

Dyslexia and Dysgraphia in Greek in relation to Normal Development: Cross-linguistic and Longitudinal Studies.

VASSILIKI DIAMANTI

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Department of Human Communication Science
University College London

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ABSTRACT

Studies on developmental dyslexia in transparent orthographies have established that children learning to read in such languages hardly experience difficulties in word reading accuracy and phonological awareness tasks, but suffer from a reading speed deficit. On the other hand in the English orthography, where the mappings between graphemes and phonemes are largely inconsistent, children exhibit significant difficulties in both word reading accuracy and speed. Greek is characterized by a high degree of regularity for reading, but is inconsistent for spelling. The variability of phoneme-to-grapheme correspondences and the highly inflectional nature of the particular orthography constitute spelling in Greek a considerably demanding task. The present thesis comprises three studies that were concerned with understanding the reading and spelling difficulties that Greek children/participants with dyslexia have and their underlying cognitive deficits, in relation to typically developing children and English children/participants with dyslexia.

The first study examined the reading and spelling difficulties in Greek- and English-speaking children/participants with dyslexia, each compared with two control groups. Greek children/participants with dyslexia outperformed their English counterparts on word/nonword phoneme deletion, word/nonword reading, and grammatical spelling. However the two language groups performed similarly on rapid digit naming, spoonerisms and on the choice tasks. Results are discussed in relation to the differences in orthographic consistency between the two languages.

The second study examined the development of literacy skills in twenty-three Greek children/participants with dyslexia over a period of 18 months (10 years 5 months to 12 years 3 months). At Time 1 children/participants with dyslexia performed worse on literacy tests than chronological-age control children, but similarly to reading-age controls. At Time 2 children/participants with dyslexia performed worse on all the tasks than CA control children, and worse than RA controls on the tasks of phoneme deletion of nonwords, nonword reading and orthographic spelling. Moreover the concurrent and longitudinal predictors of children's/participants' with dyslexia and typically developing children's reading and spelling abilities were examined. The findings are discussed in relation to theories of normal and atypical reading and spelling development.

The third study investigated the ability of twenty-three 10-13 year-old Greek children/participants with dyslexia, and their reading-level and age-level-matched children to spell derivational and inflectional suffixes. Children/participants with dyslexia performed significantly worse than CA controls and RA controls. When they spelled the inflectional ending of adjectives and nouns children/participants with dyslexia did not differ from RA controls. It is suggested that children/participants with dyslexia have weaknesses in grasping the morphological rules of the Greek orthographic system and applying this knowledge in the spelling of word suffixes.

The thesis concludes with a discussion of findings in relation to previous literature, the limitations of the present studies and avenues for future research.

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Chapter 1. Models of Normal Reading Development

Many aspects of human cognitive behaviour and the development of certain cognitive abilities such as reading and spelling acquisition are often described within the framework of stage models; these models provide a descriptive account for the changes that occur in cognitive developmental processes, and explore the nature of the mechanisms responsible for these changes. All the theoretical models of reading and spelling development have been developed in relation to learning to read and spell in the English language.

Developmental models postulate that literacy acquisition passes through a number of stages in order to become completely and successfully developed. Each stage is characterised by a qualitatively different cognitive strategy employed by the developing reader and speller; the development of strategies at the earlier stages is assumed to be responsible for prompting the development of later strategies. A number of the most influential stage models of reading development will be presented in this chapter.

1.1. Marsh, Friedman, Welsh and Desberg (1981)

Marsh and his colleagues have suggested that children's reading development follows a sequence of four successive stages. In the first stage of *linguistic guessing* children use a strategy of rote learning to associate a word's analysed visual stimulus and oral response or they use contextual information to guess the pronunciation and meaning of words. When the word is presented in isolation children are unable to recognize it and respond. In the stage of *discrimination net guessing* a child uses strategies like rote learning and visual/linguistic cues in order to respond to unfamiliar words that are visually similar to familiar ones; however the visual similarity is initially limited to the first letter of the

word. During the phase of *sequential decoding* the strategies available to the child are rote learning and decoding from left to right. The child is able to pronounce an unfamiliar word –with the prerequisite that it is a CVC (consonant-vowel-consonant) word- by analysing it into phonemes and using letter-sound correspondences. The fourth stage of reading development is that of *hierarchical decoding*; children are at this point able to use ‘higher order’ rules in order to master the complex and conditional rules of the English orthography.

Linguistic Guessing	<ul style="list-style-type: none"> • Rote learning through linguistic context
Discrimination Net Guessing	<ul style="list-style-type: none"> • Rote learning
	<ul style="list-style-type: none"> • Visual and linguistic cues
	<ul style="list-style-type: none"> • Initial letters are used as cues
Sequential Decoding	<ul style="list-style-type: none"> • Rote learning
	<ul style="list-style-type: none"> • Letter-sound correspondences
	<ul style="list-style-type: none"> • Ability to read regular and unfamiliar CVC words
Hierarchical Decoding	<ul style="list-style-type: none"> • Rote learning
	<ul style="list-style-type: none"> • Application of ‘higher order’, complex and conditional rules of orthographic structure

FIG. 1.1. Marsh et al’s model (1981)

1.2. Frith’s Model (1985)

Frith has proposed a model of reading development consisting of three stages: the ‘logographic’, the ‘alphabetic’ and the ‘orthographic’. Within this framework developmental progress is seen as a change in the mastery of reading strategies in each developmental phase.

Logographic Phase

In the first stage children can instantly recognise familiar words. Salient features or contextual and pragmatic cues play an important role in the recognition process, whereas letter order or phonological factors are secondary.

Alphabetic Phase

During this phase children rely on their knowledge of individual phonemes and graphemes and their correspondences to pronounce novel words and pseudowords. Letter order and phonological factors are thought to employ a significant role in the decoding process.

Orthographic Phase

In this stage children acquire skills that enable them to analyse words into orthographic units without phonological conversion. These units ideally coincide with morphemes and are internally represented as abstract letter-by-letter strings. The strategies employed in this phase are different from the ones in the earlier phases in terms of the way they operate and the modality they use. More specifically, the orthographic differs from the logographic strategy by being analytic in a systematic way and by being non-visual. The orthographic phase differs from the alphabetic by operating in bigger units and by being non-phonological.

Logographic skills	Instant recognition of familiar words
	Salient graphic features as cues
	Pronunciation retrieved from meaning
Alphabetic skills	Knowledge/use of individual graphemes and phonemes and letter-sound correspondences
	Ability to read unfamiliar words and nonwords
Orthographic skills	Word analysis into morphemes without phonological conversion
	Internal representations of letter-by-letter strings

FIG. 1.2. Frith's model (1985)

1.3. Development of Sight Word Reading (Ehri, 1992)

Ehri (1992,1998) devised a model of sight word reading development which comprises of four phases; each phase is defined by the type of connections that are formed between the visual cues seen in print and the information about a particular word stored in memory.

Phase 1: Visual Cue Reading

In the first phase of visual cue reading a word is read by selecting and forming connections out of the word's visual cues that have arbitrary relations to the word's meaning, but are not related to its pronunciation. The selected visual cues may be part of the spelling, such as a circle at the end of the word (e.g. hero), or they may be adjacent to the spelling as in the case of a logo behind a word (e.g. McDonald's). Ehri (1992) points out that at this point of reading development children are not aware of letter-sound relations, rather children are able to read print in their environment by identifying and

remembering shapes of the selected letters as visual cues; letters are selected only because they are visually distinctive or salient.

Several studies (Goodman and Altwerger, 1981; Harste, Burke and Woodward, 1982; Masonheimer, Drum and Ehri, 1984) have shown that logographic readers read signs in their environment by remembering the visual cues that accompany these signs and not the actual letters. For instance it was found (Masonheimer et al., 1984) that a sample of logographic readers pronounced the sign “Xepsi” as “Pepsi”. These children failed to notice the altered letter because, as it was explained by the experimenter, they formed connections between visual cues and meanings of printed words rather than visual cues and pronunciations.

Ehri (1992) states that logographic reading is responsible for the visual errors that children make at this stage. Since most connections formed between the spelling of words and their meanings are arbitrary and visual cues forming the connections can be found in more than one word, visually similar words are often mispronounced. However, these mispronunciations are eliminated when children move to the next phase of sight word reading development during which they learn letter names and sounds and acquire low-level phonemic awareness.

Phase 2: Phonetic Cue Reading.

The second phase is characterised by children’s ability to form visual-phonetic connections between letters seen in spellings and sounds detected in the pronunciations of words, based on their knowledge of letter shapes, letter names, letter sounds of most letters of the alphabet and on their low-level phonemic awareness. The alphabetic

connections formed at this point are partial; this means that only some of the letters in the written words are connected to the sounds detected in their pronunciations and these letters are often the first and the final as they are the most salient. When partial alphabetic readers learn how to read the word “moon”, they might detect initial /m/ and final /n/ segments in their pronunciation of the word, and recognize that the letters they see symbolise these sounds. The connections that are made every time beginners learn a word are stored in memory and can be accessed the next time they are encountered with the same word. The cognitive skill that enables readers to detect the existence of separate sounds in words’ pronunciation and in letter names is that of phonetic segmentation.

According to Ehri (1992, 1998) the elements that differentiate this phase from the phase of visual cue reading are the following: a) connections are no longer arbitrary, but systematic and therefore constitute word reading a more reliable process, and b) while in phase one the primary connection is formed between the spelling of a word and its meaning, in phase two the primary connection is formed between the spelling of a word and its pronunciation; again this characteristic makes sight word reading more reliable.

The shift from the first to the second phase is believed to occur quite early; more specifically as soon as children acquire letter knowledge and become capable of reading even a very limited number of words in isolation, they have passed from the logographic to the alphabetic phase of sight word reading. A study conducted by Ehri and Wilce (1995) provides sufficient evidence for this assumption. These authors allocated kindergarteners into three groups according to their reading skills: a) the group of pre-readers who knew only some letters and a few letter-sound relations and could read new pre-primer words, b) the group of novice readers who knew most letter names and sounds

and could read a few preprimary words and c) the group of veteran beginning readers who knew most letter names and sounds and could read from 11 to 36 pre-primer words. It was found that the group of novice readers who had just moved into reading was able to learn sight words by forming visual-phonetic connections.

Phase 3: Full Alphabetic Phase

Cipher Reading

During the third phase children read sight words by setting up connections in memory between the whole sequence of letters in spellings and the phonemic constituents in the word's pronunciation. Readers are now aware of how most graphemes symbolize phonemes in the conventional spelling system and when this knowledge is applied to form connections for sight words, spellings become bonded to pronunciations in memory.

A number of characteristics of cipher readers are described by Ehri (1992, 1998) to discriminate between the second and the third phase. At this stage readers' representations about the phonemic structure of words and how spellings symbolize this structure are sufficiently developed to distinguish between similarly spelled words. Phonemic segmentation and recoding skills are the cognitive strategies that enable this process to occur. Moreover, full-alphabetic readers differ from partial alphabetic ones in terms of their ability to decode words never encountered with before by blending letters into a pronunciation.

