–459. doi:doi:10.1007/s10579-010-9130-z

Protopapas, A., & Vlahou, E. (2009). A comparative quantitative analysis of Greek orthographic transparency. *Behavior Research Methods*, *41*(4), 991–1008. doi:10.3758/BRM.41.4.991

Puranik, C. S., & Alotaiba, S. (2011). Examining the contribution of handwriting and spelling to written expression in kindergarten children. *Reading and Writing: An Interdisciplinary Journal*, (25), 1523–1546.

Puranik, C. S., Lombardino, L. J., & Altmann, L. J. (2006). Writing through retellings: an exploratory study of language-impaired and dyslexic populations. *Reading and Writing*, *20*(3), 251–272. doi:10.1007/s11145-006-9030-1

Puranik, C. S., Lombardino, L. J., & Altmann, L. J. P. (2008). Assessing the microstructure of written language using a retelling paradigm. *American Journal of Speech-Language Pathology / American Speech-Language-Hearing Association*, *17*(2), 107–20. doi:10.1044/1058-0360(2008/012)

Pye, R. (2008). *Predicting improvement in dyslexia : A longitudinal treatment study*. University of Reading.

Quirk, R., & Greenbaum, S. (1973). *A university grammar of English*. Harlow: Longman.

Quirk, R., Greenbaum, S., Leech, G., & Svartvik, J. (1985). *A Comprehensive Grammar of the English Language*. New York: Longman.

Rabin, J., & Deacon, H. (2008). The representation of morphologically complex words in the developing lexicon. *Journal of Child Language*, *35*(2), 453–465. doi:10.1017/S0305000907008525

Ralli, A. (2000). Greek nominal inflection. *Glossologia*, *11-12*, 201–227.

Ralli, A. (2002). The role of morphology in gender determination: evidence from Modern Greek. *Linguistics*, *40*(3), 1–27. doi:10.1515/ling.2002.022

Ralli, A. (2003). Morphology in Greek linguistics. *Journal of Greek Linguistics*, *4*, 77–129.

Ralli, A. (2004). Stem-based versus Word-based Morphological Configurations: The Case of Modern Greek Preverbs. *Lingue E Linguaggio*, *2*, 241–275.

Ralli, A. (1998). On the Morphological Status of Inflectional Features: Evidence from Modern Greek. In B. D. Joseph, G. Horrocks, & I. Philippaki-Warburton (Eds.), *Themes in Greek Linguistics II* (pp. 51–74). Amsterdam: John Benjamins.

Ramus, F., Rosen, S., Dakin, S., Day, B., Castellote, J., White, S., & Al., E. (2003). Theories of developmental dyslexia: Insights from a multiple case study of dyslexic adults. *Brain*, *126(4)*, 841–865.

Raven, J., Raven, J. C., & Court, J. H. (2004). *Manual for Raven's Progressive Matrices and Vocabulary Scales. Section 2: The Coloured Progressive Matrices.* Oxford, San Antonio: Oxford Psychologists Press/The Psychological Corporation.

Raven J.C. (1938). *Progressive Matrices: A Perceptual Test of Intelligence*. London: HK Lewis.

Read, C. (1986). *Children's creative spelling*. London: Routledge & Kegan Paul.

Ricketts, J., Nation, K., & Bishop, D. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading*, *11*(3), 235–257. doi:10.1080/10888430701344306

Rittle-Johnson, B., & Siegler, R. S. (1999). Learning to Spell: Variability, Choice, and Change in Children's Strategy Use. *Child Development*, *70*(2), 332–348. doi:10.1111/1467-8624.00025

Rose, J. (2009). Identifying and Teaching Children and Young People with Dyslexia and Literacy Difficulties. In *An independent report from Sir Jim Rose to the Secretary of State for Children, Schools and Families*.

Rust, J. (1996). *The Manual of the Wechsler Objective Language Dimensions (WOLD) UK edition.* London: The Psychological Corporation.

Seidenberg, M., & McClelland, J. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review*, *96*, 523–568.

Seymour, P. H. K. (1986). *Cognitive Analysis of Dyslexia*. London: Routledge & Kegan Paul.

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, *94*, 143–174.

Share, D. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition*, *55*, 151–218.

Share, D. (2008). Orthographic learning, phonological recoding, and self-teaching. In R. Kail (Ed.), *Advances in child development and behavior* (pp. 31–81). New York: Elsevier.

Sharp, A. C., Sinatra, G. M., & Reynolds, R. E. (2008). The Development of Children ' s Orthographic Knowledge : A Microgenetic Perspective. *Reading Research Quartely*, *43*(3), 206–226.

Siegel, L. S. (2003). IQ-Discrepancy Definitions and the Diagnosis of LD: Introduction to the Special Issue. *Journal of Learning Disabilities*, *36*(1), 2–3.

Siegel, L. S., Share, D., & Geva, E. (1995). Evidence for Superior Orthographic Skills in Dyslexics. *Psychological Science*, *6*(4), 250–254. doi:10.1111/j.1467-9280.1995.tb00601.x

Singleton, C. (2002). Dyslexia: cognitive factors and implications for literacy. In G. Reid & J. Wearmouth (Eds.), *Dyslexia and Literacy*. West Sussex: Wiley and Sons.

Singleton, C. (2009). *Intervention for Dyslexia. A review of published evidence on the impact of specialist dyslexia teaching.*

Siok, W., Perfetti, C., Jin, Z., & Tan, L. (2004). Biological abnormality of impaired reading is constrained by culture. *Nature*, *431*, 71–76.

Slobin, D. I. (1973). Cognitive prerequisites for the development of grammar. In C. A. Ferguson & D. I. Slobin (Eds.), *Studies of child language development* (pp. 175–208). New York: Holt, Rinehart & Winston.

Smythe, I., & Everatt, J. (2000). Dyslexia diagnosis in different languages. In L. Peer & G. Reid (Eds.), *Multilingualism, Literacy and Dyslexia*. London: David Fulton Publishers.

Smythe, I., & Everatt, J. (2004). Dyslexia: A cross-linguistic framework. In I. Smythe, J. Everatt, & R. Salter (Eds.), *International Book of Dyslexia. A cross language comparison and practice guide*. Chichester: Wiley and Sons.

Smythe, I., Everatt, J., Al-Menaye, N., He, X., Capellini, S., Gyarmathy, E., & Siegel, L. S. (2008). Predictors of Word-level Literacy amongst Grade 3 Children in Five Diverse Languages. *Dyslexia*, *14*, 170–187. doi:10.1002/dys

Smythe, I., Everatt, J., & Salter, R. (Eds.). (2004). *The International Book of Dyslexia*. John Wiley & Sons.

Snow, C. E., Barnes, W. S., Chandler, J., Goodman, I. F., & Hemphill, L. (1991). *Unfulfilled expectations: Home and school influences on literacy*. Cambridge: MA: Harvard University Press.

Snowling, M. (1995). Phonological processing and developmental dyslexia. *Journal of Research in Reading*, *18*, 132–138.

Snowling, M., Chiat, S., & Hulme, C. (1991). Words, nonwords, and phonological processes: Some comments on Gathercole, Willis, Emslie, and Baddeley. *Applied Psycholinguistics*, *12*, 369–373.

Snowling, M. J. (1994). Towards a model of spelling acquisition: The development of some component skills. In G. D. A. Brown & N. C. Ellis (Eds.), *Handbook of Spelling: Theory, Process and Intervention* (pp. 111–128). Chichester: John Wiley and Sons.

Snowling, M. J. (2000). *Dyslexia* (2nd ed.). Oxford: Blackwell.

Snowling, M. J., Goulandris, N., & Defty, N. (1996). A longitudinal study of reading development in dyslexic children. *Journal of Educational Psychology*, *88*(4), 653–669. doi:10.1037//0022-0663.88.4.653

Snowling, M. J., Stackhouse, J., & Rack, J. (1986). Phonological dyslexia and dysgraphia: A developmental analysis. *Cognitive Neuropsychology*, *3*, 309–339.

Socre, L., & Masterson, J. (2001). *Single Word Spelling Test*. Slough: NFER-NELSON.

Spencer, L. H., & Hanley, J. R. (2003). Effects of orthographic transparency on reading and phoneme awareness in children learning to read in Wales. *British Journal of Psychology*, *94*, 1–28.

Sprenger-Charolles, L., Colé, P., Lacert, P., & Serniclaes, W. (2000). On subtypes of developmental dyslexia: evidence from processing time and accuracy scores. *Canadian Journal of Experimental Psychology = Revue Canadienne de Psychologie Expérimentale*, *54*(2), 87–104. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10881393

Sprenger-Charolles, L., Siegel, L. S., Béchennec, D., & Serniclaes, W. (2003). Development of phonological and orthographic processing in reading aloud, in silent reading, and in spelling: A four-year longitudinal study. *Journal of Experimental Child Psychology*, *84*(3), 194–217. doi:10.1016/S0022-0965(03)00024-9

Stage, S. A., & Wagner, R. K. (1992). The development of young children's phonological and orthographic knowledge as revealed by their spellings. *Journal of Educational Psychology*, (83), 346–360.

Stainthorp, R. (2003). Phonology and learning to read. In N. Hall, J. Larson, & J. Marsh (Eds.), *Handbook of Early Childhood Literacy*. London: Sage.

Stainthorp, R., & Hughes, D. (1999). *Learning from children who read at an early age*. Routledge.

Stainthorp, R. W., Powell, D., Stuart, M., Quinlan, P., & Garwood, H. (2010). Visual processing deficits in children with slow RAN performance. *Scientific Studies of Reading*, *14*(3), 266–292.

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. *Journal of Learning Disabilities*, *21*, 590–612.

Stanovich, K. E., & West, R. F. (1989). Exposure to print and orthographic processing. *Reading Research Quarterly*, (24), 402–433.

Stanovich, K., & Siegel, L. (1994). The phenotypic performance profile of reading-disabled children: A regression based test of the phonological-core variable-difference model. *Journal of Educational Psychology*, *86*, 1–30.

Steffler, D. (2004). An investigation of grade 5 children's knowledge of the doubling rule in spelling. *Journal of Research in Reading*, (27), 248–264.

Stein, G. (2007). *A dictionary of English affixes: their function and meaning* (LINCOM Stu.). Munich: Lincom Europa.

Stein, J. (2001). The magnocellular theory of developmental dyslexia. *Dyslexia*, *7*, 12–36.

