# Learning to read Greek

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## 1 Introduction
### 1.1 Greek and its Orthography

Greek (in Greek: *ελληνικά* /elinika/) is spoken by an estimated total of thirteen million people worldwide, including Greece, where it is the national language, and expatriates in many other countries[1]. It is written with the Greek script, a "true alphabet" from its beginnings many centuries ago (ca. 740 B.C.E.; Threatte, 1996), which was derived from the Phoenician script (Swiggers, 1996; Voutyras, 2001) and adopted for the ancient Greek dialects in archaic times (Karali, 2001).

### 1.2 Synchronic and Diachronic Characterization

Standard Modern Greek is a descendant of Koine, the language of the hellenistic era, lying on the Greek branch of the Indoeuropean family of languages (Tonnet, 1995). Attempts to "purify" the language towards ancient attic resulted in *katharevousa* forms, leading to problems of diglossia in recent centuries. Today the spoken language has settled near the southern regional dialects of the ottoman and modern era, enriched with a wealth of loan words and minor grammatical innovations. Modern "demotic" Greek (with elements of katharevousa) was officially adopted by the Greek state in 1976 (Holton, Mackridge, & Philippaki-Warburton, 1997). See Christidis (2001, 2007) for a history of the ancient language up to the Hellenistic years, Tonnet (1995) for a discussion of the trajectory from the Koine towards the modern language, Petrounias (2002) for recent developments, and Mackridge (2009) for the associated sociolinguistic saga.

Very briefly, through the millennia since the classical era Greek has become more analytic, with fewer grammatical types and classes and somewhat more restrictive word order. The phonetic repertoire has expanded in consonants and diminished in vowels. Orthography has not followed the phonetic evolution, resulting in a system rife with spelling ambiguities, as phonetic shifts and neutralizations have taken place in the context of relatively stable spelling. As a result, there are several ways to spell certain phonemes, permitting lexical disambiguation through complex spelling patterns.

A number of reforms and attempted reforms of the spoken and written language have punctuated the evolution of Greek from ancient through modern times (Tonnet, 1995; Petrounias, 2002). The adoption of demotic in 1976 was followed by a spelling reform in 1981 in which Hellenistic breathing and pitch accent marks no longer relevant in contemporary pronunciation were officially abolished, replacing *polytonic* (multi-accent) spelling with the *monotonic* (single-accent) system, in which only a single stress diacritic remained. Additional reforms are still proposed, on a variety of grounds, or said to be imminent (e.g., Tzakosta, 2012; Tzakosta, Christianou, & Kalisperaki, 2011).

### 1.3 Literacy and Schooling

The Greek educational system is highly centralized via a compulsory national curriculum that applies to every accredited school, public or private. The national curriculum lists detailed educational goals and methods along a specific progression of instructional units

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[1] http://www.ethnologue.com/language/ell

through preschool, elementary, and secondary education. By law, all children begin Grade 1 in the year of their sixth birthday. Pre-kindergarten attendance (at 4 years of age) is optional but starting with kindergarten, at 5 years of age, attendance is mandatory through the ninth grade (third grade of junior high school), for a total of ten years of compulsory education (K-9). Primary school attendance has been compulsory since the early days of the modern Greek state but actual attendance in the 1830s was very low and limited to 2–3 years (Hadjistefanidis, 1990). It has reached 97% in recent decades, with large disparities between major cities and rural areas (Panaretos et al., 1995). Compulsory attendance of Kindergarten for all children was introduced in the 2007-2008 school year (Manolitsis & Tafa, 2011); prior to that Kindergarten attendance was about 50% (Panaretos et al., 1995).

As described by Aidinis (2012), the Kindergarten language arts curriculum includes early literacy activities capitalizing on home experience to develop skills, knowledge, and concepts. Children are encouraged to read and write and are presented with a variety of texts, contexts, and opportunities, without systematic teaching of phonics. Manolitsis and Tafa (2011) relate the current emergent literacy activities to the 2003 reform of the National Kindergarten Curriculum, which put emphasis on alphabet letters and phonological awareness without teaching the children to read and write.

In first grade, children are taught to read using systematic phonics instruction through an *analytic-synthetic* method (Aidinis, 2012) with syllabic and suprasyllabic elements. This includes teaching of letter shapes and sounds, articulation and blending drills, and emphasis on decoding at the single-word level. Children begin to write texts by the second semester of Grade 1. Most children can read simple words by February of Grade 1. Long and complex words and pseudowords are mastered by the majority of children by Grade 3 or earlier.

The overall instruction approach is evidently effective: In a comparison to Cypriot children[2], who were taught using a whole-language approach, Greek children in Grade 1 were significantly better in pseudoword decoding and other phonological and cognitive tasks (but not in real word reading accuracy) (Papadopoulos, 2001).

## 2 Description of Greek and its Written Forms

Greek is a language with average-size vowel and consonant inventories, complex syllable structure, and lexical stress. It is strongly suffixing and fusional with respect to inflectional morphemes, SVO/VSO with respect to the dominant order of subject, verb, and object, and uses prepositions (preceding the noun phrase) (Dryer et al., 2011).

### 2.1 Linguistic System

#### 2.1.1 Phonology

The Greek phonemic inventory includes five vowels. There is no consensus as far as consonants are concerned: Their number ranges from 15 to 31 depending on the theoretical and empirical criteria applied by different researchers, (cf. Holton et al. 1997; Holton,

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[2] Studies in both Greece and Cyprus are included in this chapter. Standard Greek is the language spoken throughout Greece at homes, with minor dialectic variation, and the sole language of administration and education. In contrast, in Cyprus the home language is Cypriot Greek, a dialect with no standardized or written form, but the language of administration and education is very similar to standard Greek, in a situation of diglossia (Hadjioannou, Tsiplakou, & Kappler, 2011). There are differences between standard and Cypriot Greek in most linguistic domains and the two dialects are not entirely mutually intelligible (see discussion and references in Arvaniti, 2006, 2010). Although many phonological awareness tasks may be largely equivalent when used in Greece and Cyprus, it might be kept in mind that Cypriot children are taught and tested in a nonnative linguistic system.