Phase 4: Consolidated Alphabetic Phase

At the final phase of reading development the storage of completely connected spellings of an increasing number of words in memory results in letter patterns that reoccur across

different words becoming consolidated. Consolidation of letter patterns is assumed to facilitate the reading process as it enables readers to operate with multiletter units, such as morphemes and syllables, or intrasyllabic units, such as onsets and rimes. Larger letter units reduce the memory load involved in retaining sight words in memory and thus speed up the process of accessing words by facilitating letter identification (Juel, 1983; Venezky & Massaro, 1979).

Ehri's account of phases in normal reading acquisition has been subject to criticisms by Jackson and Coltheart (2001). These authors have attempted to discuss each phase of Ehri's model in relation to the dual-route-cascaded (DRC) model of skilled reading (a description of the model will follow later in the chapter). Even though dual-route models have been developed for interpreting skilled word recognition and not beginning reading or reading acquisition, it is proposed that partial-alphabetic reading (second phase in Ehri's model) resembles the mature reading system with different contents of some of its components (see diagram in figure 1.3.); the pre-alphabetic reader "does have a functional, but imperfect reading system, one in which further change could be...increasing the knowledge available and efficiency of operation within each system component" (p. 100).

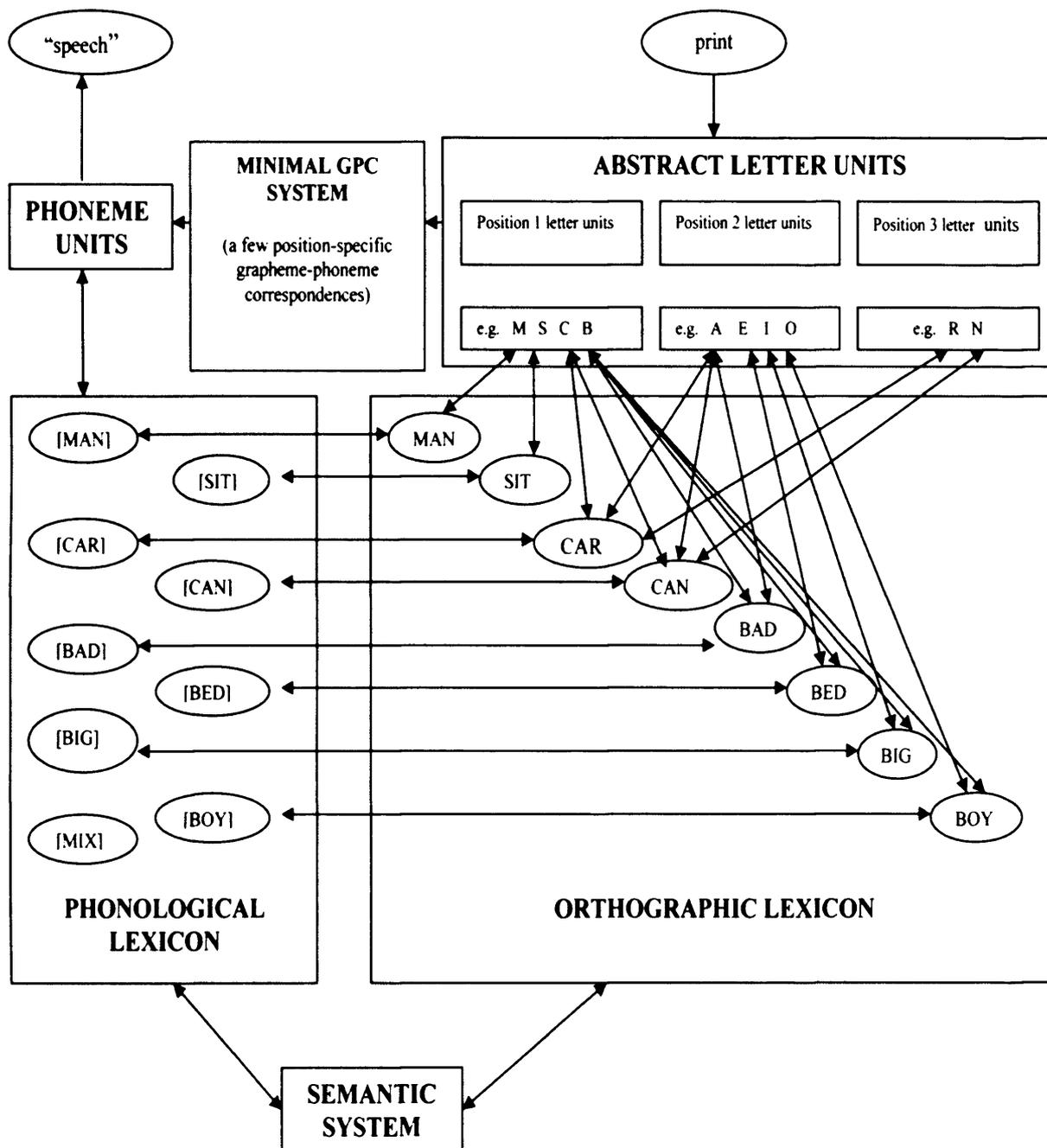


FIG. 1.3. A model of the partial-alphabetic reading system (Jackson & Coltheart, 2001)

In regard to the lexical route of the DRC model it is proposed that this route is in operation when the pre-alphabetic reader reads a word. Share and Stanovich (1995b)

showed that partial-alphabetic readers are able to read some short, highly familiar words (e.g., their names) with the use of the lexical route. Evidence from children's reading errors supports the hypothesis that partial-alphabetic readers have in their disposal an operational lexical route. Ehri (1999) observed that when a partial-alphabetic reader reads incorrectly an unfamiliar word or nonword, his/her errors are usually a word that is familiar to them and have an orthographic similarity with the letter string they try to read. According to the DRC model what the partial-alphabetic reader is doing when encounters a word he/she cannot read, is selecting the word from his/her orthographic lexicon the letter string and then retrieving the pronunciation of this word from his/her phonological lexicon. It is argued that the partial-alphabetic reader's reading system is not yet fully operating as a unit, therefore mappings between letter units and words in his/her phonological lexicon are incomplete, as well as mappings between letter units and units in the orthographic lexicon.

With respect to whether partial-alphabetic readers have any nonlexical route, Jackson and Coltheart (2001) suggested that there is a very rudimentary nonlexical route that develops gradually as the child is in the process of entering the full-alphabetic reading phase. Evidence to support this claim comes from data on standardised (Woodcock & Johnson, 1989) and experimental (Thompson, Cottrell, & Fletcher-Finn, 1996) pseudoword reading measures, which showed that average readers attending kindergarten or first grade are likely to read accurately a few two- or three-letter nonwords [children at this age are in the partial-alphabetic reading phase (Ehri, 1999)].

Thereafter it could be argued that Ehri's phase model and the DRC model agree on the same basic data on partial-alphabetic reading in the way they both acknowledge the

important long-term role of letter-sound correspondences in associating written word forms with their pronunciations and meaning, and storing this information in lexical memory. However, Jackson and Coltheart (2001) have criticised Ehri's partial-alphabetic reading as not being able to suggest testable links between normal beginning reading and skilled reading or acquired dyslexia.

The third phase in Ehri's model of reading development, namely the full-alphabetic phase of cipher reading, and the fourth and final phases of consolidated-alphabetic reading have been suggested to have a number of limitations. In contrast to computational models like the DRC or the PSMP (Plaut, McClelland, Seidenberg, & Patterson, 1996), Ehri's account lacks specification in that it cannot be readily modeled in a computational reading system (Jackson & Coltheart, 2001); nevertheless, it is broadly consistent with connectionist (single route) models in assuming that sublexical phonology always participates in generating the pronunciation and meaning of a familiar word.

Subsequently to the full-alphabetic phase children enter the consolidated-alphabetic phase of reading during which lexical processes dominate. According to Ehri and MacCormick (1998) a child that has moved to this phase would have the ability to read the polysyllabic word *interesting* based on its component morphemic or grapho-syllabic units, such as rimes, and not in terms of its phonemes. But this does not mean that the child has stopped realising the grapho-phonetic nature of these units. Ehri's theorising about the way a reader in this phase reads a word has been supported by research evidence indicating that rimes are not very salient to young children and the skill to read words by onset-rime analogies is not evident in early reading development (Muter, Hulme, Snowling & Stevenson, 2004). This is in contrast to other theories proposing that onset-rime analogies are

paramount in early reading. Goswami and Bryant (1990) suggested that very young children appear to use onset-rime units for mapping letters onto sounds before they acquire the skill to use grapheme-phoneme correspondences. Firstly children become aware of large units involved in rhyme and alliteration and this awareness continues to develop until children become aware of small units (phonemes) and able to detect them. Thus this developing refinement in level of speech-sound awareness helps them to learn about grapheme-phoneme correspondences and finally it helps them to read (Goswami & Bryant, 1990).

Developmental models of reading acquisition can be proved particularly useful and valuable in the area of applied education, since they can provide a theoretical framework for understanding the cognitive processes required to learn to read and for the evaluation of their development, and they can also be used as a basis for educational programs in literacy.

However they have also been subjected to serious criticisms, most of which challenge the existence of discrete and sequential phases of reading development. There is a body of evidence indicating that children do not necessarily follow the proposed sequence of stages. In particular, it has been shown that pre-school children do not start to read 'logographically' but their phonological awareness in relation to their letter-sound knowledge is a significant predictor of their reading age (Stuart & Coltheart, 1988). Children's reliance on a phonological rather than a 'logographic' reading strategy has been revealed to be the case in more transparent orthographies, such as French (Sprenger-Charolles & Cassalis, 1995), German (Wimmer & Hummer, 1990) and Brazilian Portuguese (Pinheiro, 1995).

It has also been suggested that stage models are incompatible with models of skilled reading because they lack an effective mechanism for parsing the letter string of a word into the graphemic units that are relevant for translation (Stuart & Coltheart, 1988). For this reason these models are believed to be unable to provide a clear explanation of the processes during which children pass from single letter-sound decoding of print to sound to decoding by using grapheme-phoneme correspondence rules.

1.4. Dual Route and Parallel Distributed Processing Models

Many theorists have postulated a dual-route model of reading aloud whose fundamental property is the idea that the system used by skilled readers involves two different procedures for converting print to speech. A word that a reader has learned is represented as an entry in a mental lexicon and can be read aloud by using the *lexical procedure*; this involves accessing the word's lexical entry from its printed form and retrieving from that entry its phonological form. However this procedure is unable to read letter strings that the reader has never been encountered with before, since the mental lexicon contains only representations of real words. Therefore the dual-route model proposed that skilled readers have at their disposal a second procedure, often referred to as the *sublexical procedure*, which is able to read nonwords. This nonlexical route involves using a system of rules, which specify the relationships between orthographic and phonological segments (e.g., grapheme-phoneme correspondence rules). Although the sublexical route produces correct responses for pronounceable non-words and of words that obey the spelling-sound rules of English, it is not able to read correctly irregular and exception words like *yacht* and *pint* that do not obey the correspondence rules.

Models of the dual-route architecture have been popular as they are formulated in an explicit way, with each submodule of the reading system being clearly displayed in box-and-arrow diagram form. Furthermore, they have succeeded in accounting for a range of facts about both normal (reading development and skilled reading) and abnormal reading (developmental and acquired dyslexia) (Coltheart, Curtis, Atkins and Haller, 1993).