Sterling, C., Farmer, M., Riddick. B., Morgan, S., & Matthews, C. (1998). Adult dyslexic writing. *Dyslexia*, *4*, 1–15.

Stone, G. O., Vanhoy, M., & Orden, G. C. V. (1997). Perception Is a Two-Way Street: Feedforward and Feedback Phonology in Visual Word Recognition. *Journal of Memory and Language*, *36*(36), 337–359. doi:10.1006/jmla.1996.2487

Stuart, G., McAnally, K., McKay, A., Johnston, M., & Castles, A. (2006). A test of the magnocellular deficit theory of dyslexia in an adult sample. *Cognitive Neuropsychology*, *23*, 1215–1229.

Stuart, Masterson, Dixon, & Quinlan. (n.d.). *Children's Printed Word Database*. Retrieved from http://www.essex.ac.uk/psychology/cpwd/

Sumner Emma Jane. (2013). *Children with Dyslexia: Spelling as a Constraint on Writing Development*. Oxford Brookes University.

Swanson, H. L., & Berninger, V. W. (1994). Working memory as a source of individual difference in children‟s writing. In E. Butterfield (Ed.), *Children's Writing; Toward a Process Theory of Development of Skilled Writing* (pp. 31–56). Greenwich, CT: JAI Press.

Taft, M., & Forster, I. K. (1975). Lexical storage and retrieval of prefixed words. *Journal of Verbal Learning and Verbal Behaviour*, *14*, 638–647.

Tainturier, M. J., & Rapp, B. C. (2004). Complex graphemes as functional spelling units: evidence from acquired dysgraphia. *Neurocase : Case Studies in Neuropsychology, Neuropsychiatry, and Behavioural Neurology*, *10*(2), 122–131. doi:10.1080/13554790490497238

Tainturier, M.-J., Bosse, M.-L., Roberts, D. J., Valdois, S., & Rapp, B. (2013). Lexical neighborhood effects in pseudoword spelling. *Frontiers in Psychology*, *4*(November), 862. doi:10.3389/fpsyg.2013.00862

Tainturier, M.-J., & Rapp, B. (2001). The spelling process. In B. Rapp (Ed.), *The Handbook of Cognitive Neuropsychology: What deficits Reveal about the Human Mind.* (pp. 263–289). New York: Psychology Press.

Tallal, P., Miller, S. L., Jenkins, W. M., & Merzenich, M. M. (1997). The role of temporal processing in developmental language-based learning disorders: Research and clinical implications. In B. A. Blachman (Ed.), *Foundations of Reading Acquisition and Dyslexia: Implications for Early Intervention*. Mahwah, NJ: Lawrence Erlbaum Associates.

Temple, C. (1985). Developmental surface dysgraphia: A case report. *Applied Psycholinguistics*, *6*, 391–405.

Torgesen, J. K., Wagner, R. K., & Rashotte, C. A. (1999). *Test of word reading efficiency.* Austin, TX: PRO-ED.

Treiman, R. (1985). Onsets and rimes as units of spoken syllables: Evidence from children. *Journal of Experimental Child Psychology*, *39*, 161–181.

Treiman, R. (1992). The role of intrasyllabic units in learning to read and spell. In P. B. Gough, L. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 65–106). Hillsdale, NJ: Lawrence Erlbaum Associates.

Treiman, R. (1993a). *Beginning to Spell*. New York: Oxford University Press Oxford.

Treiman, R. (1993b). *Beginning to spell. A study of first-grade children*. New York: Oxford University Press.

Treiman, R. (1994). Use of consonant letter names in beginning spelling. *Developmental Psychology*, *30*, 567–580.

Treiman, R. (1997). Spelling in Normal Children and Dyslexics. In B. Blachman (Ed.), *Foundations of reading acquisition and dyslexia, implications for early intervention* (pp. 191–218). London: Lawrence Erlbaum Associates.

Treiman, R. (2005). Linguistic constraints on literacy development: Introduction to the special issue. *Journal of Experimental Child Psychology*, *92*(4), 303–306. doi:10.1016/j.jecp.2005.09.004

Treiman, R., & Bourassa, D. C. (2000). The Development of Spelling Skill. *Topics in Language Disorders*, *20*, 1–18.

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

Treiman, R., & Cassar, M. (1997). Spelling acquisition in English. In C. A. Perfetti, L. Rieben, & M. Fayol (Eds.), *Learning to spell*. Mahwah, NJ: Erlbaum.

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

Treiman, R., & Kessler, B. (2006). Spelling as statistical learning: Using consonantal context to spell vowels. *Journal of Educational Psychology*, *98*(3), 642–652. doi:10.1037/0022-0663.98.3.642

Treiman, R., Mullennix, J., Bijeljac-Babic, R., & Richmond-Welty, E. D. (1995). The special role of rimes in the description, use, and acquisition of English orthography. *Journal of Experimental Psychology: General*, *124*, 107–136.

Treiman, R., Zukowski, A., & Richmond-Wely, E. D. (1995). What happened to the "n" of sink? Children's spellings of final consonant clusters. *Cognition*, *55*, 1–38.

Tsesmeli, S. N., & Seymour, P. H. K. (2006). Derivational morphology and spelling in dyslexia. *Reading and Writing*, *19*, 587–625.

Tsopanakis, A. (1948). Συμβολή στη Ρύθμιση του Νεοελληνικού Κλιτικού Συστήματος [A Contribution to the Normalization of the Modern Greek Inflectional System]. *Epistimoniki Epetiris Filosofikis Sxolis Panepistimiou Thessalonikis*, *6*, 243–280.

Tunmer, W. E., & Nesdale, A. R. (1985). Phonemic segmentation skill and beginning reading. *Journal of Educational Psychology*, *77*(4), 417–427.

Valdois, S., Bosse, M., Ans, B., Carbonnel, S., Zorman, M., David, D., & Al., E. (2003). Phonological and visual processing deficits can dissociate in developmental dyslexia: Evidence from two case studies. *Reading and Writing*, *16*, 541–572.

Van den Bos, K. P. (1988). IQ, phonological awareness and continuous naming speed related to Dutch poor decoding children's performance on two word identification tests. *Dyslexia*, *4*, 73–89.

Van Galen, G. P. (1991). Handwriting: Issues for a psychomotor theory. *Human Movement Science*, (10), 165–191.

Van Orden, G. C., & Goldinger, S. (1994). Interdependence of form and function in cognitive systems explains perception of printed words. *Journal of Experimental Psychology: Human Perception and Performance*, *20*(6), 1269–1291.

Varnhagen, C. K., Mccallum, M., & Burstow, M. (1997). Is children' s spelling naturally stage-like ? *Reading and Writing: An Interdisciplinary Journal*, *9*, 451–481.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): what have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *45*(1), 2–40. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14959801

Venezky, R. L. (1970). *The structure of English orthography*. The Hague: Mouton.

Venezky, R. L. (1999). *The American Way of Spelling. The Structure and Origins of American English Orthography*. New York: Guildford Press.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, *101*, 192–212.

Wagner, R. K., Torgesen, J. K., Laughan, P., Simmons, K., & Rashotte, C. A. (1993). The development of young readers' phonological processing abilities. *Journal of Educational Psychology*, (85), 1–20.

Walker, J., & Hauerwas, L. B. (2006). Development of phonological, morphological, and orthographic knowledge in young spellers: The case of inflected verbs. *Reading and Writing*, *19*(8), 819–843. doi:10.1007/s11145-006-9006-1

Wang, H.-C., Castles, A., Nickels, L., & Nation, K. (2011). Context effects on orthographic learning of regular and irregular words. *Journal of Experimental Child Psychology*, *109*(1), 39–57. doi:10.1016/j.jecp.2010.11.005

Waters, G., Bruck, M., & Seidenberg, M. S. (1985). Do children use similar processes to read and spell words? *Journal of Experimental Child Psychology*, *39*, 511–530.

Waters, G. S., Bruck, M., & Malus-Abramowitz, M. (1988). The Role of Linguistic and Visual information in Spelling: A Developmental Study. *Journal of Experimental Child Psychologysychology*, (45), 400–421.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children* (3rd ed.). San Antonio: TX: Psychological Corporation.

Weekes, B. S., Castles, A. E., & Davies, R. A. (2006). Effects of inconsistency and age of acquisition on reading and spelling developing readers. *Reading and Writing: An Interdisciplinary Journal*, *19*, 132–169.

Whechsler, D. (1991). *The Whechsler intelligence scale for children-third edition.* San Antonio: The Psychological Corporation.

Wilson, M. D. (1988). The MRC Psycholinguistic Database: Machine Readable Dictionary, Version 2. *Behavioural Research Methods, Instruments and Computers*, *20*(1), 6–11.

Wimmer, H., & Goswami, U. (1994). The influence of orthographic consistency on reading development: word recognition in English and German children. *Cognition*, 91–103.

Wimmer, H., & Hummer, P. (1990). How German-speaking first graders read and spell: Doubts on the importance of the logographic stage. *Applied Psycholinguistics*, (11), 349–368.

Wimmer, H., Mayringe, H., & Landerl, K. (1998). Poor reading: A deficit in skill automatization or phonological deficit? *Scientific Studies of Reading*, *2*, 321–340.

Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: A specific disability in regular orthographies. *Journal of Educational Psychology*, *94*(2), 272–277. doi:10.1037//0022-0663.94.2.272

Wimmer, H., Mayringer, H., & Landerl, K. (2000). The Double-Deficit Hypothesis and Difficulties in Learning to Read a Regular Orthography. *Journal of Educational Psychology*, *92*(4), 668–680. doi:10.10371/0022-0663.92.4.668

Wimmer, H., Mayringer, H., & Raberger, T. (1999). Reading and Dual-Task Balancing: Evidence Against the Automatization Deficit Explanation of Developmental Dyslexia. *Journal of Learning Disabilities*, *32*(5), 473–478. doi:10.1177/002221949903200513

Wise, J. C., Sevcik, R. A., Morris, R. D., Lovett, M. W., & Wolf, M. (2007). The relationship among receptive and expressive vocabulary, listening comprehension, pre-reading skills, word identification skills, and reading comprehension by children with reading disabilities. *Journal of Speech, Language, and Hearing Research : JSLHR*, *50*(4), 1093–1109. doi:10.1044/1092-4388(2007/076)

Wise, J. C., Sevick, R. A., Morris, R. D., Lovett, M. W., Wolf, M. (2007). The relationship among receptive and expressive vocabulary, listening comprehension, pre-reading skills, word identification skills, and reading comprehension by children with reading disabilities. *Ournal of Speech, Language, and Hearing Research*, *50*, 1093–1109.