Mackridge, Philippaki-Warburton, & Spyropoulos, 2012; Klairis & Babiniotis, 2004; Mennen & Okalidou, 2006; Okalidou, 2008; see Arvaniti, 2007; and Petrounias, 2002, for extensive discussions). It seems that twenty-six consonants are phonetically distinctive and require individual treatment in artificial speech synthesis (Bakamidis & Carayannis, 1987) and in tracking phonological development (e.g., Mennen & Okalidou, 2006). This set includes six palatal consonants (Petrounias, 2002) and two affricates (Tzakosta & Vis, 2009) and is most likely the relevant inventory for the child becoming phonologically aware.[3]

| b | d | ɟ | g | p | t | c | k | v | ð | z | j | ɣ | f | θ | s | ç | x | m | n | ɲ | l | ʎ | r | ts | dz |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|----|
| a | e | i | o | u |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |    |

        Greek has relatively few monosyllables, most of which are closed-class (grammatical) words or otherwise atypical (e.g., recent loans from English, acronyms and abbreviations). Mean word length is 5.4 letters, 5.0 phonemes, 2.4 syllables, by token count (Protopapas, Tzakosta, Chalamandaris, & Tsiakoulis, 2012). With a few exceptions, content words are multisyllabic and bear lexical stress. A relative majority (28%) of all words is stressed on the penultimate syllable (Protopapas, 2006). Syllables are predominantly open (estimated at 86%; with CV accounting for 56% and V for 17%; Protopapas, Tzakosta, et al., 2012) with only a few codas permitted, mainly /n/ and /s/. A variety of complex onset clusters are allowed (Holton et al., 1997), ranging on a continuum of acceptability (Tzakosta & Karra, 2011), with two or three consonants being relatively common (estimated at 15% of syllable tokens).  A corpus-based analysis suggests that approximately 900 syllables account for 99% of all syllable tokens, whereas the total number of different syllables appearing at least once in the corpus is less than 2000.

## 2.1.2 Inflectional morphology

        Greek is characterized by an extensive system of inflectional morphology. Nouns and adjectives are inflected for gender, number, and case. There are three genders (masculine, feminine, and neuter, for adjectives; each noun belongs to a single gender), two numbers (singular and plural), and four cases (nominative, genitive, accusative, and vocative). Some of the corresponding inflectional suffixes are phonologically identical (homonymous). Masculine nouns and adjectives have up to seven distinct forms (suffixes) whereas feminine and neuter ones have only four.

        Verb forms include a stem and an inflectional ending, both of which may be simple or complex (Ralli, 2003). An *augment* prefix is added to certain past tense forms. Verb inflections involve stem changes, suffixes, and a variety of particles indicating moods and modalities. There is a basic set of 48 word forms for each verb, 24 for each of two voices (active and non-active), including two aspects (perfective and imperfective), two tenses (past and non-past), two numbers, and three persons. In addition, there are up to four imperative forms for each voice. These word forms are combined with particles and auxiliaries to form the complete structure of verb types (see Holton et al., 1997, 2012, and Klairis & Babiniotis, 2004, for comprehensive descriptions). Homonymy among verb forms is very limited.

        Distinct inflectional classes (verb conjugations and nominal declensions) are recognized both in verbs and in nouns/adjectives. Ralli (2003, 2005) postulates eight general noun declensions, not distinguished by gender, whereas Holton et al. (1997, 2012) list more than twenty noun classes, classified by gender, and twelve adjective classes, plus variants and exceptions. Two major verb conjugations are generally recognized. Stem variation is present in both verbs and nouns/adjectives, with different *allomorph* stems used in different contexts (e.g., perfective vs. imperfective aspect, for verbs, and singular vs. plural, for nouns; Ralli, 2003).

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[3] In addition, the velar nasal /ŋ/, though nondistinctive, is associated with specific orthographic patterns and appears in transparency analyses.

### 2.1.3 Word formation processes

Word formation in Greek includes systematic derivational processes, especially for nouns (based on verb stems) and adjectives (based on verb and noun stems). A variety of derivational suffixes has been described in the literature (Ralli, 2003), ranging from one to three syllables long. There is a much richer variety (an order of magnitude) of derivational suffixes producing nouns and adjectives, compared to verbs (cf. the tables of suffixes in Papanastasiou, 2008, pp. 303–317, or Ralli, 2005, pp. 147–153). Prefixation, both with bound and free morphemes, is also extensive in Greek and produces a variety of verbs, nouns, and adjectives (Papanastasiou, 2008; Ralli, 2003). Derivational affixes often carry their specific stress pattern, systematically affecting derived words (Revithiadou, 1999).

Compounding is a highly productive process in Greek whereby new adjectives, nouns, verbs can be created from existing stems and words (Ralli, 2005; including bound stems appearing only in compounds; Ralli, 2003). The semantics of compounds may be transparent or noncompositional. Stress rules apply in compound formation; moreover, a linking vowel is inserted between the two constituents under certain morphophonological conditions. See Ralli (2003, 2005) for more information.