However, some theorists have challenged this architecture of the reading system and have proposed alternative models (Seidenberg and McClelland, 1989; Sullivan, 1991; Sullivan and Damper, 1993). Glushko (1979) and Marcel (1980) argued that reading pseudowords aloud need not involve the usage of a nonlexical procedure, but makes use of word-based analogies; a skilled reader is able to produce a correct pronunciation of a nonword because the nonword activates the lexical entries for words that have an orthographic similarity with it. These arguments have been dismissed on the basis that they do not specify the processes involved in reading pseudowords by analogy to real words. It has been questioned how pseudowords, such as *zuve* that do not have real-word analogies, could be accurately read by an analogy procedure (Jackson & Coltheart, 2001).

Alternative models have been developed by other researchers, such as the parallel-distributed-processing (PDP) connectionist model of Seidenberg and McClelland (1989) and the computational model of reading by analogy of Sullivan (1991). Seidenberg and McClelland argued that the reading system can be explained by “a single uniform procedure for computing a phonological representation from an orthographic representation that is applicable to exception words and nonwords as well as regular words” and does not need the operation of separate lexical and nonlexical procedures (p. 525).

The Seidenberg and McClelland model attempted to provide an integrative computational account for aspects of normal and impaired visual word recognition. The model is a neural net trained by back propagation that implements a single route from print to speech (figure 1.4). The lexical processing module consists of sets of units encoding orthographic, phonological and semantic codes. Each code is represented by patterns of activation over appropriate sets of units and each unit takes part in the representation of many codes. This means that the model uses distributed representations in contrast to 'localist' systems whereby individual units are used to represent the orthographic, phonological and semantic form of individual words. Knowledge of the relations between the codes is encoded by weights on connections between units. Weights are set during a learning phase in which the model is exposed to 2897 English monosyllabic words using the back propagation learning algorithm. A basic component of the model is the layer of hidden units (200 units), which represent higher-order correlations between the orthographic and phonological codes. Lexical processing involves the computation of the relevant codes based on written or spoken input. This simulation model of human skilled reading operates as follows: letter strings are presented as input; then two sorts of output are produced: an activation pattern over the phonological units and an activation pattern over the orthographic units. Computed codes are subsequently used to perform tasks of reading aloud or lexical decision tasks. The amount of training that the model receives and the ways in which it is configured depends on the different types of words or nonwords that the model has to 'read'. Error scores are used to assess the model's performance; these scores reflect the fit between the orthographic and phonological codes computed by the model and those that would be produced if the model's performance were free of errors.

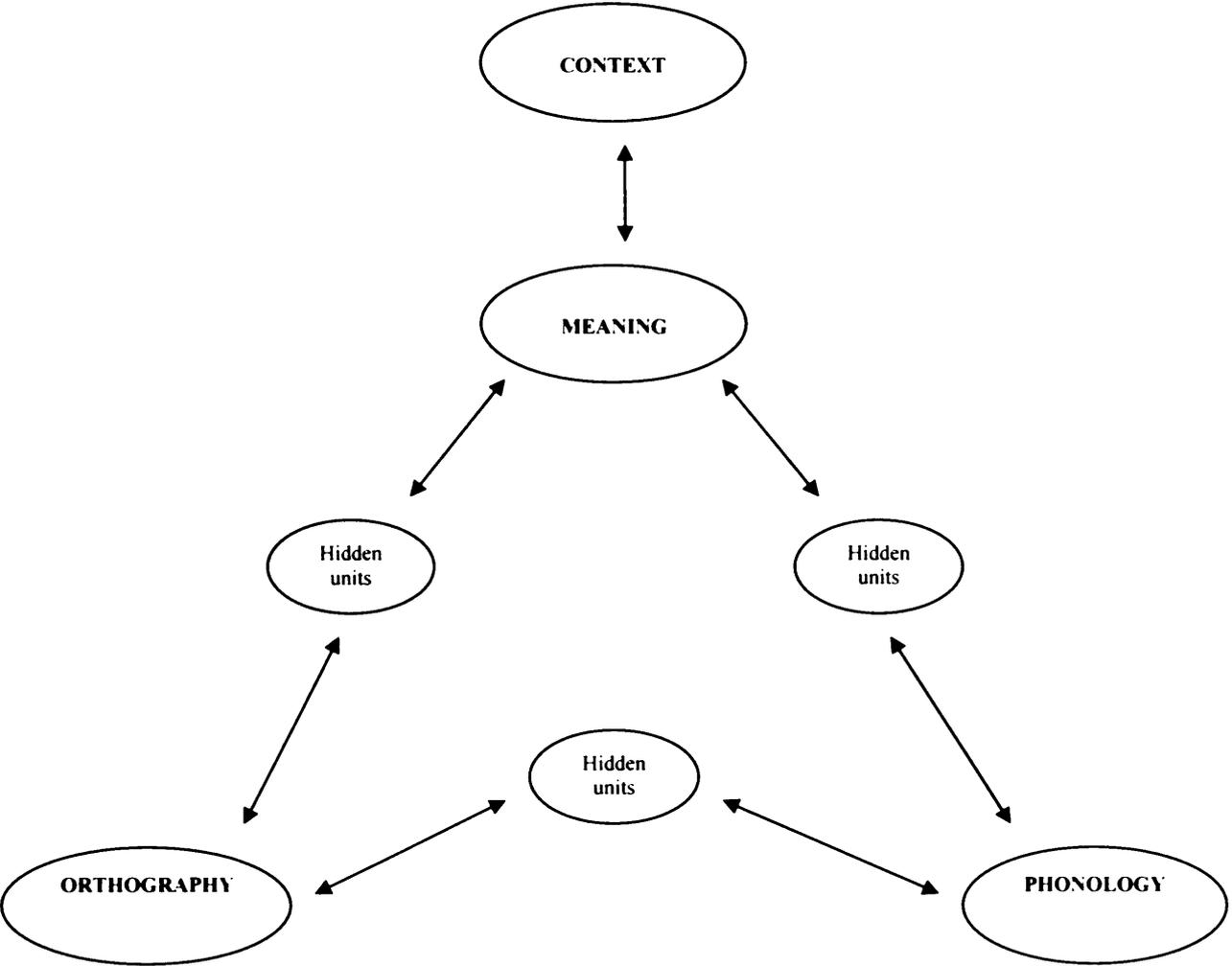


FIG. 1.4. The Seidenberg and McClelland model.

The model has been proposed to be capable of simulating existing behavioural data and also test novel predictions. It is considered to provide an explicit computational account of the types of knowledge and processes involved in word recognition, as well as in the tasks of naming and lexical decision.

Moreover the model is not specific to the English language, but its architecture can account for processing in different orthographies (Frost, Katz, & Bentin, 1987; Turvey, Feldman, & Lukatela, 1984). It has been found that there are larger effects of frequency

and lexicality on naming latencies in orthographic systems characterised by deep spelling-sound correspondences in comparison to shallow orthographies (Frost et al, 1987). The parallel-distributed-processing (PDP) model can simulate the effects of orthographic depth by manipulating the corpus used in training. For instance the model can be trained using English grapheme-phoneme correspondences that are completely regular. These are picked up by the learning algorithm of the model and are encoded by the connection strengths. The result is that frequency effects and lexicality differences (word/nonword) decrease in this simulation. In addition the PDP model has been capable of simulating different forms of developmental and acquired dyslexia (Hinton & Shallice, 1991; Manis, Seidenberg, Moi, McBride-Chang, & Patterson, 1996; Harm and Seidenberg, 1999) by manipulating separate components of the model. For example by limiting the number of hidden units to 100 from 200, the model is left with fewer computational resources; it is still able to learn, but performs poorly on irregular words and nonwords even after receiving extensive training.

Although the PDP model has been effective in replicating a range of effects observed in behavioural studies of skilled word recognition, such as frequency and lexicality effects, it has important limitations. It is not capable of addressing issues concerned with the time course of processing or response variability because it does not operate in a cascaded way for computing output.

The Seidenberg and McClelland model's inadequacies in simulating skilled readers' performance on pronouncing orthographically legal pseudowords and lexical decision tasks under various conditions were the starting point for implementing a new model by Plaut, McClelland, Seidenberg and Patterson (1996). Similarly to the previous model this

one was a neural network trained by back propagation and had a computationally implemented route from an orthographic layer to a phonological layer via hidden units. The novelty of Plaut and his colleagues' model was in the structure of both orthographic and phonological levels; the new model used local representations instead of distributed representations of graphemes and phonemes at input and output levels. This reform enabled the system to generate accurate pronunciations of nonwords comparable to those of human skilled readers'.

Arguably connectionist models have been very influential in the field of reading research, as they have a computational architecture that can adequately simulate human behaviour of skilled word recognition, and, in principle, predict reading patterns/errors. It is also important and particular to the context of the present thesis to reflect upon the role of connectionist models from a developmental viewpoint. Unlike stage models that provide a framework for conceptualising children's reading development up to a certain point, and unlike dual-route models that account only for the final outcome of reading development, connectionist models have the advantage of simulating both learning and skilled performance by using the same processing system. Nonetheless these models are still limited and future research has to address these limitations; the models' inadequacies should be taken into consideration when one attempts to interpret behavioural evidence within these systems.

The computational architecture of connectionist models as opposed to the static form of the dual-route models of the mature reading system has been recognised by Coltheart, Curtis, Atkins and Haller (1993). These researchers developed a computational model that has dual routes for proceeding from print to speech, which operate in a cascaded and

not in a threshold manner (figure 1.5). A level of letters – and not graphemes as in Reggia, Marsland and Berndt's computational realisation of the dual-route model (1988) – is the first stage for both routes in the model. This stage stimulates the grapheme-phoneme conversion stage of the nonlexical procedure and the stage of visual word recognition of the lexical procedure. The latter stage is that of “graphemic parsing” (Coltheart, 1978) in which a process of converting a letter string into a string of phonemes takes place. Coltheart et al (1993) developed an algorithm that enables the model to learn the GPCs of the English language. The model is trained to learn the grapheme-phoneme correspondence rules embodied in the training set of the printed forms of words and their pronunciations. In this way the model is able to read aloud words that it has not been presented with before by applying these rules to each new input string of letters.

Moreover, it is strongly believed that a crucial property of the DRC model is the cascaded processing that has brought to light important implications for the ways in which the model operates (Coltheart et al, 1993). By this type of processing it is meant that when the interactive – activation model is encountered with a letter string, an activation at the level of the visual word recognition will occur and it will cause activation in the spoken word lexicon, since each input unit in the visual word recognition module is connected to a corresponding entry in the spoken word production module. Finally, activation will be passed on to the phoneme system and an output string of phonemes for each input string of letters will be produced.

Three other significant properties of the DRC model include the following: (a) within each set of units every unit inhibits every other. The role of these inhibiting connections is to enable the correct unit to suppress the incorrect ones that are partially activated at the

beginning stages of word processing, (b) adjacent components of the model are interconnected; a given letter unit has excitatory, as well as inhibitory connections to all words in the orthographic lexicon that begin with the same letter and vice versa, and (c) positional encoding occurs at letter and phoneme levels; there is a separate set of letter and phoneme detectors for every possible position in the input for enabling the model to discriminate between words that contain the same letters/phonemes in different positions.