Wolf, M., & Bowers, P. G. (1999). The Double-Deficit Hypothesis for the Developmental Dyslexias. *Journal of Educational Psychology*, *91*(3), 415–438.

Wydell, T. N. (2003). Dyslexia in Japanese and the “hypothesis of granularity and transparency.” In N. Goulandris (Ed.), *Dyslexia in different languages* (pp. 255–276). London: Whurr.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effects in word reading and other tasks. *Journal of Memory and Language*, *47*(1), 1–29. doi:10.1006/jmla.2001.2834

Ziegler, J. C. (2006). Do differences in brain activation challenge universal theories of dyslexia? *Brain and Language*, *98*(3), 341–3. doi:10.1016/j.bandl.2005.05.002

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

Ziegler, J. C., Perry, C., & Coltheart, M. (2003). Speed of lexical and nonlexical processing in French: The case of the regularity effect. *Psychonomic Bulletin & Review*, *10*, 947–953.

Ziegler, J. C., Perry, C., Jacobs, A. M., & Braun, M. (2001). Identical words are read differently in different languages. *Psychological Science*, *12*, 379–384.

Ziegler, J. C., Perry, C., Ma-Wyatt, A., Ladner, D., & Schulte-Körne, G. (2003). Developmental dyslexia in different languages: Language-specific or universal? *Journal* *of Experimental Child Psychology*, *86*(3), 169–193. doi:10.1016/S0022-0965(03)00139-5

Zoccolotti, P., & Friedmann, N. (2010). From dyslexia to dyslexias, from dysgraphia to dysgraphias, from causes to causes: A look at current research on developmental dyslexia and dysgraphia. *Cortex*, *46*, 1211–1215.

Zorzi, M. (2000). Serial processing in reading aloud: No challenge for a parallel model. *Journal of Experimental Psychology: Human Perception and Performance*, *26*, 847–856.

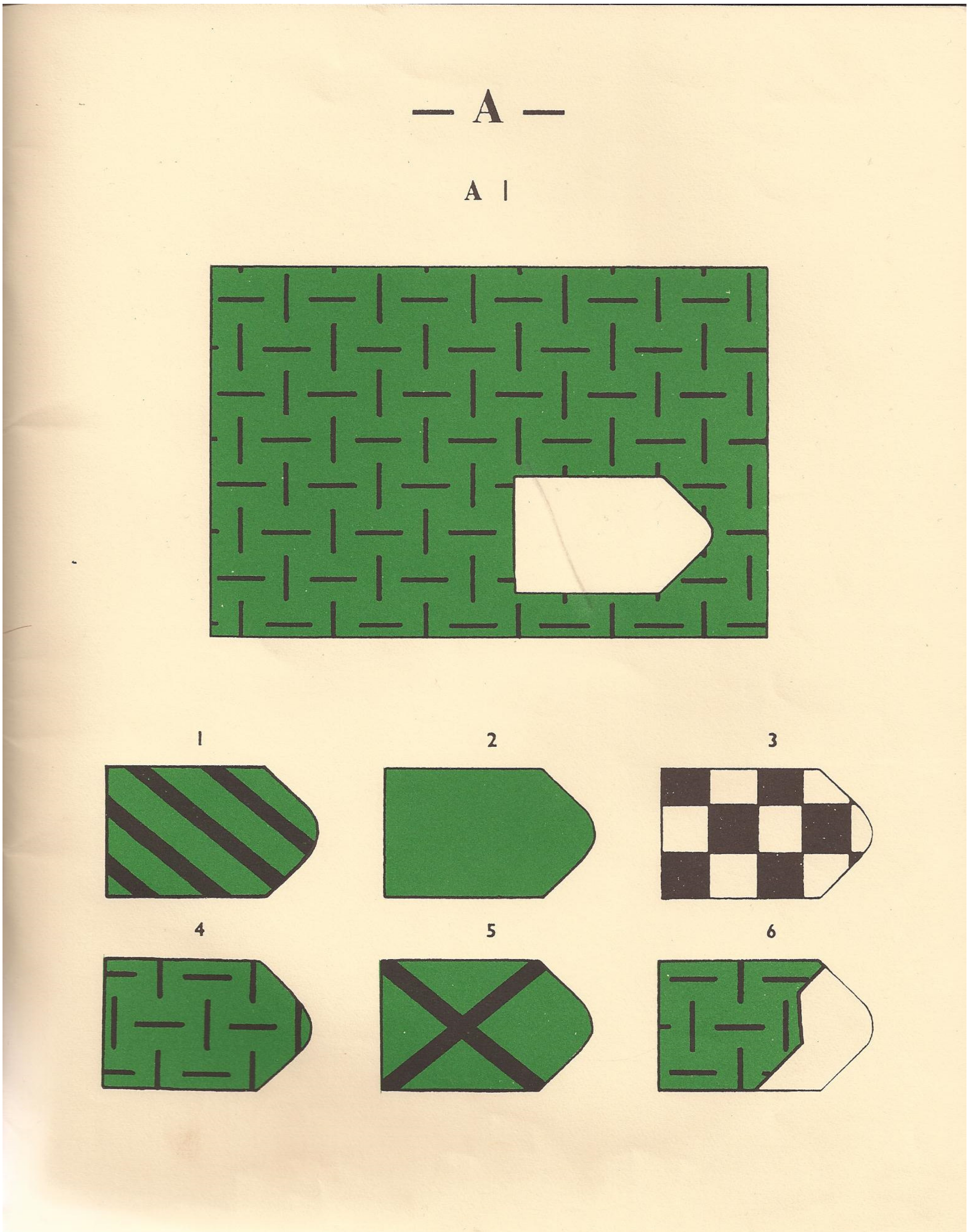
APPENDICES

Appendix A

The English and Greek Baseline Measures

Appendix A1

Example of Raven's CPM (Raven, 1938)



Appendix A2

The Vocabulary test (WISC-III): English Version (Wechsler, 1991)

1. Clock	11. Brave	21. Mimic
2. Umbrella	12. Island	22. Rivalry
3. Hat	13. Absorb	23. Seclude
4. Thief	14. Nonsense	24. Unanimous
5. Cow	15. Precise	25. Amendment
6. Bicycle	16. Transparent	26. Compel
7. Donkey	17. Boast	27. Imminent
8. Alphabet	18. Migrate	28. Affliction
9. Ancient	19. Fable	29. Dilatory
10. Leave	20. Strenuous	30. Aberration

Appendix A3

The Vocabulary test (WISC-III): Greek Version (Georgas et al., 1997)

1. Ρολόι	11. Νησί	21. Εμφανής
2. Αγελάδα	12. Εύστοχος	22. Ομοφωνία
3. Καπέλο	13. Αμφιβολία	23. Οδύνη
4. Ομπρέλα	14. Απορροφώ	24. Υπαινιγμός
5. Άλογο	15. Αναπαριστάνω	25. Προλογίζω
6. Κλέφτης	16. Ανταγωνισμός	26. Υποβαστάζω
7. Ποδήλατο	17. Καυχιέμαι	27. Υποδηλώνω
8. Φεύγω	18. Αναβάλλω	28. Αμφίδρομος
9. Αρχαίο	19. Απομονώνω	29. Τροπολογία
10. Γενναίος	20. Αποδημώ	30. Επικείμενος

Appendix A4

The Test of Word Reading Efficiency: English Version (TOWRE; Torgesen et al., 1999)

The List of Words: Form A

is	work	crowd	uniform
up	jump	better	necessary
cat	part	inside	problems
red	fast	plane	absentee
me	fine	pretty	advertise
to	milk	famous	pleasant
no	back	children	property
we	lost	without	distress
he	find	finally	information
the	paper	strange	recession
and	open	budget	understand
yes	kind	repress	emphasis
of	able	contain	confident
him	shoes	justice	intuition
as	money	morning	boisterous
book	great	resolve	plausible
was	father	describe	courageous
help	river	garment	alienate
then	space	business	extinguish
time	short	qualify	prairie
wood	left	potent	limousine
let	people	collapse	valentine
men	almost	elements	detective
baby	waves	pioneer	recently
new	child	remember	instruction
stop	strong	dangerous	transient

The List of Words: Form B

go	shop	chance	mountain
dog	meat	instead	project
in	best	farmer	factories
at	then	spring	straighten
am	spell	present	clarify
it	come	strong	frequent
so	start	huge	mediate
big	green	believe	threshold
be	want	office	modulate
do	better	question	prudent
box	learn	contact	exercise
one	black	history	protect
look	train	invent	desperate
if	even	invoice	quantity
not	went	complete	wonderful
car	thing	custom	initiate
hot	other	inquire	spurious
this	fruit	natural	particular
have	wrong	purchase	emergency
some	watch	vacant	selection
now	truck	everyone	verbatim
need	stars	swollen	awkward
give	winter	fireplace	wilderness
sat	begin	together	grandiose
good	forest	horizon	ornament
here	street	embassy	penitent

The List of Non-Words: Form A

ip	barp	cratty
ga	stip	trober
ko	plin	depate
ta	frip	glant
om	poth	sploosh
ig	vasp	dreker
ni	meest	ritlun
pim	shlee	hedfert
wum	guddy	bremick
lat	skree	nifpate
baf	felly	brinbert
din	clirt	clabom
nup	sline	drepnort
fet	dreef	shratted
bave	prain	plofent
pate	zint	smuncrit
herm	bloot	pelnador
dess	trisk	fornalask
chur	kelm	fermabalt
knap	strone	crenidmoke
tive	lunaf	emulbatate

The List of Non-Words: Form B

mo	mest	flimp
ik	stree	girtus
pu	weaf	strale
bi	barch	debmer
ib	glack	happon
ku	prot	framble
eb	runk	progus
pog	loast	supken
dat	mact	jeltlic
mip	blork	tegwop
ral	phet	slinperk
nas	wogger	plinders
mib	klup	thundelp
faw	skad	bramtich
shum	keast	chimdruff
bice	churt	darlankert
nade	glamp	stremfick
teap	prait	morlingdon
derl	flact	revignuf
marl	throbe	obsorfelm
berk	creft	pitocrant