## 2.2 Writing System

### 2.2.1 Script and punctuation

Modern Greek uses twenty-four letters, which come in uppercase and lowercase variants, plus a lowercase-only variant for word-final sigma. Seven letters correspond to vowels in isolation, namely α, ε, η, ι, o, υ, ω. In lowercase, stress is marked on the vowel of the stressed syllable with an acute accent. A diaeresis diacritic is used to indicate that an iota or upsilon does not constitute a digraph with the preceding letter but stands on its own (e.g., εϊ, αϋ; also on uppercase: Ϊ, Ϋ; combined with stress: ΐ, ΰ).

| Α | Β | Γ | Δ | Ε | Ζ | Η | Θ | Ι | Κ | Λ | Μ | Ν | Ξ | Ο | Π | Ρ | Σ | Τ | Υ | Φ | Χ | Ψ | Ω |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| α | β | γ | δ | ε | ζ | η | θ | ι | κ | λ | μ | ν | ξ | o | π | ρ | σ ς | τ | υ | φ | χ | ψ | ω |

Greek punctuation is similar to other European languages with the exception of the semicolon (;) which is used as a question mark, while *ano teleia* (the upper dot of the colon) plays the role of the semicolon. Period, comma, exclamation point, parentheses, and apostrophe have similar shape and function to their English equivalents. Quotation marks appear as double angle brackets (« »). The hyphen is used to break words at the end of a line. It also appears in certain multi-word compounds though not as extensively as in English. For more details, examples, and additional rare symbols and uses, see Papanastasiou (2008, chapter 13).

### 2.2.2 Orthography

Letters and letter combinations correspond to phonemes in a largely systematic manner. Petrounias (2002) described a set of mappings allowing graphophonemic and phonographemic transcription. A "rule" system derived from these mappings achieves word-level regularity of reading around 95% (Protopapas & Vlahou, 2009), indicating that phonemes can be determined from letter sequences in the great majority of cases. There is no comparable estimate of spelling regularity.

Greek orthographic transparency is convenient to analyze because the string of phonemes making up each word corresponds to a string of letters or contiguous letter groups in the same order without gaps or jumps. Every orthographic string can be segmented into phoneme-size chunks, termed *graphemes*, when the corresponding phoneme string is known. The consistency of Greek orthography has been calculated at about 95% for reading (i.e., 95% of individual grapheme tokens map to their most frequent phoneme) and about 80% for spelling. There are 84 graphemes in a total of 118 graphophonemic mappings. See Protopapas and Vlahou (2009) for tables of mappings and frequencies.

Of the 84 graphemes, 36 consist of a single letter and cumulatively account for 91.1% of phoneme tokens, 37 are composed of two letters (digraphs) and account for 8.9%, and 11 are three letters long and account for only 0.01%. Thus the great majority of mappings involve single letters to single phonemes or vice versa, even though not all of them are either consistent or predictable.

Here are a few frequent word examples: *λέξη*→/leksi/ 'word'; *κάτι*→/kati/ 'something'; *και*→/ce/ 'and'; *είναι*→/ine/ 'is'; *γιατί*→/jati/ 'why'; *πολύ*→/poli/ 'much'; *αυτά*→/afta/ 'these'; *παιδιά*→/peðja/ 'children'; *μου*→/mu/ 'my'; *μπορείς*→/boris/ 'you can'. These spelling patterns are not uncommon and exemplify many features of the Greek orthographic system, including mostly single-letter graphemes and a variety of complexities and inconsistencies. For example, /b/ is spelled with the digraph *μπ*, *κ* corresponds to both /k/ and /c/ in different contexts, *ξ* spells the phoneme pair /ks/, both *γι* and *ι* (and other graphemes) can map to /j/, /e/ can be spelled with *ε* or *αι*, /i/ can be spelled with *η, ι, υ, ει* (and other digraphs), and *υ* can map to the vowel /i/ or the consonant /f/, or to /u/ as part of the *ου* digraph. Still, almost all mappings from letters to phonemes are predictable, even though the reverse mappings (from phonemes to letters) are less so.

In addition to these complexities, there is a genuinely ambiguous orthographic pattern, which occurs in every case of a consonant letter followed by a letter or letter sequence that can spell /i/ followed by a vowel. This *CiV* (consonant-i-vowel) pattern occurs in an estimated 7% of word tokens (18% of types; Protopapas & Vlahou, 2009). In every such case there are two possible readings: one that includes the /i/ phoneme and one without /i/. For example, the letter string *δια* can spell the single syllable /ðja/ (as in *σανίδια* /sa.ni.ðja/ 'planks') and the two-syllable string /ði.a/ (as in *σακίδια* /sa.ci.ði.a/ 'backpacks'). In real words the ambiguity is resolved lexically because readers know which of the two readings corresponds to a word. In rare cases both readings are words, constituting homographs. None of the two alternatives is irregular, as both are used productively in pseudoword reading (Protopapas & Nomikou, 2009).

The diacritic placed on the vowel of the stressed syllable is obligatory on every word with two or more syllables. It is not allowed on monosyllables except in a few prescribed cases. This makes it perfectly regular for the speller but is sometimes at odds with phonological stress (Petrounias, 2002). The stress diacritic resolves ambiguities between minimal stress pairs, such as *μέτρο* 'meter' – *μετρό* 'metro'. However, the necessity of the diacritic for lexical disambiguation has been estimated at less than 1% and possibly well below that taking context into account (Protopapas, 2006).

Morphology has extensive orthographic consequences insofar as derivational and grammatical suffixes are associated with specific spellings, which also serve to disambiguate homonyms. For example, in a certain class of adjectives, singular feminine nominative and accusative both end in /i/, like plural masculine nominative and vocative, but the singular suffixes are spelled with *η* whereas the plural ones are spelled with *οι*. Similarly, some verb suffixes are distinguished orthographically. For example, a final /e/ is found in several forms but is spelled with *ε* in some cases and *αι* in others. Thus homonymy and partial homography are not completely overlapping. Knowledge of the inflectional type is often required for correct spelling of adjective, noun, and verb suffixes.

## 2.3 Conclusions

The complexities of Greek spelling are a consequence of the phonetic evolution of the spoken language through the centuries. As the vowel inventory has diminished, distinctions have been neutralized. Therefore, letters and letter combinations used to denote different vowels or diphthongs in ancient Greek are now used as alternative spellings for the same vowel. In contrast, the consonant repertoire has expanded. As a result, there are not enough letters to spell all the modern consonants, necessitating digraphs and context-sensitive

combinations. The neutralization of phonologically double consonants has left behind additional relics of "historic orthography" in the form of letter doubling lacking synchronic motivation.