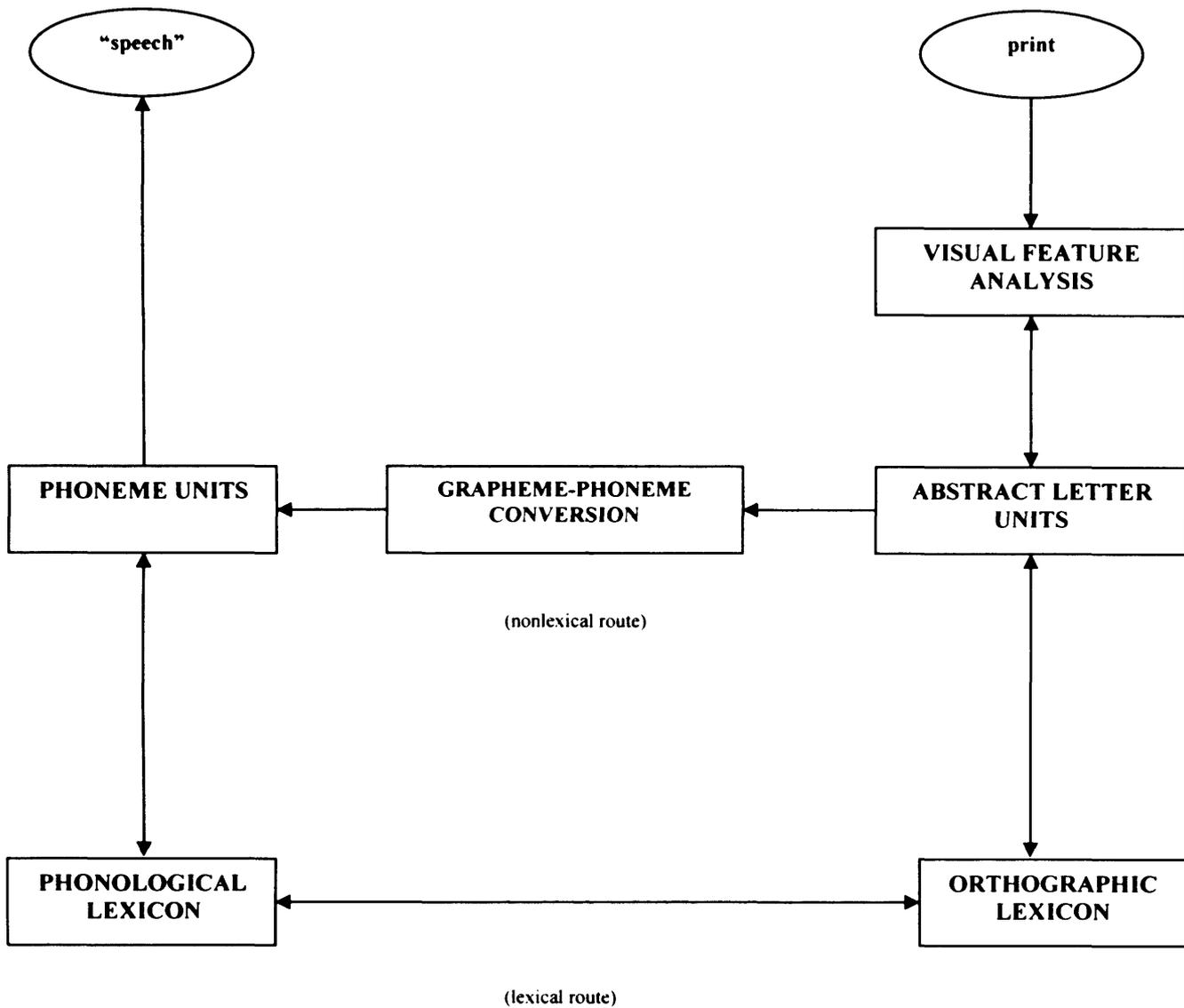


FIG. 1.5. The dual-route cascaded (DRC) model of reading aloud (Jackson & Coltheart, 2001).

Stuart (2002) has provided a very informative and comprehensive account of the similarities and differences between the dual-route-cascaded model and the parallel-distributed-processing model of skilled word reading and discussed which model could give a better account of existing behavioural evidence on reading. The similarities of the two models include the following: (a) they both have a triangle form (angle of the PDP model reversed) with the longest side on the right and the apex on the left, (b) the right

side in both models is involved in the computation of phonological output from orthographic input, (c) the left-hand side of the PDP model and one of the short left sides of the DRC model are involved in the computation of phonological output from orthographic input through the semantic system. The other short left-hand side of the DRC model forms the direct lexical route (letter detectors → orthographic input lexicon → phonological output lexicon → phoneme system), and (d) both models operate in parallel; however the DRC model also employs a serial process and includes word-level representations in contrast to the PDP model that operates based on orthographic and phonological units.

In relation to the difference in the way of processing between the DRC and the PDP models, there is sufficient evidence to support the existence of a second serial process for producing pronunciation from print input through the GPC rule system. Weekes (1997) found that nonwords with many letters require more time to be pronounced than nonwords with fewer letters. This finding indicates that letters are mapped onto sounds in a serial rather than a parallel manner.

The prediction of a second serial route in the skilled reading system is supported by the “whammy” effect observed by Rastle and Coltheart (1998). These authors showed that when a word or nonword includes a grapheme that is represented in spelling by a sequence of two letters (e.g., in the word *chef*), during the encounter of the nonlexical route with the first letter, the incorrect phoneme begins to be activated. When the nonlexical route gains access to the second letter, the correct phoneme begins to be activated; however, the correct phoneme will receive inhibition by the incorrect one and the period needed to overcome the inhibition slows down the reading time. When a

phoneme is realised by a single letter, this effect is not evident. Double or even triple “whammies” can occur. Rastle and Coltheart (1999b) also showed that the earlier the irregularity occurs in a word, the slower is the reading speed of the word. The DRC model is able to account for effects like the *whammy* and *position of irregularity* effects that influence skilled reading behaviour.

Hutzler, Ziegler, Perry, Wimmer and Zorzi (2004) investigated whether the triangle model proposed by Plaut, McClelland, Seidenberg and Patterson (1996), and the dual process model proposed by Zorzi, Houghton and Butterworth (1998a) could simulate empirical evidence from cross-language research, according to which the higher degree of regularity of a more consistent orthography than English has a main effect in the early phases of reading acquisition, but this advantage is not as strong during later phases of learning to read (Seymour et al., 2003). An English and a German version of the two connectionist models were implemented. Both models were trained on comparable training corpora matched in size and frequency across languages. In addition the set of nonwords used during the course of training was identical in both implementations. The prediction that the models’ performance would benefit when the orthography to be learned has a higher degree of regularity, was correct, since both models displayed a better nonword reading performance for the regular German orthography compared to the less regular English orthography. However Plaut’s triangle model did not predict the empirical pattern of large cross-languages differences during early learning phases and small differences in later learning phases. On the other hand the two-layer associative network predicted a constant advantage of the regular over the irregular orthography. The inability of the two-layer associative model to simulate the empirical large initial advantage of the regular over the irregular orthography that decreases over the course of

learning was addressed by investigating whether the phonics teaching method in regular orthographies accounts for this learning pattern. The phonics pre-trained versions of the German and English two-layer associative model exhibited an initial advantage of about 35% over the pre-trained English model, which decreased to about 10% as learning proceeded. These findings were taken to suggest that current connectionist models are able to simulate reading development when they take into account the statistical regularities in the input-output mapping, as well as the constraints of the learning environment.

All in all both parallel-distributed processing and dual-route cascaded models can be considered as useful frameworks for defining the processes involved in skilled word recognition, as well as conceptualising early reading acquisition in terms of indicating what has to be acquired by the young learner (Stuart, 2002). Moreover, there is some evidence that current computational models have the potential of simulating reading development in different orthographies, when they are sensitive to the statistical structure of spelling-to-sound relations, as well as to the method used for teaching reading in different countries (Hutzler et al, 2004). However, the learning procedure applied to computational models (i.e., the operation of a neural net learning mechanism named back propagation) is not currently able to simulate the cognitive mechanisms that might account for the changes that occur in children's reading system (Jackson et al, 2001). For instance the English and German versions of the Plaut et al's (1996) and Zorzi et al's (1998a) models were trained by repeated exposure to 1293 words and 300 training epochs before producing only four and two erroneous pronunciations respectively (Hutzler et al, 2004). When real children learn to read, they are exposed to small sets of words and they learn them with few exposures (when they have a typical reading development). In

addition children do not have to relearn words they have already mastered, whereas a neural net trained by back propagation would fail to reread correctly a set of words that it originally read after being trained on a second set of words. This limitation of connectionist computational models is referred to as “catastrophic forgetting” (McCloskey & Cohen, 1989).

Another limitation of current computational neural networks concerns their inadequacy in addressing the effects of morphological and syllabic structures in processing, as well as syllabic stress assignment, since their corpora consist only of monosyllabic words. These effects are particularly important in investigating reading acquisition in different orthographies (e.g., in the Greek regular orthography most words are polysyllabic of open syllable structure and children are able to read them from the early phases of reading development), which current connectionist learning models cannot account for. Future research is needed to investigate the mechanisms of change within the developing reading system and the factors that might affect them.

Chapter 2. Normal and Deviant Spelling Development in English

2.1. Normal Spelling Development in English

Learning to write in an orthography such as English is a considerable undertaking, that involves the integration of several skills, such as knowledge of phonological representations, grammatical and semantic knowledge, as well as knowledge of orthographic rules and conventions and the formulation of analogies with words in visual memory (Bradley and Bryant, 1981; Bruck and Treiman, 1990). Developmental models of spelling have been outlined by a number of researchers over the last twenty-five years (Frith, 1980, 1985; Marsh et al, 1980; Gentry, 1982; Ehri, 1986). These models share the following commonalities: (i) they are based on analyses of spelling errors when children spell novel words (invented spelling), (ii) they stress the stage-like passage of children through qualitatively different phases in which different cognitive processes are involved and (iii) they posit a stage of phonological analysis, followed by a stage in which spelling is based on lexical analogies.

It is generally agreed (Read, 1986; Henderson and Beers, 1980; Bissex, 1980; Gentry, 1982) that children move through five distinct stages of spelling development: the 'precommunicative', the 'semiphonetic', the 'phonetic', the 'transitional' and the stage of 'correct' spelling. In the 'precommunicative' stage children's spelling is characterized by the strategy of randomly selecting letter strings to represent words (e.g. spelling 'monster' as BTRSS). At this stage their spellings reflect a complete lack of letter-sound and letter-name knowledge. At the 'semiphonetic' stage children's spelling contains a partial mapping of phonetic content (e.g. LEFT for 'elephant'), whereas at the 'phonetic' stage spellings contain a complete description of the sequence of sounds in pronunciations, but

without regard for acceptable letter sequence or other conventions of English orthography (e.g. IF U LEV AT THRD STRET I WEL COM TO YOR HAWS. THE ED for 'If you live at third street I will come to your house. The End' (Bissex, 1980, p. 13). 'Transitional' spellings are characterized by the child's attempt to adhere to more basic conventions of English orthography, moving from phonological to morphological and orthographic spelling (e.g. EIGHTEE for eighty). However, at this stage spellers 'have not fully developed knowledge of environmental factors, such as position of the word, graphemic environment of the unit, stress, morpheme boundaries and phonological influences' (Brown and Ellis, 1994, p.157). Acquisition of this kind of knowledge, as well as extended knowledge of word structure, are the necessary elements for the mastery of 'correct' spelling.