Appendix A5

The Test of Word Reading Efficiency: Greek Version (G. Georgiou et al., 2012)

The List of Words

με	ράχη	βελόνι	αδρανής
που	βουλή	εθνική	πρόεδρος
αν	γιατρός	οδηγός	θάλασσα
στο	μπορεί	στοιχείο	πρόσθεση
πριν	γνωστή	επειδή	γυάλινο
για	παίζουν	ζάχαρη	πρόκειται
της	νύχτα	αριθμοί	σύγκριση
χθες	καιρό	κατσίκια	δύσπνοια
σαν	πλοίο	υγεία	ψήφισμα
μωβ	δέντρο	μένετε	προσοχή
εδώ	λίμνη	σχολείο	σύμφωνα
μάνα	παίρνει	τυχαίος	υπήρξε
ώρα	τρόπος	αντένα	ανθρώπους
κήπος	ντέφι	εκείνος	πρόγραμμα
βάρη	χαζός	πατρίδα	εκρήξεις
πρώτα	κλέφτης	γήπεδο	αγγλικά
κοντά	πέμπτη	Ιούλης	γεωργός
χέρι	τίτλος	ποτήρια	ηφαίστειο
ήρθε	χλωμή	δευτέρα	διαίρεση
χρήση	δείχνει	αγρότης	τηλέφωνο
ξένοι	φούστα	βιβλίο	μειωμένο
πολλοί	γνώμη	κουμπαράς	γυναικείος
σώμα	τσίρκο	δικαστές	λειτουργία
κάποιο	στίγμα	βρίσκομαι	ηλεκτρισμός
ρίχνω	παγωτό	ευρώπη	χρειάζεται
γιορτή	αστείο	ποσοστό	προγνωστικά

The List of Non-Words: Greek Version

απ	πλωί	τόχνη
γα	κήμος	λόπεμο
κο	άτσι	άλοιξη
εν	τολόι	σκύμος
χι	επεδή	ταθημή
ωμ	λωής	κρεβάλι
νι	ροχή	σχολέα
ήθε	δρέμο	ραπέζι
χώο	γνώη	δίντρα
δεμ	σέδιο	γαζάλιο
γέα	ίπλα	μπροσά
νας	φικιλά	τηφέλωνο
έρα	ότις	δημοκιτό
στε	αίλα	παιχνίδα
εμεί	βιβίο	τραμούδι
δώλε	φύλκα	λοπιτισμό
ήπως	άσκρο	διακιδασία
άλτο	σπίμι	φθινόπωθο
γέσε	κόπλο	αφτοκίτηνο
ντύω	πορήτι	δυσχυτώς
ικέα	δρίζα	ατοναύτης

Appendix A6

The Single word Spelling Test (BAS-II): English Version (Elliott et al., 1996)

1. on	11. was	21. are
2. and	12. home	22. well
3. the	13. old	23. new
4. up	14. do	24. work
5. go	15. play	25. bird
6. big	16. back	26. walk
7. sit	17. that	27. boat
8. bus	18. down	28. soil
9. my	19. eat	29. morning
10. box	20. come	30. eight

31. friend
32. know
33. catch
34. leave
35. flight
36. while
37. worse
38. square
39. circle
40. bridge
41. laughing
42. obtain
43. search
44. although
45. fault
46. measured
47. condition
48. vouchers
49. surround
50. caution
51. technical
52. ceiling
53. occasion
54. excellent
55. magician
56. quarrel
57. beginning
58. representative
59. leopard
60. pharmacist

Appendix A7

The Single Word Spelling Test: Greek Version (Mouzaki et al., 2007)

1. από	11. ποτίζω	21. όμως
2. και	12. ξέρω	22. επιβάτης
3. ούτε	13. πετάνε	23. χρήματα
4. είναι	14. μεγαλώνω	24. χώρισα
5. άλογο	15. φίλος	25. φωτισμένος
6. αυτός	16. ζωγραφική	26. πηγή
7. έτσι	17. φυτό	27. σωφή
8. τραπέζι	18. πέτρινο	28. δωρεάν
9. λέω	19. αυτοκίνητο	29. ταμείο
10. έλα	20. πηγαίνω	30. ονειρεύομαι

31. άδεια
32. φυλή
33. παράδειγμα
34. παιχτών
35. δανείζω
36. ζεσταίνει
37. αλλιώτικος
38. δίχτυ
39. πετρέλαιο
40. πρακτορείο
41. οικονομικότερος
42. ηθοποιός
43. μόλυνση
44. αντικείμενο
45. διευθυντής
46. κηνυγητό
47. εκατομμύριο
48. ξεφυλλίζοντας
49. χαρακτηριστικό
50. αναχώρηση
51. υποχρεωμένος
52. νοημοσύνη
53. αισθήσεις
54. επιχείρση
55. αποχαιρέτησα
56. ειδοποιήθηκε
57. ματαιώνεται
58. εγχειριστεί
59. χείμαρρος
60. αποδεικνύω

APPENDIX B

The English and Greek Experimental Spelling Tasks

Appendix B1

The English Experimental List of Words

Table B1.1

Word Frequencies of the Words of the English Experimental List

Word	Frequency per 1,000,000[a]	Word	Frequency per 1,013,252[b]
occupation	0	elves	0
approval	0	funnier	1
illegal	0	heaviest	2
employee	0	scary	2
irregular	0	armchairs	2
arrangement	0	autograph	3
dissatisfied	0	brushes	6
armchairs	0	ponies	6
heaviest	3	apples	6
necessary	3	dissatisfied	6
autograph	5	irregular	9
smartest	5	illegal	9
funnier	8	thoughtful	11
memories	8	princess	13
thoughtful	11	memories	15
bench	14	horrible	15
brushes	14	heated	16
paid	14	yell	20
tallest	14	smart	21
voices	14	knight	21
written	14	occupation	24
judge	16	employee	26
larger	16	glasses	29
immediately	22	accident	33
burning	24	arrangement	34
ponies	24	bench	35
tough	27	worried	35
knight	30	smiling	36
shoulder	30	chicken	37
scary	32	voices	38
heated	35	tough	38
accident	38	queen	41

elves	38	leaves	49
smiling	41	burning	51
families	51	approval	51
carrying	59	tall	59
between	62	shoulder	66
horrible	65	holding	67
holding	68	families	69
finally	70	carrying	71
already	73	judge	79
yell	76	dinner	91
pieces	78	pieces	92
closed	103	caught	98
apples	124	dropped	101
glasses	124	closed	112
worried	130	larger	123
dropped	138	immediately	123
chicken	154	beautiful	127
dinner	170	summer	136
caught	192	paid	149
summer	197	written	156
princess	308	finally	191
leaves	327	necessary	223
beautiful	352	already	273
always	406	saw	353
than	484	always	459
queen	552	between	730
saw	15,90	than	1,795
said	16,115	said	1,961

Note. a. Obtained from Children's Printed Word Database (Stuart et al., 1993-1996)

b. Obtained from Kucera and Francis (Kucera & Francis, 1984)

Appendix B2

Table B2.1

Properties of the English Experimental List of Words

Properties of Words	
Parts of Speech	Count
Nouns	28
Verbs[a]	13
Adjectives	13
Adverbs	5
Prepositions	1
Number	
Singular	25
Plural	11
Tense	
Present	4
Past	9
Syllables	
Min in a Word	1
Max in a Word	4
Graphemes	
Min in a Word	2
Max in a Word	10

Note. Verbs include all verb forms, such as participles

Table B2.2

Morphological Analysis of English Stimuli[a]

Whole Word	**Prefix**	**Stem(base word)[b]**	**Suffix[c]**
occupation		occup(y)	ation (der)
approval		approv(e)	al (der)
illegal	il (der)	legal	
employee		employ	ee (der)
irregular	ir (der)	regular	
arrangement		arrange	ment (der)
dissatisfied	dis (der)	satisfy	ed (infl)
armchairs		armchair	s (infl)
heaviest		heavy	est (infl)
necessary		necessary	
autograph		autograph	
smartest		smart	est (infl)
funnier		funny	er (infl)
memories		memory	es (infl)
thoughtful		thought	ful (der)
bench		bench	
brushes		brush	es (infl)
paid		pay	ed (infl)
tallest		tall	est (infl)
voices		voice	s (infl)
written		writ(e)	en (infl)
judge		judge	
larger		larg(e)	er (infl)
immediately		immediate	ly (der)
burning		burn	ing (infl)
ponies		pony	es (infl)
tough		tough	
knight		knight	
shoulder		shoulder	
scary		scar(e)	y (der)
heated		heat	ed (infl)
accident		accident	
elves		elf	es (infl)
smiling		smil(e)	ing (infl)
families		family	es (infl)
carrying		carry	ing (infl)
between		between	
horrible		horr(or)	ible(der)
holding		hold	ing (infl)
finally		final	ly (der)
already		already	

spell		spell	
pieces		piece	s (infl)
closed		clos(e)	ed (infl)
apples		apple	s (infl)
glasses		glass	es (infl)
worried		worry	ed (infl)
dropped		drop	ed (infl)
chicken		chicken	
dinner		dinner	
caught		caught	
summer		summer	
princess		princ(e)	ess (der)
leaves		leaf	es (infl)
beautiful		beauty	ful (der)
always		always	
than		than	
queen		queen	
saw		saw	
said		say	ed (infl)

Note. (der) = derivational suffix; (infl) = inflectional suffix
[a] The analysis followed consultation with two independent researchers based on information retrieved from http://languagelink.let.uu.nl/~lion/?s=Playgrounds/PCKIMMO_Playground&lang=en; https://open.xerox.com/Services/fst-nlp-tools/Consume/Morphological%20Analysis-176morpho-analysis. [b] The endings of the base words are in parenthesis. [c] The analysis of the suffixes was based on Nunes and Bryant (2009), Stein (2007) and Venezky (1999).