The combination of these factors has resulted in a situation in which individual phonemes map onto more than one spelling pattern each. The reverse is less common insofar as most individual graphemes map onto a single phoneme. In other words, the sets of multiple alternative spelling patterns of different phonemes are largely mutually exclusive. Setting aside the issue of frank ambiguities (CiV), this situation makes reading highly predictable. As far as spelling is concerned, difficulties arise from having to choose from a set of alternatives but the consequences of erroneous choices are phonologically neutral, that is, the word may be orthographically incorrect but remains phonologically as intended. Thus, the orthographic system makes it difficult to produce the correct spelling but easy to produce the intended phoneme string. The ease of learning to read accurately and the very low rate of phonological spelling errors, as documented below, are both consistent with these properties of the orthography.

## 3 Acquisition of Reading and Spelling in Greek

Learning to read and spell in Greek has been studied since the eighties (see Porpodas 1999, 2002) and continues at an increasing rate, driven primarily by the pragmatic needs of educators and observations on children manifesting severe and persistent difficulties.

### 3.1 Becoming Linguistically Aware

#### 3.1.1 Phonological development and phonological awareness

Greek children acquire most phonemes by four and a half years of age. The full inventory is acquired by six years, including all two-element consonant clusters and most three-element clusters in word-initial position (Mennen & Okalidou, 2006; Papathanasiou, Dimitrakopoulou, Ntaountaki, & Vasiliou, 2012).

Children become phonologically aware in preschool and by Grade 1 they are generally thought to exhibit adequate phonological processing. Precocious readers enter school with a phonological awareness advantage, which may dissipate by the end of Grade 2 (Papadopoulos, Kendeou, Ktisti, & Fella, 2012; Tafa & Manolitsis, 2008; cf. Tafa & Manolitsis, 2012). Syllabic awareness appears earlier than phonemic awareness but they subsequently develop in parallel (Papadopoulos, Kendeou, & Spanoudis, 2012) and both predict reading independently (Aidinis & Nunes, 2001; Papadopoulos, Spanoudis, & Kendeou, 2009). Studies have examined the sequence of phonological awareness skills over a wide combined age range (3 years and 10 months to Grade 3). Syllable segmentation and blending are among the easiest tasks, in which performance approaches ceiling by mid-Kindergarten. Rhyme identification, syllable matching and initial and final phoneme matching exceed floor performance in Kindergarten and continue to improve in Grade 1. Phoneme segmentation, elision, and blending exhibit rapid development, from floor Kindergarten performance to near ceiling by the end of Grade 1. Syllable and phoneme transposition do not approach ceiling before Grade 3 (Aidinis, 2007, 2012; Giannetopoulou, 2003; Papadopoulos, Kendeou, & Spanoudis, 2012; Papadopoulos, Spanoudis, & Kendeou, 2009).

The relative difficulty of these tasks may depend on specific properties of the materials. The aforementioned studies used short items, composed of mostly open syllables with simple onsets. When task demands are increased, using long pseudowords with consonant clusters, reliable performance differences in phoneme deletion can be detected in Grades 3–4 (Protopapas, Skaloumbakas, & Bali, 2008) and, in children with reading difficulties, through secondary education (Anastasiou & Protopapas, 2014; Protopapas & Skaloumbakas, 2007).

The dimensionality of phonological awareness has received some research attention. One set of studies has resulted in a structure of three correlated factors distinguishing performance in *base level*, *epi-phonological*, and *meta-phonological* tasks (Aidinis, 2007, 2012). Other researchers have argued in favor of an overall unidimensional trajectory, augmented by nested factors accounting for residuals in phonemic and supraphonemic sensitivity skills (Papadopoulos, Spanoudis, & Kendeou, 2009; Papadopoulos, Kendeou, & Spanoudis, 2012).

**3.1.2 Morphological development and morphological awareness**

Research in morphological development and awareness remains limited. It is generally thought that by the age of entering elementary education most children have mastered the inflectional paradigms of the language to a large extent, at least as far as the suffixes with orthographic consequences are concerned (i.e., case, gender, and number, for adjectives and nouns, and person and number, for verbs). Normally developing Kindergarten children approach ceiling performance in the production of verb past tense and noun gender, number, and case (Mastropavlou, 2006) although persistent difficulties with verb aspectual formation and noun gender are observed in certain word classes with unusual properties (Stavrakaki & Clahsen, 2009; Varlokosta & Nerantzini, in press-a, in press-b). Thus morphological acquisition is largely but not entirely completed by Grade 1.

The study of metamorphological skill is still in its infancy. Nunes, Aidinis, and Bryant (2006) published a battery of morphological awareness tasks and presented only their predictive power for spelling (see also Aidinis & Paraschou, 2004; Bryant, Nunes, & Aidinis, 1999; Harris & Giannouli, 1999; but cf. Pittas & Nunes, in press). Aidinis and Dalakli (2006) tested children with morphosyntactic tasks such as grammaticality judgment, word order reconstruction, and number/tense transposition. They found that performance increased from Grade 1 to Grade 2 but was still well below ceiling. This is interpreted as ongoing morphosyntactic development, considering that Grade 6 children approached ceiling on these tasks (Aidinis & Paraschou, 2004).

Several researchers have noted the potential importance of morphological awareness for the development of reading and spelling skills (but its unique contribution remains equivocal, cf. Pittas & Nunes, 2014; Rothou & Padeliadu, 2014). Morphological knowledge is sometimes surmised on the basis of postulating spelling strategies by qualitative analysis of children's spellings (e.g., Chliounaki & Bryant, 2002, 2007; Diakogiorgi, Baris, & Valmas, 2005; Diamanti, Goulandris, Stuart, & Campbell, 2014). In a related vein, Tsesmeli & Koutselaki (2013) found that semantic understanding of compounds is related to their correct spelling.