Marsh et al (1980) proposed a model of spelling development. Initially, spelling strategy involves a sequential phonetic encoding, in which children successfully decode simple consonant-vowel-consonant (CVC) patterns. Later on, there is a shift from the phonemic encoding strategy to a strategy based on analogy with words in visual memory. According to Marsh et al (1980), this developmental shift occurs around grade 5.

Likewise, Frith (1980, 1985) suggested a model of spelling development in which three stages were outlined. In the initial stage, known as the 'logographic' stage children's spelling is restricted to a few rote words and is unsupported by sound-letter knowledge; in the second stage, the 'alphabetic', decoding takes place; in the final stage, the 'orthographic', spelling becomes independent of sound and is characterized by precise knowledge of word spellings.

Both models agree that in the final stages of skilled spelling children make use of 'orthographic' strategies. Marsh and his colleagues held the view that the use of orthographic strategies is an extension of the simple decoding strategy and that in this stage children learn more complex rules of orthographic structure, whereas Frith suggested that when skilled readers apply orthographic strategies the words are instantly analyzed into orthographic units without being converted into phonological ones.

Henderson (1985) proposed a model in which spelling development follows a sequence of five stages. The first stage is characterized by children's 'predictable writing'. Children begin to experiment with 'writing', which resembles scribbles. In this stage children understand the difference between drawing and writing, but they cannot realize that writing represents speech. Children enter the second stage, which is called 'letter-name spelling', when they start to realize that speech communication can be done through writing and that alphabetic letters represent speech sounds. During this stage children learn the letter names. Their spellings contain several kinds of errors. For example, a child might write a letter to represent the sounds of the letter's name or he/she might have difficulty in representing in his/her spellings certain sounds that cannot be perceived as separate units. Henderson explained children's tendency to make these odd errors as a result of their inadequate knowledge about the conventions of the English writing system.

The third stage is called the 'within-word pattern' stage and is characterized by children's correct spelling of short vowels, clusters and the use of silent markers. This change occurs as a consequence of their knowledge of sight words. In addition, children become able to use frequent letter patterns, which correspond to sequences of sounds and understand the ways in which meaning relations among words are featured in print. Henderson's fourth

stage, the 'syllable juncture stage' is marked by children's learning about the use of double consonants to mark a short vowel and by their understanding about when the addition of a suffix (e.g., -ed and -ing) in a word requires or not double consonants. For those children who are at a higher level of progress in learning to spell their entrance to this stage takes place at the middle years of elementary grades, whereas for the older children this stage is not reached until later. The fifth and last stage of spelling development outlined by this author is the stage of 'derivational principles'. At this stage children learn about the spelling relations among words on the basis of their origins (e.g., ignore, ignorance, ignorant). Children with a rapid progress in learning to spell might enter this stage at the late elementary grade, whereas other children enter this stage later on. It should be mentioned that this stage continues throughout the lifetime of a writer.

Ehri (1991, 1997) viewed the development of children's ability to spell closely related to reading development and described it in terms of four levels: the prealphabetic, the partial alphabetic, the full alphabetic, and the consolidated alphabetic levels. Except for the first two levels, development depends on how well the previous level has been mastered. The most important factor that determines spelling development is the extent of knowledge of the alphabetic system.

At the first level, children use visual cues in order to read words. When writing words the use of what looks like cursive writing may be a collection of arbitrary letters and scribbles that do not correspond to the actual sounds.

When children learn the names or sounds of alphabetic letters they are able to move to the partial alphabetic level of development. However their knowledge of the alphabetic

system is still incomplete and rudimentary and when attempting to spell they have difficulty with detecting and segmenting words into phonemes. They still lack the knowledge for representing all the sounds with letters, specifically vowel sounds. For example, the word BEAVER may be spelled to represent its main sounds: BV or BVR.

At the full alphabetic level of spelling development children are able to apply their knowledge of phoneme-grapheme correspondences to spell words. The spellings of words are more complete and may include extra sounds especially when a word is not spelled in a conventional way. For example, spelling “blouses” as BALAOSIS.

At the last developmental level, referred to as consolidated, alphabetic, transitional, within-word pattern or morphemic, larger units in words, such as affixes or suffixes, become consolidated through children’s experience with reading and writing conventional spellings of words. This knowledge enables students to form connections between graphemes and phonemes more easily in order to retain spelling patterns of specific words in memory.

Apart from providing a general description of spelling acquisition, predicting certain individual differences on constraint spelling tests, and forming a guide for the development of instructional methods for teaching spelling, stage models have been subject to serious criticism. The static form of developmental stage theory has been questioned by many researchers who postulate that spelling development should be conceptualized as an active process of developing interrelated strategies and knowledge (Varnhagen et al, 1997). Ehri (1992) suggested that sets of features rather than individual features may define better the stages of spelling acquisition. Templeton (1992) proposed

an instructional system for older children that integrates phonological, orthographic and morphological aspects of spelling.

Based on naturalistic and experimental evidence of children's early spellings, Treiman (1994) proposed that children's spelling development has the following characteristics: at first children believe that the correspondence between speech and writing is at the level of the syllable, and they tend to use one letter to represent the sounds of the syllable. However some children exhibit an early ability to divide syllables into smaller sound units and represent them with a letter. According to Treiman these cases form a bridge between the precursors of alphabetic writing and the emergence of the alphabetic principle. As children's spelling development continues and they learn more about conventional spellings in words, they realize that the number of letters in a word's spelling does not usually match the number of syllables in the spoken form of the word. During this time they start to symbolize speech at an intermediate level between syllables and phonemes instead of representing each phoneme with a letter. Evidence from studies on the spelling of initial and final consonant clusters indicated that children tend to spell groups of phonemes with single letters. Often children fail to spell the first consonant of final consonant clusters (Read, 1975, 1986; Snowling, 1994; Treiman, 1993; Treiman, Zukowski & Richmond-Welty, 1995). They may omit the *r* from *warm* because they believe that *warm* contains three units of sound (initial /w/followed by /or/ followed by /m/). Similarly children's omissions of consonants in initial clusters may reflect their grouping of sounds (Bowey & Francis, 1991; Fowler, Treiman & Gross, 1993; Kirtley, Bryant, Maclean & Bradley, 1989; Treiman, 1985a, 1989, 1992). Later on when children appear to fully divide spoken words into phonemes, their spellings may be different than those assumed by the conventional English system. For example they might spell *her* as

hr because they may analyse the word into two rather than three phonemes (Treiman, 1993; Treiman, Berch, Tincoff & Weatherston, 1993a). Children also make substitution or omission errors that reflect phonological structures. For example a child might write *chruck* instead of *truck*, because of the sound similarity between /t/ before /r/ and /tʃ/, and not because of visual similarity. Treiman's naturalistic study (1993) strongly suggested that children as young as first graders are aware of orthographic patterns and take them into account in their spellings. When they had to spell the word 'cake', most of the errors they made included 'kack' and not 'ckak' that violates the constraints; children seemed to be aware of the restriction against initial 'ck' even though they had not received any formal instruction about this restriction.

Treiman (1997) suggested that four types of changes occur as children's spelling ability increases: (a) children change their classifications of specific potentially ambiguous sounds (Derwing, 1992; Fowler, 1991). For example the first sound in 'dry' may be classified by a number of children as /d / rather than /dʒ/; however as they learn more about conventional orthography, they take notice that the sound /d/ is always spelled with the letter 'd' and thus their classifications gradually change; (b) children start to rely more on conventional spellings, resulting in producing less unconventional spellings, but producing spellings of sounds that are used in the wrong context. For instance the phoneme /æ/ in 'plaid' is usually misspelled using 'a' rather than 'ai' ('plad'); (c) as children's knowledge about orthographic patterns increases, they make generalizations about letter sequences that either occur in words or not (Treiman, 1993; Pick et al, 1978); (d) children realize that morphemes are usually spelled in a consistent fashion. Treiman, Cassar and Zukowski's study (1994) on the spelling of words such as 'dirty' and 'attic' showed that children misspelled words containing *flaps* that signaled a morphological

boundary less often than when they did not (a *flap* is the phonetic term used for the pronunciation of the medial consonant in words like 'dirty' and 'attic' in American English; the phonetic value of the 't' is [d] in both cases. For example they produced more correct spellings of the word 'dirty' than the word 'attic'. It was argued that children used the stem 'dirt' to aid them to spell the *flap* of 'dirty' with 't'.

Treiman's work on the analysis of the phonological features of words, which indicated that children may employ a letter name strategy, is supported by Varnhagen, McCallum and Burstow's study (1997). In an attempt to examine the stage-like nature of children's spelling development, this group of researchers obtained naturalistic writing samples from 272 native English children attending first to sixth grade in a large elementary school. They randomly selected thirty-five stories from each grade. Their analysis of the children's spellings was concentrated on two spelling patterns that have been shown in the literature to undergo changes across several spelling stages: (i) marking a long vowel in a closed syllable with a silent -e at the word ending, e.g., lake, and (ii) affixing the past tense marker -ed, e.g., peeked. Words containing a silent -e long vowel at the end were classified as a precommunicative spelling if most of the phonemes were not represented, as a semiphonetic spelling if it included at least the initial and final consonant letter and either did not represent a letter or the vowel was inappropriate. A word was categorized as a phonetic spelling if the consonants were represented by the correct letters and the vowel was spelled using the appropriate long vowel letter name. Transitional spelling was considered to be an incorrect marking of the long vowel sound. Finally correctly spelled words were classified as correct. As far as the -ed words are concerned, these were separated on the basis of their phonological properties (into /t/, /d/ and /əd/ words) for classifying their spellings into the intermediate stages. A spelling was classified as

precommunicative if few of the phonemes were represented and correct if the –ed marker was correctly represented.

Based on developmental stage theories it was hypothesized that children's spellings of long vowel and past tense words would go through qualitative changes from grades one to six. Additionally it was hypothesized that individual children would produce spelling patterns consistent with a specific developmental spelling stage. Statistical analyses revealed that children's spelling of silent –e long vowels and the spelling of different types of –ed past tense words did not follow a strict developmental sequence through distinct stages. On the contrary spellings were found to progress from the phonetic stage directly to correct spelling. It was also found that most incorrectly spelled words fell into the phonetic stage category, but there was noticeable variability in errors within this stage, reflecting children's variability in phonological knowledge and strategies. These findings stress the inadequacy of present stage models to accurately describe children's spelling acquisition. Thereafter the authors suggested that the naturalistic approach adopted by Treiman (1993, 1994) may be more useful in comprehending the nature of spelling development; a more specific developmental theory that focuses on the ways children progress, generalize and alter their strategic behaviour within small domains could provide a more precise account of how children's spelling skills are acquired.

Stage models describe spelling development in terms of a sequence of developmental stages during which children's ability to spell progresses from novice to expert levels. The spelling process has also been conceptualised by models that separate lexical and phonological strategies involved in spelling, namely dual-route models.