Appendix B3

The Single Word Spelling Task: English Version

1. Judge. According to the judge the man is innocent. Judge
2. Than. Natalie is prettier than her sister. Than
3. Between. I sat down between Sue and Jane. Between
4. Bench. We sat on a park bench. Bench
5. Chicken. My grandma has a chicken in her back yard. Chicken
6. Queen. At the age of 18, Victoria was crowned queen. Queen
7. Yell. Don't yell at me, please. Yell
8. Glasses. I need a new pair of glasses. Glasses
9. Occupation. What is your mother's occupation? Occupation
10. Princess. Princess Joanna was the name of the king's daughter. Princess
11. Summer. I spent a lovely summer with my grandparents. Summer
12. Paid. Mum paid for my new jeans. Paid
13. Approval. The president has given his approval to the plan. Approval
14. Voices. I could hear voices in the room. Voices
15. Armchairs. My parents enjoy sitting on their favourite armchairs. Armchairs
16. Beautiful. The weather was beautiful. Beautiful
17. Always. She always wears a scarf in the winter. Always
18. Brushes. We need paint and brushes to redecorate your bedroom. Brushes
19. Memories. I only have good memories of his party. Memories
20. Dinner. We're having fish for dinner tonight. Dinner
21. Elves. Santa's elves are busy looking after the reindeer. Elves
22. Tallest. Michael is the tallest boy in our class. Tallest
23. Immediately. He answered the phone immediately. Immediately
24. Smartest. She is the smartest girl in her class. Smartest
25. Burning. She was rescued from a burning building. Burning
26. Families. Do you know all the families living in this block? Families
27. Funnier. Jane's jokes are funnier than yours. Funnier
28. Leaves. The leaves were falling off the trees. Leaves
29. Holding. He was holding a pencil in his hand. Holding

30. Dropped. He dropped his cup on the floor. Dropped
31. Smiling. Her smiling face is the most beautiful thing I've ever seen. Smiling
32. Said. She said she was very tired. Said
33. Heaviest. This large box is the heaviest of all. Heaviest
34. Saw. I just saw George leaving his flat. Saw
35. Apples. I need four apples to make a pie. Apples
36. Caught. He caught the bus right on time. Caught
37. Ponies. I remember we used to ride ponies on our farm. Ponies
38. Closed. Make sure the window is closed. Closed
39. Heated. I heated up the milk to make hot chocolate. Heated
40. Larger. London is larger than any other city in UK. Larger
41. Written. My name was written on a blue envelope. Written
42. Already. Is he home already? Already
43. Autograph. I asked the footballer for an autograph at the end of the game. Autograph
44. Dissatisfied. If you are dissatisfied with the product, you can return it. Dissatisfied
45. Worried. She gave me a worried look. Worried
46. Scary. The movie was really scary. Scary
47. Horrible. I had a horrible dream last night. Horrible
48. Carrying. Linda came into the classroom carrying her school bag. Carrying
49. Shoulder. He put his hand on her shoulder. Shoulder
50. Finally. After much discussion she finally agreed to come with us. Finally
51. Knight. The Black Knight was really scary in his armour. Knight
52. Pieces. Please, could I have two more pieces of cake for my friends? Pieces
53. Tough. Tough decisions will have to be made. Tough
54. Necessary. It's not necessary to wear a tie. Necessary
55. Accident. We had a car accident last winter. Accident
56. Employee. We now have 10 employees in our office. Employee
57. Irregular. It's quite irregular to see him around on weekdays. Irregular
58. Thoughtful. It was really thoughtful of you to buy me flowers. Thoughtful
59. Illegal. It is illegal to sell alcohol to someone under 18. Illegal
60. Arrangement. I'll help with the arrangements for the party. Arrangement

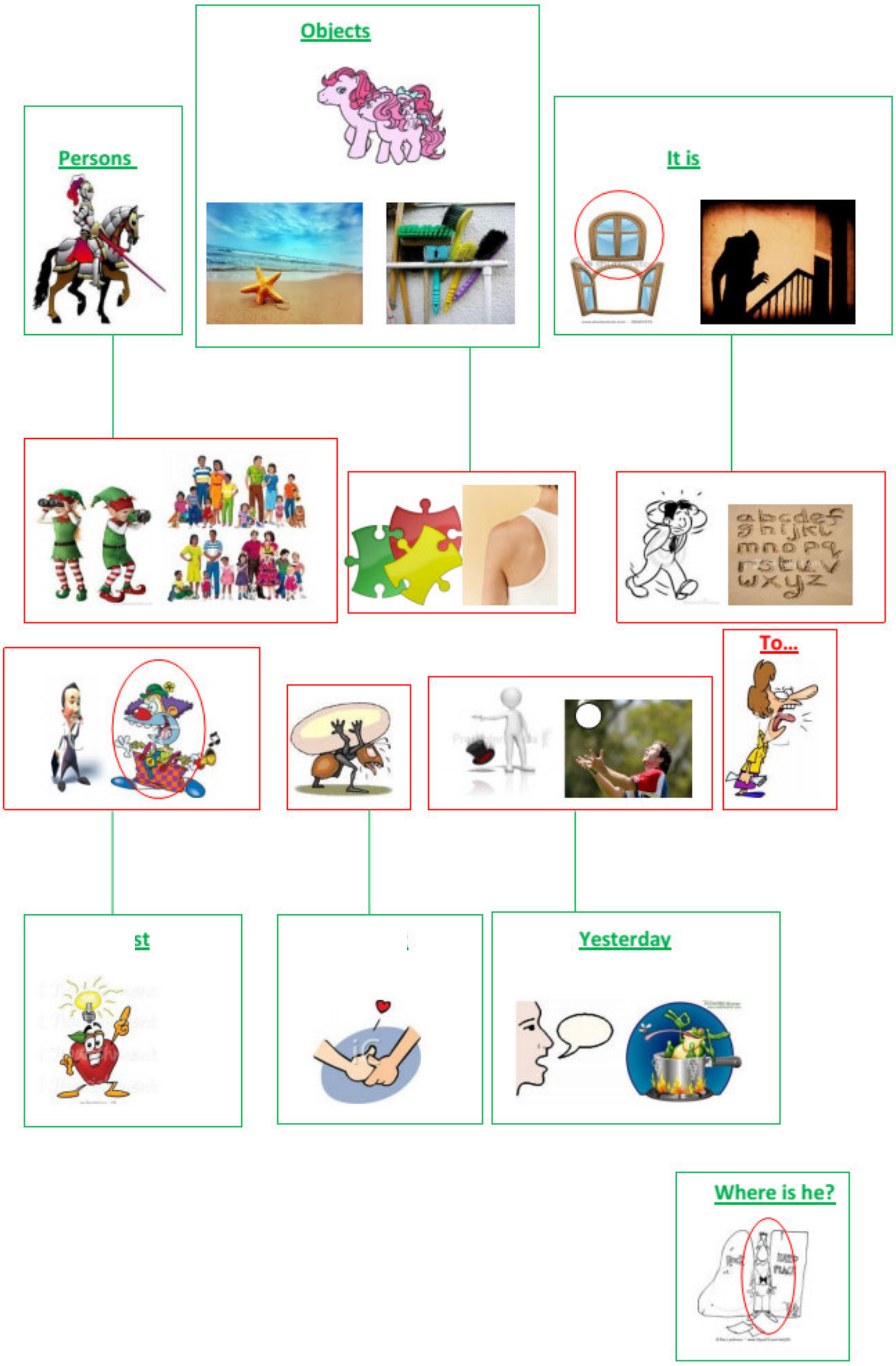
Appendix B4

The Passage Completion Task: English Version

I am so excited to have *already* received a letter from my cousin! Our *families* used to live next door to each other until last *summer* when they moved to New York. His new address was *written* on a blue envelope and inside there was the *autograph* of my favourite American basketball player! My cousin's letter was full of *memories* of our times together; how much fun it was hiding away a bunch of fresh flowers Mum had *paid* a fortune to buy, how much *larger* the dog had become after eating four *pieces* of cake, how we both *caught* a *horrible* cold, and how my uncle was *worried* about us breaking our backs when he *saw* us *carrying* his favourite *bench* away! He also *said* that he would *always* remember us riding Dad's *ponies* on the beach and the terrible pain on our *shoulders* afterwards!

Appendix B5

Example of the Pictures Used for the Text Composition Task: English Version



Appendix B6

The Greek List of Words

Table B6.1

Word Frequencies of the Words Dictated in the Greek Single Word Spelling Task

Words	Frequency per 332,418[a]	Word	Frequency per 1,000,000[b]
έμμεσα	0	πριγκίπισσα	0
αναρριχήσεις	0	ελλειπτικές	0
δανεικό	0	ευτυχέστεροι	0
φιλώντας	0	αναρριχήσεις	0
βαρύ(τερο)	1	ώμοι	0
εγκαταλειμμένο	1	κλήμα	0
πριγκίπισσα	1	αυτόγραφο	1
αυτόγραφα	1	τσαγκάρης	1
ευτυχέστεροι	1	τελειομανείς	1
τελειομανείς	1	φιλώντας	1
τσαγκάρης	1	συλλεκτική	1
ευγενής	1	βούρτσα	1
έγγραφο	1	φλιτζάνι	1
φτώχεια	2	βαρύτερο	2
βούρτσα	2	εγκαταλειμμένο	2
εκκίνηση	2	δανεικό	2
κάηκε	2	ωραιότερο	3
κοινωνικός	2	ευγενής	3
καυτή	2	κρυμμένο	4
ώμοι	2	κολλά	4
ωραιότερο	2	κάηκε	5
συλλεκτική	2	καυτή	7
κλήμα	3	μπαίνοντας	7
εγγύηση	3	έσωσε	9
μελλοντική	3	μπάνιο	9
αρρώστια	4	αρρώστια	10
κρυμμένο	4	γελώντας	10
κατευθείαν	5	γραμμένο	10
έσωσε	7	εκκίνηση	12
ελλειπτικές	7	δάκρυα	14
κολλά	8	φτώχεια	15
μπάνιο	10	κατευθείαν	15
γελώντας	11	έστειλαν	16
ειδήσεις	12	κοινωνικός	16
δίνοντας	13	ειδήσεις	20
συγγραφείς	14	μελλοντική	20
φλιτζάνι	14	εγγύηση	21
γραμμένο	15	έμμεσα	22
ύψη	20	γλώσσες	23
οικογένειες	21	συγγραφείς	31

κοινό	23	οικογένειες	32
καλύτερος	23	έγγραφο	33
γλώσσες	25	δίνοντας	37
πόλεις	25	γύρισε	40
δάκρυα	27	καλύτερος	41
έστειλε	34	φωνές	47
λάθη	34	θάλασσα	62
μπαίνει	37	πόλεις	64
γύρισε	42	κομμάτι	66
φωνές	47	λάθη	77
αλλιώς	49	αλλιώς	90
κομμάτι	50	βρήκε	91
βρήκε	51	είδα	97
έπειτα	81	έπειτα	113
περισσότερο	100	ύψη	115
είδε	114	κοινό	194
συνέχεια	117	συνέχεια	315
θάλασσα	220	παιδιά	354
είπε	619	περισσότερο	442
παιδιά	885	είπε	991