**3.2 Development of Word Identification**

Most Greek children enter school with some literacy background. By the end of kindergarten children know on average about half of the letters of the alphabet (Aidinis, 2006; Dalakli & Aidinis, 2010; Manolitsis & Tafa, 2011). About a third know no letters and about a quarter know all of the letters (Aidinis, 2006). Children are more familiar with uppercase than lowercase letters and with letter sounds than letter names, consistent with the emphasis on letter sounds and lack of teaching letter names.

According to Dalakli and Aidinis (2010; as cited in Aidinis, 2012), 55% of children at the end of Kindergarten (May) and 30% at the beginning of Grade 1 (September–October) cannot read any single words at all whereas 28% and 25%, respectively, cannot write at all. About 16% of children at the end of Kindergarten and 30% at the beginning of Grade 1 can read sentences fluently whereas 17% and 35%, respectively, can write alphabetically correct texts.

### 3.2.1 Word decoding development

According to Porpodas (2001, 2002), Greek children do not go through an initial logographic stage but approach reading directly by an alphabetic process. Letter knowledge and phonological awareness at or prior to school entry predict later word and pseudoword reading (Georgiou, Manolitsis, Nurmi, & Parrila, 2010; Georgiou, Torppa, et al., 2012; Harris & Giannouli, 1999; Mouzaki, Protopapas, & Tsantoula, 2008; Papadimitriou & Vlachos, 2014) whereas home literacy environment does not (Manolitsis, Georgiou, & Parrila, 2011). Phonemic awareness is concurrently correlated with word and pseudoword reading in the early grades (Porpodas, 1992, 1999) but its effects may diminish by Grade 3 (Porpodas, 2002; cf. Rothou & Padeliadu, 2014). Accurate phonological decoding (alphabetic reading) is observed before the end of Grade 1 (Porpodas, 1999, 2001), including children with difficulties (Porpodas, 2002). Although accuracy is not a major issue with reading difficulties (Nikolopoulos, Goulandris, & Snowling, 2003), individual differences in accuracy persist through elementary grades, at least to Grade 7 (Protopapas, Simos, Sideridis, & Mouzaki, 2012; Protopapas & Skaloumbakas, 2007; Protopapas, Skaloumbakas, & Bali, 2008).

Word accuracy and fluency develop rapidly throughout the elementary grades (see, e.g., tables for Grades 2–5 in Protopapas, Mouzaki, et al., 2013; Protopapas, Sideridis, et al., 2007). Fluency follows an almost linear trajectory through Grades 2–6, with little divergence between the most and least fluent children (Protopapas, Parrila, & Simos, 2014). Precocious readers enter school with a naming advantage and retain a fluency advantage through Grade 6 (Papadopoulos, Kendeou, Ktisti, & Fella, 2012; Tafa & Manolitsis, 2012). There is little evidence for a primarily sublexical (graphophonemic) mode of word recognition past the early stages; findings from a stress assignment study are consistent with effective sight-word reading by the end of Grade 2 (Protopapas & Gerakaki, 2009).

Reading fluency is concurrently and longitudinally predicted by rapid serial naming (digits, colors, and objects)[4] throughout the elementary grades. Strong concurrent correlations have been documented in Grades 1–6 (Antoniou & Patsiodimou, 2009; Georgiou, Papadopoulos, & Kaizer, 2014; Georgiou, Parrila, Cui, & Papadopoulos, 2013; Nikolopoulos et al., 2006; Protopapas, Altani, & Georgiou, 2013), increasing somewhat in higher grades. Moderate to strong longitudinal correlations have been reported from Kindergarten through Grade 10 (Georgiou, Manolitsis, et al., 2010; Georgiou, Papadopoulos, Fella, & Parrila, 2012; Georgiou, Papadopoulos, & Kaizer, 2014; Georgiou, Parrila, & Papadopoulos, 2008; Georgiou, Torppa, et al., 2012; Nikolopoulos et al., 2006). Articulation time (i.e., the total duration of articulated items) is more strongly related to reading fluency than pause time (i.e., the silent intervals between items), in contrast to English and Chinese (Georgiou, Aro, Liao, & Parrila, 2014; Georgiou, Parrila, & Liao, 2008), and increasingly over time (Georgiou, Papadopoulos, & Kaizer, 2014). It remains unclear whether the longitudinal contribution from RAN to reading goes beyond the autoregressive effect (cf. Georgiou, Papadopoulos, et al., 2012; Nikolopoulos et al., 2006).

Despite long-standing expectations that words and pseudowords might index separate domains or aspects of reading skills, studies show that word and pseudoword reading performance lies along the same dimensions of accuracy and speed (Protopapas, Simos, et al., 2012; Protopapas & Skaloumbakas, 2007; Protopapas, Skaloumbakas, & Bali, 2008; but see, Douklias, Masterson, & Hanley, 2009, for a different opinion).

Processing of the stress diacritic has been studied from Grade 2 through adulthood. Despite explicit teaching in Grade 1 the diacritic is not fully adhered to, especially in the

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[4] The lack of teaching letter names and the exclusive focus on letter sounds prevents early assessment using rapid naming of letters because children cannot respond fluently with the letter names, as required for the task.

early grades (Protopapas & Gerakaki, 2009). This is rarely noticed in word reading, presumably because children recognize the words from the letter sequence and pronounce them based on their knowledge of the correct stress pattern. In contrast, in pseudoword reading stress assignment errors (i.e., inconsistent with the diacritic) are prominent through Grade 7 (Protopapas, 2006; Protopapas & Gerakaki, 2009; Protopapas, Gerakaki, & Alexandri, 2006). Highly proficient adult readers make very few stress assignment errors and are delayed when the diacritic is misplaced; however, they are not affected by its omission (Protopapas, Gerakaki, & Alexandri, 2007).