The dual-route account postulates that there are two different mechanisms that spellers use in order to produce the spelling of a word (Brown and Ellis, 1994). One route is called the 'non-lexical' or 'sound-to-spelling translation' or 'assembled', and the other route is called the 'lexical' or 'direct' or 'addressed' route. The role of the 'lexical' route is to retrieve the spellings of known words from an orthographic output lexicon in which they are stored. This route can be explained in detail with reference to the English word 'cat'. In a dictation task the word 'cat' firstly would be auditorily recognized and then, as Brown and Ellis (1994) describe it, the word 'would activate its corresponding representation in the orthographic output lexicon, either via the word's meaning or via its output phonology (in a spoken word production system)' (Brown and Ellis, 1994, pp. 31). It may be argued that the 'lexical' route could be reliably correct for known words, but it could not on its own be able to spell correctly new words or non-words.

The 'assembled' route is responsible for encoding information about the correspondences between sound and spelling patterns, or in other words it is responsible for the application of knowledge of the ways in which the constituent sounds of a word are conventionally produced in spelling (Brown and Ellis, 1994). This route can also be explained with reference to the English word 'cat'. In a dictation task the spoken word 'cat' firstly would be held temporarily in the phonological buffer, which may be related to the 'articulatory loop' of short-term memory, and then each segment of the word is subject to a process of sound-to-spelling conversion. The 'non-lexical' route is appropriate for the correct spelling of regular words, such as 'hot', 'hat', 'mat' etc. However, an irregular word, such as 'yacht' would not be spelled correctly through this route, since this type of words require the involvement of lexically-specific knowledge. When the spelling of a word has been retrieved lexically or non-lexically, it is held in the graphemic output buffer (GOB)

while output processes, which can take the form of writing, oral spelling or typing, are being prepared and implemented.

The dual-route architecture of spelling has received support by cognitive neuropsychological investigations of patients with acquired disorders of spelling competence as a result of brain damage. The notion that the two routes are separate derived from evidence of dissociations found between patients with phonological and surface dysgraphia. Patients with phonological dysgraphia are unable to spell nonwords correctly, but are accurate at spelling most words (Shallice, 1981; Roeltgen, Sevush & Heilman, 1983). On the other hand patients with surface dysgraphia appear to spell nonwords correctly, but are impaired in spelling words with irregular or exceptional sound-to-spelling correspondences (Hatfield & Patterson, 1983; Goodman & Caramazza, 1986a; Baxter & Warrington, 1987). Phonological dysgraphia has been interpreted as an impairment in the assembled system (intact lexical system), whereas surface dysgraphia as an impairment in retrieving lexical representations (and therefore over-reliance on the assembled route).

The neuro-psychological evidence clearly demonstrates the dissociations of the lexical and sublexical routes. However, whether this dissociation is evident among normal spellers has been challenged by many researchers. This question has been addressed by studies of lexical priming of nonword spelling, which investigated the effects of lexical knowledge on the sublexical system. Campbell's important study (1983) examined the hypothesis that assembled spelling within normal spellers is a function or property of the lexical spelling system. Participants were presented orally with lists of words and pseudowords and they were asked to write down only the pseudowords. She found that

hearing a word containing an ambiguous segment affects the immediate spelling productions of nonwords. For example participants who heard the word 'crane' tended to spell /prein/ as 'prane', and those who heard the word 'brain' spelled the pseudoword as 'prain'. These priming effects suggest that a word that is presumably processed via the lexical route can influence the spelling of a nonword that is processed by the sublexical system. Campbell argued that her data supports a lexical analogy model of assembled spelling.

Campbell's study was extended by Barry and Seymour (1988). In their experiments they manipulated within the prime words the frequency with which spelling patterns represented vowel sounds in words; they called this the 'sound-to-spelling contingency' effect. It was proposed that when a spelling pattern is the most common way of representing a vowel sound, it has high sound-to-spelling contingency. On the other hand when a spelling pattern rarely represents a vowel sound, it has low sound-to-spelling contingency. Barry and Seymour observed two main effects; nonword spelling was lexically primed, and sound-to-spelling contingency influenced nonword spelling. Their interpretation of this pattern of results differed from Campbell's 'lexical analogy' argument. They proposed a dual-route model of normal assembled spelling in which the two routes operate in functional interaction. In this model vowel phonemes are related to weighted lists of alternative spellings sorted out by sound-to-spelling contingency. A set of probabilistic sound-to-spelling correspondences that map phonemes onto spellings is abstracted from lexical knowledge, but their representation is separate from it. Evidence from subsequent studies supported Barry and Seymour's model (Baxter & Warrington, 1987; Burden, 1989). In addition Seymour and Dargie (1990) found effects of semantically mediated priming. Adult participants were orally presented with a mixed list

of words and nonwords and were asked to put them in writing. In some cases words were associatively related to another word that had in common a vowel-consonant rhyme with the nonword that followed. It was shown that when participants heard the word 'coffee' and had to spell the nonword /stii/, they spelled it as 'stea' (via 'tea'), whereas when they heard the word 'forest' they spelled it as 'stee' (via 'tree'). This finding is a clear indication that lexical-semantic processes are involved in nonword spelling.

Recently Perry (2003) examined the effect of lexical priming through intervening items. Three experiments were carried out. The first included the classical lexical priming paradigm, but apart from the prime-target condition, two more conditions were added; in these conditions the prime and target words were separated by one and two intervening items (nonwords). The second experiment was identical to the first with the exception that participants were asked to write both words and nonwords; the fillers were words. In the third experiment, which was similar to the second, the 'subsyllabic repetition' effect was examined (the probability that two rhyming nonwords would be given the same orthographic body spelling) and not the lexical priming effect. The goal of the experiments was to identify the locus of the lexical priming effect. It was hypothesized that when increasing number of fillers are used between prime and target, a sudden drop in the size of the priming effect would be evident; this prediction was considered to support the idea that the lexical priming effect derives from residual activation. In the case that the priming effect has its roots to other sources, like changes in resting activation levels, it was expected that priming effects would not drop in size quickly with increasing number of filler items. Strong effects of word priming were found in all the conditions, especially when no intervening items were used. There was also a significant subsyllabic repetition effect. The authors argued that their evidence could be better

explained within the dual-route interactive model proposed by Barry and Seymour (1988), in that “exposure to a word or nonword primes sound-spelling correspondences and orthographic entries...” (p.528). It seems that changes in resting activation levels of sound-spelling rules occur, that influence which spelling will be used for a nonword. The findings are not consistent with connectionist models, since they suggest that the lexical priming effect is not likely to derive from residual activation.

Alternative accounts for interpreting the prime effect on nonword spelling come from fairly recent connectionist models of spelling (Nation, 1997; Houghton & Zorzi, 1998; Shallice, Glasspool & Houghton, 1995). In such frameworks the activation of a nonword is influenced by residual activation; when the preceding word and the nonword to be spelled share phonology, the word might leave residual activation responsible for biasing the spelling of the nonword (Perry, 2003). Within connectionist models when the phonology-to-orthography route responsible for nonword spelling partially activates various spelling correspondences that have to compete for being selected, the residual activation might bias the competition, resulting in correspondences similar to the prime word having higher probability to dominate in this competition.

It is clear that the evidence reported so far, that letter choice in nonword spelling depends on lexical influences, cannot be accommodated by the standard dual-route model (Ellis & Young, 1988; Morton, 1989). On the other hand, connectionist models have been speculated to encounter difficulties with nonword spelling and the accommodation of ‘phonological dysgraphia’ (Seymour, 1992). Stage models are limited in capturing the perplexities of spelling acquisition, whereas models that propose that children’s lexical and phonological strategies work separately have failed to account for certain aspects of

skilled spelling behaviour. Snowling (1994) proposed that spelling acquisition is an interactive process whereby children's lexical and phonological strategies are in an interplay that promotes their spelling development.

It is well documented that spelling development in English is a long-term and complicated process during which children use various cognitive strategies. The skills of phoneme awareness, letter name knowledge, and knowledge of phoneme-grapheme correspondences (Caravolas et al, 2001), as well as the integration of orthographic (Ehri, 1997), and morphological (Bryant et al, 1997) knowledge are necessary for the development of spelling ability among English-speaking learners. Since most research on spelling development has been conducted in the English orthography, the question of whether the acquisition of spelling skills follows a similar pattern in more regular orthographies than English is raised. The developmental aspect of spelling is relevant to the context of the present thesis, as one of its goals was to investigate the role of foundation skills, such as phoneme awareness and rapid naming, in the acquisition of competent spelling skills by Greek children with dyslexia and typically developing learners, as well as to explore the contribution of phonological, orthographic and morphological spelling skills to the acquisition of conventional spelling abilities.

2.2. Deviant Spelling Development in English

Some children seem to have difficulties in developing correct spelling. In terms of stage models, children's spelling difficulties can be seen as a developmental disorder. The notion that children pass through different developmental stages in spelling suggests that some children's spelling problems derive from their inability to pass beyond a particular stage (Brown and Ellis, 1994). Moreover, Ellis' suggestion that there are two separate mechanisms of the dual-route model that develop at different times raises another possible explanation for children's developmental spelling disorders; they may be the result of an over-reliance on one of the two routes. For example, an over-reliance on the lexical route might result in incorrect spelling of those words that are not stored in the lexicon, but their spellings are generated only when the assembled route is in operation. It is therefore important for both routes to be operating optimally in order to produce correct spellings of all words.

Lennox and Siegel (1994) suggested that children with poor spelling skills display a deviant developmental pattern in learning to spell, rather than a delay in their spelling development or immaturity. If this is the case we would expect to find a different pattern of scores in spelling tests displayed by older poor spellers in comparison to younger good spellers at the same spelling level. In their study (1993a) they compared older poor spellers at spelling grade levels three and five to younger good spellers at the same spelling grade levels (matched control group) and found that the former group produced more visual than phonological errors, while the reverse pattern was true for good spellers. Lennox and Siegel argued that poor spellers when compared with good spellers displayed

a deviant developmental pattern in learning to spell, with a greater success in the reliance on visual memory skills than on phonological analysis.

As it has already been mentioned, a commonality of both the developmental and information-processing models of spelling development concerns the importance of children's phonological skills. Good phonological abilities are considered to be necessary for the development of good spelling skills and deficits in phonological processing are often associated with spelling difficulties (Snowling, Stackhouse and Rack, 1986). Snowling and colleagues (1991) showed that children/participants with dyslexia have poor phonological spelling strategies in relation to younger normal readers, which may stem from underlying speech problems. A group of children/participants with dyslexia and a group of younger control children having a reading age of seven years were assessed on a spelling task that contained thirty words of one-, two-, and three syllables. Children's spelling errors were classified either as phonetic (e.g., 'coler' for collar) or dysphonetic (e.g., 'tert' for tent). Both groups spelled equal number of words correctly, but there was a significant difference between the groups' spellings of one- and two-syllable words. The majority of children's/participants' with dyslexia spelling errors were dysphonetic, whereas normal readers produced similar number of phonetic and dysphonetic errors. Additionally children in both groups had great difficulties spelling the three-syllable words; they produced mostly non-phonetic errors.