Note. a. Obtained from the Children's Textbook Database (Protopapas, 2010)

b. Obtained from the ILSP PsychoLinguistic Resource (IPLR) (Protopapas et al., 2012)

Appendix B7

Table B7.1

Properties of the Words of the Greek Experimental List

Properties of Words	
Parts of Speech	Count
Nouns	26
Verbs[a]	14
Adjectives	15
Adverbs	5
Prepositions	0
Number	
Singular	24
Plural	16
Tense	
Present	4
Past	10
Syllables	
Min in a Word	2
Max in a Word	6
Graphemes	
Min in a Word	3
Max in a Word	11

Note. Verbs include all verb forms, such as participles

Table B7.2

Morphological Analysis of Greek Stimuli[f]

Words	Prefix	Stem(base word)	Suffix
έμμεσα		έμμεσα	α (der)
αναρριχήσεις		αναρριχή	σ (der) εις (infl)[b]
δανεικό		δαν	εικ (der) ό (infl)
φιλώντας		φιλ	ώντας (infl)[c]
βαρύτερο		βαρύ	τερ (der) ο (infl)[b,c]
εγκαταλειμμένο		εγκαταλελειπ	μέν (der) ο (infl)[b]
πριγκίπισσα		πριγκίπ	ισσα (der)[b]
αυτόγραφα		αυτόγραφ	α (infl)[d]
ευτυχέστεροι		ευτυχέσ	τερ (der) οι (infl)[c,d]
τελειομανείς		τελειομαν	εί (der) ς (infl)[d]
τσαγκάρης		τσαγκάρη	ς (infl)[d]
ευγενής		ευγεν	ή (der) ς (infl)[d]
έγγραφο		έγγραφ	ο (infl)[d]
φτώχεια		φτώχ	εια (der)[b]
βούρτσα		βούρτσα[b,d]	
εκκίνηση		εκκίνη	ση (der)[b]
κάηκε		κάηκ	ε (infl)[b,c]
κοινωνικός		κοινων	ικ (der) οί (infl)[d]
καυτή		καυτή[d]	
ώμοι		ώμ	ους (infl)[d]
ωραιότερο		ωραιό	τερ (der) ο (infl)[c,d]
συλλεκτική	συν (der)	λεκτ	ικ (der) ή (infl)[b]
κλήμα		κλήμα[d]	
εγγύηση		εγγύη	ση (der)[b]
μελλοντική		μελλοντ	ική (der)[d]
αρρώστια		αρρώστ	ια (der)[d]
κρυμμένο		κρυβ	μέν (der) ο (infl)[b,d]
κατευθείαν		κατευθείαν	
έσωσε[a]	έ (infl)[b]	σωσ	αν (infl)
ελλειπτικές		ελλειπτ	ικ (der) ες (infl)[b,d]
κολλά		κολλ	ά (infl)[b]
μπάνιο		μπάν	ιο (infl)[d]
γελώντας		γελ	ώντας (infl)[c]
ειδήσεις		ειδή	σ (der) εις (infl)[b]
δίνοντας		δίν	οντας (infl)[c]

συγγραφείς	συν (der)	γραφ	είς (infl)[c]
φλιτζάνι		φλιτζάνι[d]	
γραμμένο		γραφ	μέν (der) ο (infl)[b,d]
ύψη		ύψ	η (infl)[d]
οικογένειες		οικογέν	ει (der) ες (infl)[d]
κοινό		κοιν	ό (infl)[d]
καλύτερος		καλύ	τερ (der) ος (infl)[d]
γλώσσες		γλώσσ	ες (infl)[d]
πόλεις		πόλ	εις (infl)[d]
δάκρυα		δάκρυ	α (infl)[d]
έστειλε[a]	έ (infl)[b]	στειλ	ε (infl)
λάθη		λάθ	η (infl)[d]
μπαίνει		μπαίν	οντας (infl)[c]
γύρισε		γύρ	ισ (der) ε (infl)[e]
φωνές		φων	ές (infl)[d]
αλλιώς		αλλ	ιως (der)[c]
κομμάτι		κομμάτι[d]	
βρήκε[a]		βρήκ	ε (infl)[c]
έπειτα		έπειτα	
περισσότερο		περισσό	τερ (der) ο (infl)[d]
είδε[a]		είδ	ε (infl)[d]
συνέχεια		συνέχεια	
θάλασσα		θάλασσα[d]	
είπε[a]		είπ	ε (infl)[c]
παιδιά		παιδι	ά (infl)[d]

Note. (der) = derivational suffix; (infl) = inflectional suffix.

[a] Irregular formation of simple past tense. [b] Based on Melissaropoulou and Ralli (2010) and Ralli (2003). [c] Based on Clairis and Babiniotis (1996). [d] Based on Ralli (2002). [e] Based on Ralli (2004).

[f] The analysis followed consultation with one independent researcher based on information retrieved from the Computational Morphological Dictionary of Institute for Language and Speech Processing (ILSP, http://www.ilsp.gr): http://www.ilsp.gr/en/services-products/langresources/item/32-ilektronikomorfologiko after personal communication with Dr N. Glaros.

Appendix B8

The Single Word Spelling Task: Greek Version

1. Μπάνιο. Κάνω μπάνιο κάθε βράδυ μετά την προπόνηση για να είμαι καθαρός όταν ξαπλώνω στο κρεβάτι μου. Μπάνιο
2. Συνέχεια. Μου λέει συνέχεια οτι είμαστε καλοί φίλοι. Συνέχεια
3. Κοινό. Το κοινό του θεάτρου χειροκρότησε θερμά. Κοινό
4. Κολλά. Αυτή η κόλλα δεν κολλά το σπασμένο γυαλί. Κολλά
5. Πριγκίπισσα. Το όνομα της κόρης του βασιλιά ήταν Πριγκίπισσα Όλγα. Πριγκίπισσα
6. Κάηκε. Το φαγητό μας κάηκε εχτές και παραγγείλαμε απ'έξω. Κάηκε
7. Δάκρυα. Δε μπορούσε να συγκρατήσει τα δάκρυά της από τη συγκίνηση. Δάκρυα
8. Ειδήσεις. Στα νέα των 9.00 βλέπουμε όλες τις ειδήσεις της μέρας. Ειδήσεις
9. Λάθη. Ο δάσκαλος μου υπογράμμισε όλα τα λάθη ορθογραφίας με κόκκινο χρώμα. Λάθη
10. Ευτυχέστεροι. Οι γονείς μου ήταν ευτυχέστεροι με τους βαθμούς μου φέτος απ' ότι με τους βαυμούς που πήρα πέρυσι. Ευτυχέστεροι
11. Μπαίνοντας. Μπαίνοντας στο σπίτι πέταξε την τσάντα του στο πάτωμα. Μπαίνοντας
12. Γελώντας. Βγήκε από το δωμάτιο γελώντας δυνατά με το αστείο της φίλης του. Γελώντας
13. Έστειλε. Η μαμά μου έστειλε στον αδελφό της ένα δέμα στη Λαμία. Έστειλε
14. Έσωσαν. Οι πυροσβέστες έσωσαν τη γιαγιά από το φλεγόμενο κτήριο. Έσωσαν
15. Αυτόγραφο. Πάνω από το κρεβάτι μου έχω κρεμάσει το αυτόγραφο του αγαπημένου μου ποδοσφαιριστή. Αυτόγραφο
16. Κοινωνικοί. Οι γονείς μου είναι πολύ κοινωνικοί. Κάνουν πολύ συχνά πάρτυ στο σπίτι μας και επισκέπτονται τους φίλους του κάθε βδομάδα.
17. Φτώχεια. Η φτώχεια τους ήταν τόσο μεγάλη που ζητιάνευαν για να φάνε. Φτώχεια
18. Ώμους. Στους ώμους της είχε ρίξει ένα μπουφάν γιατί έκανε λίγο κρύο. Ώμους
19. Έγγραφο. Το απολυτήριο του σχολείου θεωρείται δημόσιο έγγραφο. Έγγραφο
20. Ελλειπτικές. Οι πλανήτες διαγράφουν ελλειπτικές τροχιές γύρω από τον Ήλιο. Ελλειπτικές
21. Συλλεκτική. Αυτή η έκδοση του βιβλίου είναι συλλεκτική γιατί έχει εξαντληθεί από την αγορά και μόνο σε δημοπρασίες μπορείς πια να το αγοράσεις. Συλλεκτική

22. Τσαγκάρης. Ο τσαγκάρης άλλαξε τα τακούνια στα παπούτσια της μαμάς μου. Τσαγκάρης

23. Φλιτζάνι. Μπορώ να έχω ένα φλιτζάνι καφέ, παρακαλώ; Φλιτζάνι

24. Αρρώστια. Η αρρώστια του δεν πέρασε ούτε με τα ισχυρότερα φάρμακα. Αρρώστια

25. Γλώσσες. Μιλάει τρεις ξένες γλώσσες, αγγλικά, γαλλικά και γερμανικά. Γλώσσες

26. Κομμάτι. Μου δίνεις ένα κομμάτι κέικ ακόμα;. Κομμάτι

27. Οικογένειες. Στην πολυκατοικία μας μένουν πέντε οικογένειες με το λιγότερο δύο παιδιά η κάθε μια. Οικογένειες

28. Παιδιά. Στην τάξη μου φοιτούν τριάντα παιδιά. Παιδιά

29. Συγγραφείς. Τρεις συγγραφείς συνεργάστηκαν για να γράψουν αυτό το θεατρικό έργο. Συγγραφείς

30. Πόλεις. Από όλες τις πόλεις που επισκεφτήκαμε, η Θεσσαλονίκη μου άρεσε περισσότερο. Πόλεις

31. Ωραιότερο. Το ωραιότερο δώρο γενεθλίων το πήρα από το νονό μου φέτος. Ωραιότερο

32. Περισσότερο. Το φαγητό που μου αρέσει περσσότερο είναι τα γεμιστά. Περισσότερο