### 3.2.2 Word spelling development

Five stages of spelling development are identified in Greek, including pre-alphabetic, partially alphabetic, fully alphabetic, transitional/morphographic, and fully developed or morpho-phonemic spelling (Aidinis, 2010a, 2012; Aidinis & Dalakli, 2006; Mouzaki, 2010a, 2010b). In each stage, a mixture of spelling strategies are employed, including invention, memory, analogy, and morphology (Aidinis, 2010a, 2012). Development of the morphological strategy is not yet fully acquired by Grade 6 (Aidinis, 2010b, 2010c). The developmental trajectory of spelling through Grades 2–6 exhibits evidence for divergence in performance between the highest and lowest performing children consistent with *Matthew effects* (Protopapas, Parrila, & Simos, 2014).

Children employ phonological recoding to spell as early as Grade 1, producing correct alphabetic spellings of words and pseudowords (Loizidou-Ieridou, Masterson, & Hanley, 2010; Porpodas, 1999, 2001; Sarris & Porpodas, 2012). Mnemonic strategies for orthographic spelling are employed at the end of Grade 1 (Sarris & Porpodas, 2012). Spelling performance is longitudinally predicted by phonological awareness from Kindergarten throughout elementary education (Diamanti, Ioannou, Mouzaki, & Protopapas, 2012; Georgiou, Manolitsis, et al., 2010; Georgiou, Torppa, et al., 2012; Harris & Giannouli, 1999; Mouzaki, Protopapas, & Tsantoula, 2008; Nikolopoulos, Goulandris, Hulme, & Snowling, 2006), even after controlling for earlier spelling skill. Spelling is also concurrently correlated with phonological and morphological awareness, controlling for age and verbal ability (Aidinis, 2010b; Aidinis & Dalakli, 2006; Aidinis & Nunes, 2001; Nunes, Aidinis, & Bryant, 2006; cf. Papadopoulos & Georgiou, 2010, for orthographic choice).

Phonological spelling errors, that is, errors resulting in words that would be pronounced differently from the intended word, are relatively rare in the general population and in children with difficulties (Aidinis & Paraschou, 2004; Andreou & Baseki, 2012; Loizidou-Ieridou et al., 2010; Nikolopoulos, Goulandris, & Snowling, 2003; Niolaki & Masterson, 2012; Protopapas, Fakou, Drakopoulou, Skaloumbakas, & Mouzaki, 2013).

Nonphonological errors make up the bulk of error counts for children with typical and impaired spelling performance alike. These include grammatical errors, that is, misspelled inflections of adjective, noun, and verb suffixes, and orthographic errors, namely, misspellings of word stems. The relative proportion of grammatical and orthographic errors remains controversial (cf. Aidinis, 2010b, 2010c; Aidinis & Paraschou, 2004; Protopapas, Fakou et al., 2013; Tzakosta et al., 2011). However, within-word comparisons are particularly challenging to interpret because the relative difficulty of different word parts cannot be independently controlled. Moreover, if there are several vowel phonemes in a stem than can be misspelled but only one in the inflectional suffix then it is not surprising that a higher absolute number of errors will be observed on the stem than on the inflection. Notably, verb inflections, which are more numerous and less consistent, are spelled less accurately than noun inflections (Diamanti et al., 2014; Tzakosta & Dimtsa, 2012). Errors on derivational morphemes are observed with elevated relative frequency (Diamanti et al., 2014; Protopapas, Fakou et al., 2013).

Morphological spelling, that is, spelling of grammatical suffixes, proceeds from indiscriminate early use of preferred spelling patterns to gradual enrichment of the orthographic repertoire with alternative spelling patterns.  Alternative spellings are initially mixed but are eventually used in the grammatically appropriate situations (Bryant, Nunes, & Aidinis, 1999; Chliounaki & Bryant, 2002; Nunes, Aidinis, & Bryant, 2006). Learning of grammatical spelling patterns is associated with specific word experience rather than abstract grammatical knowledge (Chliounaki & Bryant, 2007). An explicit morphological strategy can be detected by Grade 3 in the spellings of grammatical suffixes and lexical stems, which remains incomplete and continues to develop throughout the elementary grades (Aidinis, 2010b, 2010c).

Spelling of the stress diacritic is an area of protracted development, as children make many errors, almost exclusively omissions. A nonnegligible proportion of children fail to use the diacritic entirely in their writing, including normally developing readers in the early elementary grades as well as children with reading difficulties through secondary education (Anastasiou & Protopapas, 2014; Protopapas, Fakou, et al., 2013).

### 3.2.3 Reading and spelling difficulties

Although dyslexia is officially recognized in Greek law as one form of specific learning disability, there is no official definition and no widespread standardized assessment practice; it is typically diagnosed on the basis of a discrepancy between intellectual ability and nonstandardized measures of reading and spelling achievement (Anastasiou & Polychronopoulou, 2009).

Greek children with dyslexia exhibit deficits in phonological awareness, rapid automatized naming, word and pseudoword reading accuracy and speed, spelling, stress assignment, and verbal working memory, through primary and secondary education (Anastasiou & Protopapas, 2014; Constantinidou & Evripidou, 2012, Constantinidou & Stainthorp, 2009; Hatzidaki, Gianneli, Petrakis, Makaronas, & Aslanides, 2011; Protopapas & Skaloumbakas, 2007, 2008; Protopapas, Skaloumbakas, & Bali, 2008). They also exhibit more and longer fixations in their eye movements (Hatzidaki et al., 2011) but no systematic deficits in auditory processing (Georgiou, Papadopoulos, Zarouna, & Parrila, 2012; Georgiou, Protopapas, Papadopoulos, Skaloumbakas, & Parrila, 2010; Papadopoulos, Georgiou, & Parrila, 2012).