The phonological deficit hypothesis is consistent with the findings of a study conducted by Bruck and Waters (1988). These researchers compared the performance of good readers/good spellers (Type A) and good readers/poor spellers (Type B) who achieved similar scores on standardized reading tests, but differed in spelling ability. The two

groups were given a number of component reading and spelling tasks to complete. The results revealed that Type B spellers (adolescents) lacked age-appropriate development of the subword transcoding system. Although they had mastered basic correspondence rules, they had failed to adduce higher-level constraints on the use of certain correspondences (e.g., the use of silent E in a monosyllabic word). According to Bruck and Waters, Type B spelling is the result of a phonological processing deficit that affects both reading and spelling. Thus, in their view poor spelling is the result of an interruption of the normal developmental sequence in the alphabetic stage. This hypothesis suggests that Type B spellers may suffer from a mild form of classical developmental dyslexia.

Unlike Bruck and Waters, Frith (1980) suggested that Type B spelling is the outcome of a mild developmental disorder that has an onset and results in a failure to develop orthographic spelling skills. Frith came to this conclusion after a series of interesting experiments (1979; 1980) in which the reading and spelling performance of good and poor spellers matched for reading age was systematically compared. She found that Type B spellers had little difficulty in using correspondence rules to transcode between sound and spelling and spelling and sound. The experiments included a letter cancellation task and reading misspelled or partly obliterate text, which indicated that Type A and Type B adolescent participants were characterized by different reading strategies. Type A spellers attended to a letter by letter decoding strategy, whereas Type B spellers appeared to recognize words on the basis of partial visual cues. The 'full cue' reading strategy adopted by Type A participants provides detailed information about both the identity and position of the constituent letters in words, resulting in accurate recall of the correct spelling. In contrast to this, the partial cue reading strategy that characterizes Type B participants provides incomplete information to the spelling system. Thus, Type B

spellers can only rely on their knowledge of sound-spelling correspondences in order to spell a word; this procedure is likely to result in the incorrect spelling of many of the English words that have an unusual relationship between sound and spelling (e.g., 'love'). Frith hypothesised that Type B spellers experience a developmental lag during the early orthographic stage, during which normal children become 'full cue' readers, they become aware of morphological structures and are also characterized by their ability to analyze written words into orthographic units. This hypothesis is supported by Ehri's study (1991), which showed that participants with good reading but poor spelling skills have inadequate knowledge of the English orthographic system, which consequently creates difficulties in choosing the conventional spelling when there are two plausible alternatives.

The view that poor phonological skills are related to spelling difficulties is not consistent with Bourassa's and Treiman's (2003) recent study that used a spelling-match design for comparing children's/participants' with dyslexia spelling performance to that of younger typically developing children. Thirty children/participants with dyslexia (mean age: 11;1) and thirty spelling-level-matched younger children (mean age: 7;5), all native speakers of English, were tested on two lists of items, each of which contained ten words and ten nonwords. The items derived from the word and nonword versions of the Treiman and Bourassa T-BEST spelling test (2000a). For each participant one list was administered as a dictation task and the other as an oral task. Based on the T-BEST scoring system, children's spellings were scored for correctness (each word was scored as conventionally correct or incorrect), overall sophistication of spelling attempts (a composite score was used reflecting both phonological and orthographic features of spellings), phonological skeleton (assessing whether the spelling attempt had an appropriate sequence of

consonant-vowel graphemes), and orthographic acceptability (a sequence of graphemes that may occur in English was considered orthographically acceptable). It was hypothesized that if the lexicality effect was stronger for the children/participants with dyslexia than for the control group, and if children/participants with dyslexia attained lower scores on the phonological skeleton measures, the phonological deficit hypothesis would be supported. Moreover it was of interest to this study to examine the effect of oral versus written spelling tasks on the performance of children with and without dyslexia. The statistical analyses performed on the measures revealed a lexicality effect in both phonological and orthographic measures, as well as an advantage of written spelling over oral spelling. However the two groups were indistinguishable in correct spelling of real words, phonological and orthographic accuracy, and oral spelling. The lack of significant differences between the spellings of the two groups led the researchers to examine potentially problematic spellings on the T-BEST. In particular the following features were investigated: (i) spellings of intervocalic flaps with 'd', (ii) /t/ and /d/ before /l/ (e.g., drip), (iii) the use of 't' to represent past tense, (iv) the omission of unstressed /ə/, (v) spelling of initial clusters, (vi) spelling of final clusters, (vii) letter-name spellings of vowels and consonants, (viii) the use of final -e and (ix) the use of double consonants. The detailed analysis of particular spellings, in their majority, did not reveal significant differences between the groups. The only significant differences that emerged in post hoc analyses involved children's/participants' with dyslexia difficulty in representing double consonants, and inappropriate use of the final -e. The authors concluded that, although children's/participants' with dyslexia spellings differ from those of younger typically developing spellers in particular subtle ways, the overall processes and strategies employed by children/participants with dyslexia are similar to the ones employed by younger normal children. Furthermore it was argued that the findings do not support the

phonological deficit hypothesis, neither are they consistent with the view children/participants with dyslexia suffer a specific phonological deficit that is evident in spelling. The authors suggested that the spelling-level-matched design does not capture “the nature and causes of spelling problems for children with dyslexia” (p.329).

There is a body of evidence on children’s/participants’ with dyslexia knowledge of orthographic patterns, which showed that these children perform at the same or higher level than younger normally developing children. Nelson (1980) and Pennington, McCabe, Smith, Lefly, Bookman, Kimberling and Lubs (1986) used spelling-level matched criteria between children/participants with dyslexia and younger normal children. The former author classified children’s spelling errors either as orthographically legal (e.g., ‘cack’ for cake) or illegal (e.g., ‘ckak’ for cake). 87% and 82% orthographically legal spelling mistakes were produced by normal children and children/participants with dyslexia respectively; the difference was insignificant. The latter authors showed that both spellers with dyslexia and normal spellers produced approximately 95% orthographically legal spelling mistakes. However on a task measuring complex orthographic accuracy (e.g., correct doubling of the ‘p’ in ‘opportunity’) children/participants with dyslexia were significantly more accurate than their younger spelling-age matched peers.

Similar findings were found in studies that matched children’s/participants’ with dyslexia and younger normal children’s performance on standardized single-word reading measures. Olson (1985) rated children’s spelling errors for phonetic and visual similarity to the target word. Children’s/participants’ with dyslexia errors were found to be significantly less phonetic than those of normal children, but no difference in visual

similarity emerged between the two groups. However it could be argued that this finding reflects differences in spelling ability; normal children could have been worse spellers than children/participants with dyslexia. Siegel, Share and Geva (1995) showed that children/participants with dyslexia were significantly better than normal readers on a task which required children to say which out of two nonwords looked more like a word (e.g., 'moke' and 'moje'). This study, along with Pennington and his colleagues' study, suggest that, although they are typically worse spellers than other children of their age, children's/participants' with dyslexia longer exposure to print has left a residue in some of their visual decision processes, resulting in a relatively less affected ability to discriminate certain misspellings from the correct forms.

The notion that children's spelling ability depends a great deal on their knowledge of orthographic conventions for representing sounds and/or meanings in English was tested by Schwartz (1983; Schwartz & Doehring, 1977). Children's ability to recognize the correct spelling of orthographic and morphological nonwords was assessed. Recognition of orthographic nonwords required knowledge of spelling conventions, whereas morphological nonwords required knowledge of how meaning is reflected in the orthography (e.g., the use of -ed to signify the past tense). The study showed that good spellers were aware of these patterns by fourth grade. Unlike studies that did not report any differences between children/participants with dyslexia and normal readers or spellers, this study found that good and poor spellers differed on both patterns, but mostly on the orthographic pattern. This suggests that knowledge of orthographic representations is a significant determinant of spelling ability and thus, a lack of this knowledge may have a negative effect on the development of correct spelling.

Research on spelling development has indicated the importance of print exposure in the development of children's spelling skills. Stanovich and Cunningham (1992) showed in multiple regression analyses that adults who have 'high print exposure' as measured on the Author and Magazine Recognition Tests, are better spellers even when controls for non-verbal intelligence were included. The same result was found in a study of third- and fourth-grade children (Stanovich and Cunningham, 1990). In particular, they found that print exposure accounted for significant variance in orthographic knowledge, even after partialling out memory ability, phonological processing abilities and IQ. It seems that exposure to the letter sequences of words in reading enables the child to develop orthographic representations that can then be used in spelling. It is therefore implied that inadequate exposure to print may affect the development of children's correct spelling.

Chapter 3. Dyslexia in the English Language

A number of research studies have examined adult patients who suffered from reading and writing disorders. These disorders are caused by brain damage and are referred to as 'acquired dyslexias'. It is of great importance, however to distinguish between individuals who have acquired dyslexia and those who have not lost their ability to read and write, but have not developed adequate literacy skills in the first place. Disorders of the latter kind may be referred to as 'developmental dyslexias' (Castles and Coltheart, 1993).

The description and definition of developmental 'dyslexia' has been a matter of considerable debate between researchers. The first case of developmental dyslexia was reported more than one hundred years ago (Pringle-Morgan, 1896). At that time the disorder was discussed under the term congenital 'word blindness'. In recent years, a widely accepted view is that children/participants with dyslexia have phonological processing deficits (Hulme, Snowling, 1992a; Stanovich and Siegel, 1994; Stanovich 1996). The British Psychological Society (1998) has suggested that the concept of dyslexia can only be logically retained if classification as child with dyslexia is extended to all children who have difficulties in phonological coding as a result of segmental language problems. These deficits reflect children's poorly specified phonological representations (Snowling, 2000). In the early stages of speech development children seem to map the speech they hear from their environment onto their speech utterances; as their phonological systems develop, refinements of the mappings take place gradually (Nitttrouer and Studdert-Kennedy, 1987). During this process the accessibility to underlying phonological representations increases. Snowling and Hulme (1994) suggested that increases in speech rate and verbal short-term memory are associated with

developments within the phonological system. When children face the task of learning to read, they already have an established phonological system that will be the basis for mapping spoken words onto their written form, and subsequently develop a reading system that will be able to generalize to new words and produce their pronunciation efficiently. It follows that children who come to the task of learning to read and write with poorly specified phonological representations will inevitably experience serious difficulties. Phonological processing difficulties have been recognized as the core deficit of dyslexia (Stanovich and Siegel, 1994).

The hypothesis that children with dyslexia have difficulty at the level of phonological processing fits with a number of recent theories of reading development, which propose that children set up direct mappings between printed words and representations of spoken words in their language system (Ehri, 1992; Goswami, 1994; Rack, Hulme, Snowling and Wightman, 1994). It is assumed that the level of a child's phonological representations determines the ease with which they learn to read (Hulme and Snowling, 1992). It is extensively documented that pre-school phonological awareness is a strong predictor of later reading attainment, even after the effects of IQ have been partialled out (Bradley and Bryant, 1983; Lundberg, 1994). However children's with dyslexia poor skills in manipulating the phonemic structure of words places difficulties in establishing the alphabetic principle (Byrne and Fielding-Barnsley, 1989).

Evidence in support of the hypothesis that dyslexia could be regarded as part of the continuum of language difficulties, and that it is a verbal processing deficit (Vellutino, 1979) comes from a variety of both behavioural and biological sources. Behavioural evidence includes: (a) studies that have used measures that tap underlying phonological

representations, such as verbal short-term memory, naming, verbal repetition, and phonological awareness, (b) studies that examined children's/participants' with dyslexia difficulties with language processing and used measures of speech perception and production, and (c) studies on nonword reading. Biological evidence in support of the core phonological deficit comes from studies on (a) the heritability of dyslexia, and (b) functional processing difficulties between dyslexic and normal brains; the latter studies have used brain-imaging techniques like PET scans. We will consider these studies separately.