33. Δίνοντας. Μου είπε ευχαριστώ δίνοντάς μου ένα φιλί στο μάγουλο. Δίνοντας

34. Βρήκε. Ο Χρήστος βρήκε κάτω από το θρανίο του το βιβλίο που είχε χάσει τη Δευτέρα. Βρήκε

35. Κατευθείαν. Μου είπε κατευθείαν οτι δε με συμπαθεί. Κατευθείαν

36. Αλλιώς. Θα φας το φαγητό σου, αλλιώς δεν έχει παιχνίδι. Αλλιώς

37. Κλήμα. Τα σταφύλια στο κλήμα στην αυλή του παππού μου είναι αρκετά για να τρώμε όλο το καλοκαίρι. Κλήμα

38. Εγγύηση. Το πληντύριο που αγοράσαμε έχει εγγύηση για δύο χρόνια. Εγγύηση

39. Τελειομανείς. Τα αδέρφια μου είναι τόσο τελειομανείς που δεν κλείνουν το βιβλίο αν δεν ξέρουν όλο το μάθημα νεράκι. Τελειομανείς

40. Αναρριχήσεις. Ο Σύλλογός μας έχει συμμετάσχει σε αναρριχήσεις στις δυσκολότερες πίστες σε όλη την Ελλάδα. Αναρριχήσεις

41. Βούρτσα. Μου δίνεις τη βούρτσα για τα μαλλιά από το συρτάρι; Βούρτσα

42. Εκκίνηση. Οι αθλητές πήραν θέση στην αφετηρία και περίμεναν την εκκίνηση του αγώνα. Εκκίνηση

43. Γραμμένο. Το όνομά μου είναι γραμμένο στα εξώφυλλα όλων το βιβλίων μου. Γραμμένο

44. Θάλασσα. Τα κύματα στη θάλασσα ήταν αρκετά μεγάλα για να κάνουμε σέρφινγκ. Θάλασσα

45. Ευγενής. Ήταν τόσο ευγενής που κρατούσε την πόρτα για να περάσουν οι κυρίες της παρέας. Ευγενής

46. Ύψη. Ο χαρταετός αυτός είναι φτιαγμένος για αν πετάει σε μεγάλα ύψη. Ύψη

47. Φωνές. Έβαλα τις ψωνές μόλις κατάλαβα οτι είχα εγκλωβιστεί στο ασανσερ. Φωνές

48. Καλύτερος. Ο Κώστας είναι καλύτερος από το Γιάννη στα Μαθηματικά γιατί παίρνει πάντα μεγαλύτερο βαθμό στα τεστ. Καλύτερος

49. Φιλώντας. Με χαιρέτησε φιλώντας με σταυρωτά στα μάγουλα. Φιλώντας

50. Είπε. Μας είπε οτι ήταν πολύ χαρούμενος που μας βλέπει. Είπε

51. Γύρισε. Ο θείος μου γύρισε στην Ελλάδα ύστερα από δέκα χρόνια στο εξωτερικό. Γύρισε

52. Κρυμμένο. Κάτω από το στρώμα του είχε κρυμμένο ένα μικρό θησαυρό. Κρυμμένο

53. Εγκατα(λε)λειμμένο. Το σπίτι της γιαγιάς ήταν εγκαταλελειμμένο για χρόνια πριν αποφασίσουμε να το πουλήσουμε. Εγκαταλελειμμένο

54. Μελλοντική. Η μελλοντική μου δουλειά δε θέλω να είναι σε επιχείρηση. Μελλοντική

55. Καυτή. Η σούπα ήταν τόσο καυτή που αναγκάστηκα να περιμένω ένα τέταρτο για να κρυώσει. Καυτή

56. Έμμεσα. Μου είπε έμμεσα οτι με θεωρεί υπεύθυνο για την αποτυχία του. Έμμεσα

57. Έπειτα. Πρώτα μπήκε στο σπίτι και έπειτα έβγαλε το μπουφάν. Έπειτα

58. Βαρύτερο. Το μωρό ήταν βαρύτερο από ότι περίμενα και δυσκολεύτηκα να το σηκώσω. Βαρύτερο

59. Είδα. Από το παράθυρο είδα τον κλέφτη να μπαίνει στο διπλανό σπίτι. Είδα

60. Δανεικό. Το βιβλίο αυτό είναι δανεικό από τον ξάδερφό μου και πρέπει να το επιστρέψω στο τέλος της βδομάδας. Δανεικό

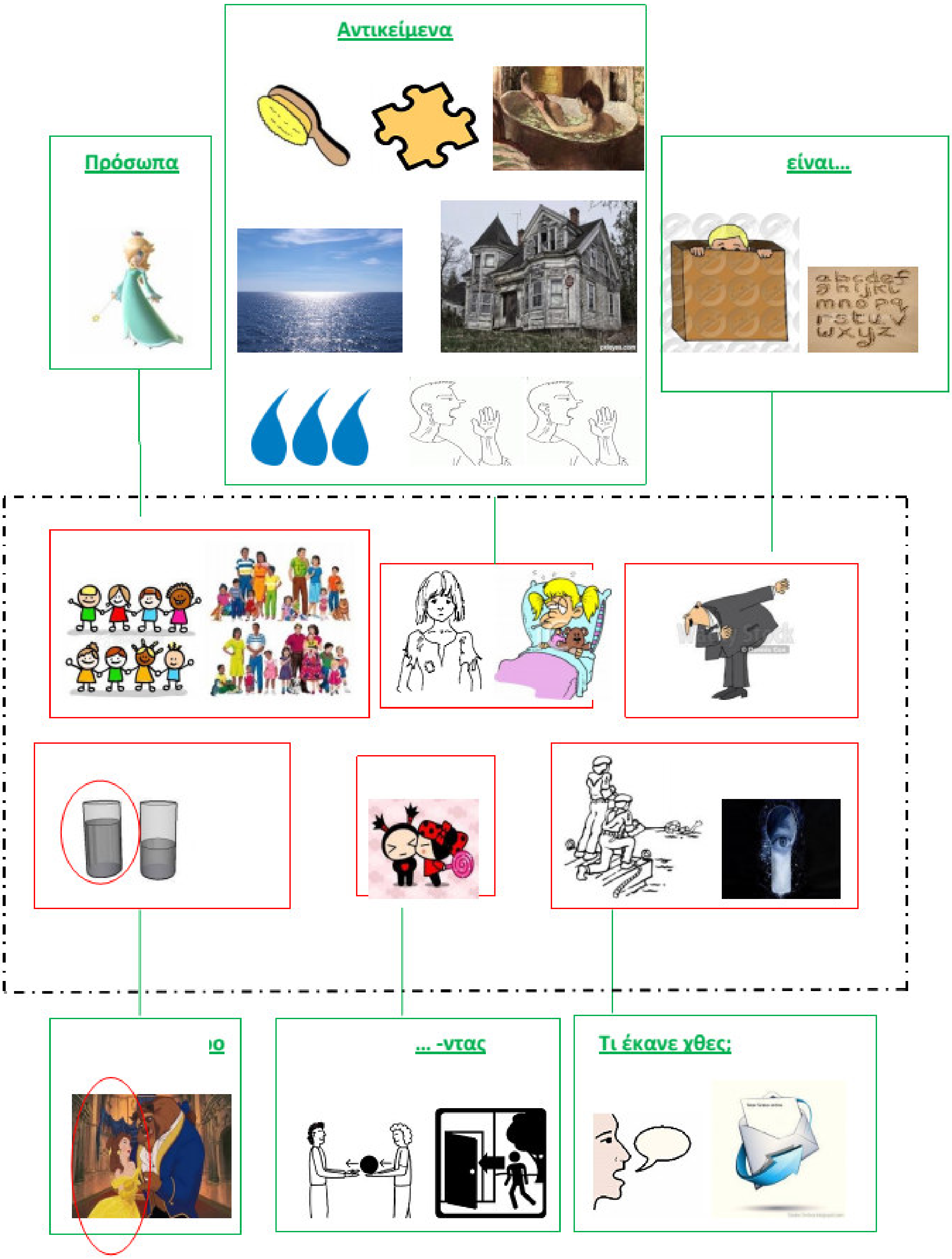
Appendix B9

The Passage Completion Task: Greek Version

Ο Σπύρος μας *είπε* χθες ότι τον έβγαλαν στις *ειδήσεις* γιατί νίκησε στο μαθητικό διαγωνισμό μαθηματικών. Η φωτογραφία, που *είδα* εγώ, ήταν από την *εκκίνηση* του διαγωνισμού, όπου ο Σπύρος χαιρετούσε *φιλώντας* το μολύβι του για γούρι! Μετά μάθαμε ότι το μολύβι ήταν *δανεικό* από το θείο του, που είναι κι αυτός πρωταθλητής μαθηματικών, *αλλιώς* ο Σπύρος δεν θα πήγαινε να γράψει. Πήρε μαζί του και άλλα τυχερά πράγματα, όπως μια *βούρτσα* που έχει από μωρό, και τη *συλλεκτική* του φανέλα στους *ώμους*. Πετούσε στα *ύψη* από τη χαρά του και *δίνοντας* το *έγγραφο* στο δάσκαλο, δήλωσε πως *έμμεσα* στους φίλους του όφειλε το ότι δεν *«κάηκε»* στο διαγωνισμό παρά τα σοβαρά *λάθη* που έκανε στις ασκήσεις.