Timed measures of reading constitute the "crucial index" of difficulty in reading acquisition from the earliest stages of learning to read (Porpodas, 1999) throughout the middle elementary grades (Constantinidou & Stainthorp, 2009; Protopapas, Skaloumbakas, & Bali, 2008) and onto secondary education (Anastasiou & Protopapas, 2014; Protopapas & Skaloumbakas, 2007). Reading fluency, a measure combining accuracy and speed into a *words per minute* metric, is the single most reliable measure distinguishing children with reading difficulties from the general population (Protopapas & Skaloumbakas, 2008). This conflation of accuracy with speed muddles the dimensional structure because, when measured separately, accuracy and speed constitute distinct dimensions (cf. Protopapas, Simos, et al., 2012) on both of which children with reading difficulties can be significantly impaired (Mouzaki & Sideridis, 2007; Protopapas & Skaloumbakas, 2007; Protopapas, Skaloumbakas, & Bali, 2008), in a pattern also consistent with the double-deficit hypothesis (Papadopoulos, Georgiou, & Kendeou, 2009; cf. Niolaki, Terzopoulos, & Masterson, 2014, for a subtyping interpretation).

Spelling is typically the domain of greatest and most persistent impairment, with orthographic and grammatical errors being most common. Children with reading and spelling problems employ phonological recoding to spell by Grade 1, achieving only 25% accurate word spelling but 88% correct (i.e., phonologically acceptable) pseudoword spelling (Porpodas, 1999). The proportion of phonological spelling errors made by children with

dyslexia in later grades is less than would be expected on the basis of their overall elevated error rate (Protopapas, Fakou, et al., 2013).  Still, children with dyslexia make more phonological spelling errors than typically developing readers (Diamanti, 2006; Protopapas, Fakou, et al., 2013). With the exception of the stress diacritic, the spelling profile of reading-impaired children is indistinguishable from that of younger typically developing spellers matched in reading and phonological awareness, consistent with an interpretation of spelling problems in dyslexia as reflecting delay rather than deviance (Diamanti, 2006; Diamanti et al., 2014; Protopapas, Fakou, et al., 2013).

**3.3 Reading Comprehension**

The development of reading comprehension has been studied in children spanning a wide age range. Aidinis (2003, cited in Aidinis, 2012) found that passage comprehension was relatively poor in Grades 1–2 despite successful identification of individual words. Inadequate inference from multiple pieces of information was found even in Grade 6 (Hatziathanasiou & Aidinis, 2006, cited in Aidinis, 2012). No evidence for Matthew effects has been detected in reading comprehension, as lower-performing children seem more likely to catch up rather than fall behind through the elementary grades 2–6 (Protopapas, Sideridis, Mouzaki, & Simos, 2011; and precocious readers fail to retain their comprehension advantage through Grade 6; Tafa & Manolitsis, 2012).

**3.3.1 Predictors of reading comprehension**

Word reading accuracy, fluency, and spelling are concurrently correlated with comprehension in the general population (Padeliadu & Antoniou, 2014; Protopapas, Sideridis, et al., 2007). However, by Grade 3 fluency no longer has a unique concurrent contribution and neither accuracy nor fluency are unique longitudinal predictors (Protopapas, Mouzaki, et al., 2013; the situation may differ for children with reading difficulties, cf. Constantinidou & Stainthorp, 2009). Comprehension typically loads on a different factor than word reading accuracy and fluency, more closely related to cognitive ability tasks (Protopapas & Skaloumbakas, 2007, 2008; Protopapas, Skaloumbakas, & Bali, 2008).

The relationship between comprehension and word-level reading skills has also been examined in poor readers. Grade 2–4 children identified on the basis of their poor word reading skills achieved on average lower reading comprehension scores than unimpaired readers (Constantinidou & Stainthorp, 2009; Mouzaki & Sideridis, 2007). In other studies, no significant difference in reading comprehension was found between children with and without dyslexia matched in age and nonverbal ability in Grades 3–4 (Protopapas & Skaloumbakas, 2008; Protopapas, Skaloumbakas, & Bali, 2008) and in Grades 7–12 (Anastasiou & Protopapas, 2014). In contrast, Grade 7 children with dyslexia scored significantly lower on reading comprehension but the corresponding effect size was smaller than reading and spelling tests and similar to that of WISC subscales (Protopapas & Skaloumbakas, 2007, 2008).

These findings concern comprehension tests composed of brief passages followed by multiple choice questions. Other forms of testing might have led to different results (cf. Maridaki-Kassotaki, 1998) as different reading comprehension tests make diverse demands on the cognitive and language skills (Kendeou, Papadopoulos, & Spanoudis, 2012; Papadopoulos, Kendeou, & Shiakalli, 2014). For example, Papadopoulos, Georgiou, and Kendeou (2009) found impaired reading comprehension among Grade 1 children with a phonological deficit using sentence completion tests. Conversely, poor performance in three different reading comprehension tests in Grade 2 was associated with distinct profiles in cognitive, language, and reading performance in Grades K-2 (Papadopoulos, Kendeou, & Shiakalli, 2014).

Reading comprehension is strongly correlated with listening comprehension, both concurrently and longitudinally, beyond autoregressive effects (Protopapas, Mouzaki, et al.,

2013). The relationship may become stronger with age (Diakidoy, Stylianou, Karefillidou, & Papageorgiou, 2005).

**3.3.2 Word level effects in comprehending text**

Throughout the elementary grades, vocabulary is the strongest concurrent and longitudinal predictor of reading comprehension, even controlling for autoregressive effects (Protopapas, Mouzaki, et al., 2013; Papadimitriou & Vlachos, 2014; Protopapas, Sideridis, et al., 2007; Rothou & Padeliadu, 2014; but cf. Georgiou, Manolitsis, et al., 2010). Vocabulary shares most of the reading comprehension variance accounted for by *print-dependent* skills even though it is usually assessed orally (Protopapas, Mouzaki, et al., 2013). The relative separability of two constructs presumably related to future reading comprehension is evident already in Kindergarten but vocabulary aligns with precursors of print-dependent skills rather than listening comprehension (Kendeou, Papadopoulos, & Kotzapoulou, 2013). Much more work will be required to elucidate the relationship of vocabulary with reading comprehension.