Appendix B10

Example of the Pictures Used for the Text Composition Task: Greek Version



APPENDIX C

Greek Grammar

Appendix C1

A Classification System for Nominal Inflection Classes in Greek (Ralli, 2003)

Inflection class 1: Stems *anθrop* "man" (masculine)
psif "vote" (feminine)

	Singular	Plural
Nominative	anθropos	anθropi
Genitive	anθropu	anθropon
Accusative	anθropo(n)	anθropus
Vocative	anθrope	anθropi

Inflection class 2: Stems (all masculine):*

tamia	~	*tami*	"cashier"
maxiti	~	*maxit*	"fighter"
papa	~	*papað*	"priest"
papu	~	*papuð*	"grand father"
kafe	~	*kafeð*	"coffee"
bakali	~	*bakalið*	"grocer"

	Singular	Plural
Nominative	maxitis	maxites
Genitive	maxiti	maxiton
Accusative	maxiti	maxites
Vocative	maxiti	maxites

Inflection class 3: Stems (all feminine):

mitera	~	*miter*	"mother"
avli	~	*avl*	"yard"
alepu	~	*alepuð*	"fox"
mama	~	*mamað*	"mummy

	Singular	Plural
Nominative	avli	avles
Genitive	avlis	avlon
Accusative	avli	avles
Vocative	avli	avles

Inflection class 4: Stem: *poli ~ pole* "city" (feminine)**

	Singular	Plural
Nominative	poli	polis
Genitive	polis/poleos	poleon
Accusative	poli	polis
Vocative	poli	polis

Inflection class	**5:** Stems (all neuter):	*vun*	"mountain"
	6:	*spiti*	"house"
	7:	*kratos*	"state"
	8:	*soma ~ somat*	"body"
		plisimo ~ plisimat	"washing"

	Singular				Plural			
Nom.	vuno	spiti	kratos	soma	vuna	spitia	krati	somata
Gen.	vunu	spitju	kratus	somatos	vunon	spitjon	kraton	somaton
Acc.	vuno	spiti	kratos	soma	vuna	spitja	krati	somata
Voc.	vuno	spiti	kratos	soma	vuna	spitja	krati	somata

(i-> j / ---- vowel
[- stress]

Appendix C2

Endings of Main Types of Greek Verbs in Active and Passive Voice (adapted from Clairis & Babiniotis, 1996)

		1st conjugation		*2nd conjugation type A*		*2nd conjugation type B*	
Active voice :	Person	Sg.	Pl.	Sg.	Pl.	Sg.	Pl.
Present	1st 2nd 3rd	΄-ω ΄-εις ΄-ει	΄-ουμε ΄-ετε ΄-ουν	-ώ -άς -άει	-άμε -άτε -ούν	-ώ -είς -εί	-ούμε -είτε -ούν
Imperfect	1st 2nd 3rd	΄--α ΄--ες ‘--ε	΄-αμε ΄-ατε ΄--αν	-ούσα -ούσες -ούσε	-ούσαμε -ούσατε -ούσαν	-ούσα -ούσες -ούσε	-ούσαμε -ούσατε -ούσαν
Simple/ Continouus Future	1st 2nd 3rd	΄-ω ΄-εις ΄-ει	΄-ουμε ΄-ετε ΄-ουν	΄-ω ΄-εις ΄-ει	΄-ουμε ΄-ετε ΄-ουν	΄-ω ΄-εις ΄-ει	΄-ουμε ΄-ετε ΄-ουν
Simple past	1st 2nd 3rd	΄--α ΄--ες ΄--ε	΄-αμε ΄-ατε ΄--αν	΄--α ΄--ες ΄--ε	΄-αμε ΄-ατε ΄--αν	΄--α ΄--ες ΄--ε	΄-αμε ΄-ατε ΄--αν
Perfect	1st 2nd 3rd	(auxiliary verb “έχω” + infinitive ΄-ει) ΄-ω ΄-εις ΄-ει	 ΄-ουμε ΄-ετε ΄-ουν	(auxiliary verb “έχω” + infinitive ΄-ει) ΄-ω ΄-εις ΄-ει	 ΄-ουμε ΄-ετε ΄-ουν	(auxiliary verb “έχω” + infinitive ΄-ει) ΄-ω ΄-εις ΄-ει	 ΄-ουμε ΄-ετε ΄-ουν
Pluperfect	1st 2nd 3rd	(auxiliary verb “είχα” + infinitive ΄-ει) ΄--α ΄--ες ΄--ε	 ΄-αμε ΄-ατε ΄--αν	(auxiliary verb “είχα” + infinitive ΄-ει) ΄--α ΄--ες ΄--ε	 ΄-αμε ΄-ατε ΄--αν	(auxiliary verb “είχα” + infinitive ΄-ει) ΄--α ΄--ες ΄--ε	 ΄-αμε ΄-ατε ΄--αν
Imperfective imperative	2nd	΄--ε/΄-ε	΄-ετε	΄-α	-άτε	- - - - -	-είτε
Perfective imperative	2nd	΄--ε/΄-ε	΄-(ε)τε	΄--ε	΄-τε	΄--ε	΄-τε
Gerund		΄-οντας		-ώντας		-ώντας	
Passive voice:		Sg.	Pl.	Sg.	Pl.	Sg.	Pl.
Present	1st	΄-ομαι	-όμαστε	-ιέμαι	-ιόμαστε	-ούμαι	-ούμαστε

	2nd 3rd	´-εσαι ´-στε ´-εται ´-ονται	-ιέσαι -ιέστε -ιέται -ιούνται	-είσαι -είστε -είτε -ούνται
Imperfect	1st 2nd 3rd	-όμουν -όμασταν -όσουν -όσασταν -όταν ´-ονταν	-ιόμουν -ιόμασταν -ιόσουν -ιόσασταν -ιόταν -ιούνταν	-ούμουν -ούμασταν -ούσουν -ούσασταν -ούνταν -ούνταν
Simple/ Continouus Future	1st 2nd 3rd	-ώ -ούμε -είς -είτε -εί -ούν	-ώ -ούμε -είς -είτε -εί -ούν	-ώ -ούμε -είς -είτε -εί -ούν
Simple past	1st 2nd 3rd	´-ηκα -ήκαμε ´-κες -ήκατε ´-ηκε ´-ηκαν	´-ηκα -ήκαμε ´-κες -ήκατε ´-ηκε ´-ηκαν	´-ηκα -ήκαμε ´-κες -ήκατε ´-ηκε ´-ηκαν
Perfect	1st 2nd 3rd	(auxiliary verb “έχω” + infinitive ´-ει) ´-ω ´-ουμε ´-εις ´-ετε ´-ει ´-ουν	(auxiliary verb “έχω” + infinitive ´-ει) ´-ω ´-ουμε ´-εις ´-ετε ´-ει ´-ουν	(auxiliary verb “έχω” + infinitive ´-ει) ´-ω ´-ουμε ´-εις ´-ετε ´-ει ´-ουν
Pluperfect	1st 2nd 3rd	(auxiliary verb “είχα” + infinitive ´-ει) ´--α ´-αμε ´--ες ´-ατε ´--ε ´--αν	(auxiliary verb “είχα” + infinitive ´-ει) ´--α ´-αμε ´--ες ´-ατε ´--ε ´--αν	(auxiliary verb “είχα” + infinitive ´-ει) ´--α ´-αμε ´--ες ´-ατε ´--ε ´--αν
Imperfective imperative		- - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - - - -
Perfective imperative	2nd	´-ου -είτε	´-ου -είτε	´-ου -είτε

Note. Obtained from (Diamanti, 2005, pp. 108-109)

APPENDIX D

Appendix D1

Example of Information Sheet (English Version)

Researcher: PhD Candidate Anna Tsakalaki
Email: [email address here]
Telephone: [telephone number here]
Supervisors: [names and email addresses of supervisors here]

Dear Head Teacher,

My name is Anna Tsakalaki and I am a PhD researcher in the Institute of Education, University of Reading. I am conducting a research project as part of my PhD studies, which is looking at the learning of writing and spelling in English language for elementary students. More specifically, the project will investigate what impact different spelling tasks might have on the children's spelling performance**.** For this purpose, randomly selected students of Years 3, 4, 5 and 6 will be invited to take part in this research and I would be very grateful if you would give me permission to conduct this study in your school, if the children and their parents respond positively to the invitation.

What is the study?
Writing and spelling are as important as reading, but at the same time they are much more demanding. Thus, many students find text writing and spelling more difficult even though they might perform well in reading. This study will look at the spelling performance of students in specific writing and spelling tasks, which have been/will be designed by the researcher for this use. In particular, the study will aim to detect the most common spelling errors that can be produced in English language by children of this age. It will focus on detecting particular difficulties arising when writing in English, as according to researchers, children make different spelling errors as they grow older.

Time and place of the study.
The study will involve one set of cognitive tests given at two separate points: one at the beginning of the school year 2012-2013 and one later on in the same school year at times convenient for the school. The tests will involve the children in some short writing/spelling activities that will be conducted in 2-3 sessions of 20 minutes each, at each research phase. The research will be carried out by me. I have full CRB clearance and I am a teacher myself. The children will work on the activities in groups and individually in the premises of the school. These activities will be arranged to take place during lesson time, however in a way that will ensure that students do not miss any important classroom work. There will be no cost to the school.

What is the impact of the study?
It is anticipated that the findings of this study will be useful to answer important questions on how spelling is learnt not only for the interest of the teachers of this school, but also for parents and every

professional working with writing in English language. Hopefully this study will also encourage more research and information on this important topic.

What will happen to the data?
Any data collected will be held in strict confidence and no real names (schools, children or staff) will be used in this study or in any subsequent publications. The records of this study will be kept private. No identifiers linking the teacher or the school to the study will be included in any sort of report or academic paper that might be published based on the data. Research records will be stored securely in a locked filing cabinet and on a password-protected computer and only me and my supervisors will have access to the records. The data will be destroyed securely after 5 years once the findings of the research have been written up.

The school's, the parents' and the children's decision to participate is entirely voluntary. Also, you are all free to withdraw your consent at any time, without giving a reason, by contacting me or my supervisors using the details above, if a child, parent or the school wishes to withdraw from the study.

This application has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct. The parents/carers will be informed of the study and of the school's participation in it with a separate information sheet (see enclosed).

Please indicate whether you are willing to give consent for your school to take part in this project by completing the enclosed Consent Form and returning it to me. I very much hope that you will be willing to contribute to this project, which I feel will be of value to the broadening of our knowledge about the important topic of spelling skills acquisition in English language.

If you have any queries or wish to clarify anything about the study, please feel free to contact us.

Yours sincerely,

The Research Team
PhD Candidate Anna Tsakalaki
[Names of Supervisors here]

Appendix D2

Example of Consent Form (English Version)

<u>Head Teacher Consent Form</u>

I have had explained to me the purposes of the project and any questions have been answered to my satisfaction. I agree to the arrangements described in the Information Sheet in so far as they relate to my providing permission for the materialisation of this study.

I understand that the children will be given some short cognitive and separate spelling tasks in two research periods.

I understand that the children's participation is entirely voluntary and that they (and their parents/carers) have the right to withdraw from the project at any time, without giving reason and without repercussions.

I have received a copy of the Consent Form and accompanying Information Sheet

Please tick as appropriate:

I consent to the [Name] School's participation in the study: ☐

Name:

Signed:

Date:

This application has been reviewed following the procedures of the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.