**3.4 Conclusions**

Early acquisition of reading and spelling Greek has been studied from a perspective of phonological awareness and application of the alphabetic principle. Because most children can read accurately very early on, researchers subsequently focused on the development and assessment of reading fluency. Spelling has received a lot of attention because it constitutes a domain of substantial difficulties for typically developing children and an area of protracted and persistent frustration and failure for children with reading problems. The systematic mappings from morphology to orthography have led a number of researchers to consider the role of morphological knowledge and awareness in learning to read and spell.

Comprehension has received comparatively less attention and therefore not much is yet known about how children learning to read and write Greek approach and process texts and how linguistic levels beyond morphology, such as syntax and pragmatics, may affect their understanding and creation of meaningful passages and communicative situations.


**4 Discussion**

**4.1 Challenges in Learning to Read Greek**

Greek has a relatively low orthographic complexity, with contiguous graphemes, most of them composed of single letters, mapping onto phonemes in a largely (but not entirely) predictable manner, despite a variety of inconsistencies and context dependencies. As a result, learning to read accurately is rapid as is the development of phoneme-level phonological awareness. Accuracy problems are barely detectable in the general population and not very substantial even in impaired readers. Failures or delays in learning to read primarily concern the development of fluency or, in the case of concomitant problems in oral language or general learning ability, may also concern passage comprehension.

Spelling is not as predictable as reading but the alternative spellings of different phonemes do not overlap. As a result, phonologically accurate spelling does not present substantial challenges to Greek children. However, to attain the final stage in spelling development and produce consistently correct spellings is not so easy. Inflectional suffixes are frequent and apply to large classes of words, so most children learn to spell them correctly, eventually, presumably as they become familiar with the inflection system and its orthographic consequences. Derivational affixes are not as broadly applicable or as frequent as inflectional ones but their spelling is every bit as arbitrary and lexically unmotivated as that of inflections. These present the greatest and most persistent challenges for the developing spellers.

At the other end, word stems are specific to particular word families but are lexically supported to the extent that one is familiar with a set of words and their associated meanings.

In the absence of difficulties with visual orthographic memory children learn to spell the majority of word stems correctly, although not before the late elementary grades. Words containing multiple challenges with conflicting solutions (e.g., μυρμήγκι /mirmiʝi/ 'ant', or ξυπνητήρι /ksipnitiri/ 'alarm clock', in both of which 3 different spellings of /i/ are found) are, naturally, most demanding and take a long time to secure an orthographic representation.

The orthographically salient inflectional morphology may also support processing of texts insofar as words display information about their syntactic roles on their suffixes and may therefore be grammatically deciphered without recourse to other phrase elements. This word-heavy approach, once mastered, may be beneficial for the assembly of sentence meaning if its implications for syntactic processing turn out to be facilitatory (order-light and perhaps memory-light; a hypothesis for psycholinguists to consider).

**4.2 Implications for Instruction**

At the word level the current system of instruction seems fully adequate. Letter sounds and phonological awareness activities in Kindergarten, followed by an analytic-synthetic approach in Grade 1, seem to work well in supporting the great majority of children to progress rapidly in word decoding and identification, on to word fluency and passages. In this respect educators would be wise to leave well enough alone and steer clear of recurring calls to turn to whole language approaches.

However, the point of reading is to understand the text. So it remains crucial to ensure that children engage with texts and acquire knowledge and pleasure from them. This includes both motivational and informational elements and may require additional instructional efforts to help children understand how to process texts, how to approach them in a systematic way, navigating text structure and monitoring their comprehension along the way. The elementary curriculum includes many passages and guidelines to engage them in the classroom but the extent to which this is achieved in actual practice remains unknown and requires more research.

Spelling presents great challenges to learners and may benefit from additional steps towards systematic teaching. A solid foundation of phonological (alphabetic) spelling may be required before the complexity of the system can be fully processed. Explicit emphasis on morphology may help children understand that different parts of words depend on different kinds of information. Thus, explicit teaching of inflections, by relation to grammar; derivations, by relation to word formation processes; and stems, by relation to meanings, etymology, and word families, may provide additional support towards the development of strong orthographic skills.

Finally, a largely neglected aspect of written language development concerns writing. Researchers have focused on the development of word reading accuracy and fluency and how that eventually supports passage comprehension. But there is comparatively little theoretical or empirical work on children's communicative efforts in the form of text production. Children with impaired reading exhibit notable difficulties in putting in writing thoughts they can express orally. Perhaps future assessments of spelling fluency may help us understand the low-level foundation that is necessary for expressive written language, in conjunction with the high-level expressive oral language skills. This is a challenge for both researchers and educators.

**5 Final Conclusion**

The Greek orthography employs an alphabetic system with high feed forward (reading) consistency but substantial ambiguities in the feedback (spelling) direction. Learning to read Greek therefore presents a relatively minor challenge to the majority of schoolchildren, resulting in highly accurate word reading as early as Grade 1. In contrast, learning to spell posits significant demands that are never fully met for a substantial

proportion of the general population. Difficulties in learning to read, expressed primarily in low reading fluency, are concurrently and longitudinally associated with poor phonological awareness and rapid naming performance. Imperfect or inadequate processing of the stress diacritic in reading and spelling may be related to its low utility for lexical access and disambiguation. Spelling difficulties are manifested in patterns of spelling errors that are common across levels of performance and can be accounted for by the properties of the orthographic system. Specifically, as several vowels have alternative spellings, either lexically or morphologically determined, spelling of vowels depends on word knowledge and morphological awareness and remains the most obvious domain of difficulty throughout elementary and secondary education. Further research is needed to elucidate the processes of reading comprehension and the limits imposed by word reading and lexical development.

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