Children with dyslexia have very often been reported to show poor short-term memory skills. The numbers of verbal items that are remembered by children/participants with dyslexia are fewer (Hulme, 1981; Shankweiler, Liberman, Mark, Fowler and Fischer, 1979), and the time in which they are retained in short-term memory is shorter than expected for their age (Hulme, Newton, Cowan, Stuart, and Brown, 1999). It has been suggested that poor short-term memory reflects an impairment in phonological coding, which in turn limits the number of verbal items that can be retained in memory, and has a negative influence on working memory (Snowling, 2000).

It has been shown that apart from difficulties in encoding verbal items into phonetic forms, children/participants with dyslexia have problems with speech rate and ability to draw upon long-term memory representations; the latter two skills are involved in the rehearsal mechanisms that refresh memory trace and in the redintegration processes responsible for reconstructing decaying memory representations (Hulme and Roodenrys, 1995). McDougall, Hulme, Ellis and Monk (1994) found that poor readers' speech rates are slow. Children's/participants' with dyslexia limitation to employ redintegration

processes due to their deficit in retrieving verbal information from long-term memory has been shown to impair their ability of sound blending during the process of decoding, and therefore affect learning to read (Baddeley, 1986; Torgesen et al, 1989).

A consistent finding among studies on dyslexia is that children perform poorly on naming tasks that require the explicit retrieval of verbal information from long-term memory (Denckla and Rudel, 1976a and b). Studies on naming have used two types of tasks: (a) naming-to-definition that refers to the procedure in which participants have to provide a name in response to the verbal description of an object and (b) confrontation naming that refers to the procedure whereby participants are shown the picture of an object and have to provide its name. Findings from both paradigms have shown that children's/participants' with dyslexia naming skills are poorer than same-age normally developing children's and they cannot be attributed to lack of semantic information for the test items. In their first experiment Snowling, Van Wagtendonk and Stafford (1988) asked twenty children/participants with dyslexia and twenty-nine normal readers of the same age (7;10- 11;11) to name objects depicted by pictures or following their spoken definition. The analyses showed differences between 10-year-old children/participants with dyslexia and same-age controls; the former group named fewer objects correctly, but performed at the same level as younger normal readers. When the naming latencies were examined, no group differences were apparent. In the second experiment eleven 9-year-old children/participants with dyslexia and thirteen same-age controls were compared in relation to their performance on a receptive vocabulary test which required participants to match pictures to spoken words; again no difference was found between the groups. However on a picture naming task the participants with dyslexia performed significantly

worse than the control participants. The authors argued that children's/participants' with dyslexia phonological representations for some words are not well specified.

Studies using confrontation-naming tasks, whereby children are presented with the picture of an object and are asked to provide its name, have produced equivocal results. Katz (1986) examined 8-year-old children's/participants' with dyslexia performance on an object-naming task in comparison to same-age average and good readers. It was found that children/participants with dyslexia were less accurate than controls; more specifically they produced higher error rates when the names were multisyllabic words of low frequency. The interpretation of these results, however, cannot be straightforward due to the lack of a younger reading-level-matched control group. Snowling, Van Wagendonk and Stafford (1988) tackled this limitation by including a younger reading-level-matched control group in their study. Nation, Marshall and Snowling (2001) tested the hypothesis that children's with dyslexia difficulty with the retrieval of the names of familiar objects reflects inadequate phonological representations and not semantic ones. Indeed it was found that children/participants with dyslexia made more semantic errors than younger reading-level matched children (e.g., sword → 'knife'), and the proportion of phonemes shared between target word and wrong word was higher for children/participants with dyslexia indicating that there was a stronger phonological association between naming errors and target words for the dyslexic group than the control group. Snowling (2000) argued that the evidence from studies on naming skill is indicative of a developmental dissociation between receptive and expressive vocabulary skill, which is attributed to children's with dyslexia phonological representations of known words lacking in specification.

Another naming task that has been extensively used in recent studies is the task of rapid automatised naming (RAN), which involves naming highly familiar objects, colors, digits or letters under speeded conditions. Denckla and Rudel (1976a and b) introduced this task; items were arranged in matrices consisting of 50 randomized stimuli in a 10 x 5 format. A recent format of the task is a 9 x 4 (36 items) (Wagner, Torgesen, and Rashotte, 1999). RAN tests assess children's time of naming the stimuli using a stopwatch. There is robust evidence that children/participants with dyslexia and adults with a history of developmental dyslexia are significantly slower than normal readers in rapid naming (Wolf, 1986; Felton and Wood, 1989; Pennington, Orden, Smith, Green, and Haitl, 1990). According to the phonological deficit hypothesis children's/participants' with dyslexia poor performance on RAN tasks is due to poorly specified representations of the phonological forms of words, but their semantic representations are intact (Snowling and Hulme, 1994). In this respect it is assumed that rapid naming difficulties affect reading skills (Torgesen, Wagner, Rashotte, Burgess, and Hecht, 1997; Wagner, Torgesen, and Rashotte, 1994).

Children's with dyslexia poor performance on verbal repetition tasks has been considered to reflect problems in establishing and accessing adequate phonological representations. Snowling (1981) assessed readers with dyslexia and younger normal readers on a verbal repetition task that contained multisyllabic words, such as 'magnificent', and nonwords that were matched to the words on phonological structure (e.g., 'bagmivishent'). It was shown that children's/participants' with dyslexia performance was efficient when they had to repeat the words, but not when they had to repeat the nonwords. In order to rule out the hypothesis that this difficulty was due to difficulties in perceiving complex nonwords, the experimenters devised and administered an auditory discrimination task,

whereby children had to decide whether two nonwords were the same or different. The items differed in terms of a single phonetic feature. The lack of any differences between the groups led the authors to conclude that children's/participants' with dyslexia difficulty with verbal repetition was related to difficulties with segmentation processes that operate prior to creating a new motor programme for executing the articulation of a nonword.

Snowling, Goulandris, Bowlby and Howell (1986) sought to examine the argument made by Brady, Shankweiler and Mann (1983) that children/participants with dyslexia can perform more accurately in verbal repetition when the auditory signal is more distinct. They assessed children/participants with dyslexia whose reading level was two years behind the expected level for their age, and compared them to a chronological-age control group and a reading-age control group on the monosyllabic words of high- and low-frequency used in the Brady and colleagues' paradigm; they also assessed them on nonwords that derived from the high-frequency words. Moreover, three sets of stimuli had to be repeated for the purposes of assessing proficiency of phonological processing with and without lexical support. Both groups' performance was found to deteriorate in the noise masking condition, suggesting that children's/participants' with dyslexia difficulty with verbal repetition cannot be depicted at the level of perceptual processing. Participants' with dyslexia performance was poorer than both control groups' when they had to repeat nonwords; when they had to repeat low-frequency words, they were significantly less accurate than the same-age control group. It was argued that children/participants with dyslexia have a deficit in the system of analysis and segmentation prior to constructing a new motor programme for articulation of nonwords.

Children's with dyslexia poor performance on phonological awareness tasks has been consistently reported in dyslexia literature. Metaphonological awareness or phonological awareness as it is widely used in the English literature, refers to the specific metalinguistic ability of identifying the phonological components in linguistic units and intentionally manipulating them (Gombert, 1992). Phonological awareness might refer to small speech segments (phonemes) or to larger segments, such as syllables, or intrasyllabic units, such as onsets and rimes.

Several studies have demonstrated that a child is capable of distinguishing between linguistic and non-linguistic sounds at a very early stage of his/her life (before the age of three) (Smith and Tager-Flusberg, 1982), and experimenting with the morphophonological characteristics of language. Children's experimentation with language contributes to the development of their ability to produce rhymes, on their own or on request, and subsequently their ability to recognise rhymes in artificial contexts (Gombert, 1992). The ability to effectively engage in such activities does not imply that the child has to "possess either a reflective attitude towards the phonological composition of language or any awareness of manipulating constituent elements of meaningful segments in the speech chain [...] these are manifestations of an epiphonological order based more on intuition than on any real reflection" (Gombert, 1992, p.36). This type of segmentation can be obtained from tasks that require the child to reproduce "just a little bit" of a word (Fox and Routh, 1975), or from tasks that require the removal of the final syllable of a word, or from tasks in which children have to judge whether two words rhyme. In addition a rhyme oddity task, in which the child is asked to identify the odd word between some words that share a common sound, can be indicative of an epiphonological awareness of rhyme (Duncan, Seymour, Hill, 2000). In Gombert's (1992)

view the majority of the epilinguistic controls do not emerge before the age of five years. Most of these controls are acquired between the age of five and six years. The progression from this level to the level of metalinguistic functioning takes place when the child begins to learn how to read. It is, therefore, at about the age of 6 to 7 years that the first forms of metaphonological awareness are generally identified. There seems to be an interval between the emergence of metaphonological awareness and "that of deliberate control of the means of processing the phonological components of language" (Gombert, 1992, p.36). Indeed, it has been found that it is more complex for children when the task extends beyond simply connecting phonemes to identifying them. In Calfee et al's (1973) study children aged 6-17 were orally presented with phonemes in syllables and were asked to arrange colour cubes in a way that would reflect the arrangement of the phonemes in the syllables (/i/ and /p/ in /pi/, /ip/, /pip/...). In the second test children were verbally presented with more complicated syllables and at the same time they were shown the arrangement of cubes reflecting the syllables. They were required to create different syllables using the same phonemes (e.g., "here is /ips/, please show me /psi/"). The results showed that children of eight years old and over gave the majority of correct answers. It should also be mentioned that one third of twelve-year-old children failed the test. These findings indicate that metaphonological ability to identify phonemes develops at a later stage.

Studies on the relationship between children's phonological awareness and reading have established the ways in which phonological awareness progresses and how the sequence of this progression is related to literacy. More specifically, two opposing current theoretical positions have been identified: the "small unit" theories and the "large unit" theories (Duncan et al., 1997). Small unit theories postulate that awareness of phonemes

emerges before awareness of rhyme and is the prerequisite for the acquisition of literacy skills (Byrne, 1998; Byrne and Fielding-Barnsley, 1989; Liberman and Shankweiler, 1979). On the other hand, there is evidence that phonological awareness is the consequence of literacy, rather than a prerequisite (Read et al, 1986; Mann, 1986; Patel and Soper, 1987). Morais and his colleagues (1979) studied a group of illiterate Portuguese adults. This group was compared to a similar adult group who had learned to read in programmes of adult literacy. Two tasks were given to both groups, an addition and a removal task. The results showed that the illiterate group made more mistakes in the tasks than the literate group, although the former did manage some of the words (46% success in the addition task with real words). It was concluded that phonological awareness skills emerge from learning to read. Morais, Alegria and Content (1987) argued that learning how to use the alphabet affects directly children's awareness of phonemes and that the phonological units involved in awareness of rhymes have a global character therefore they cannot have a significant effect on children's reading.

Large unit theories hold the view that a pre-literate sensitivity to a large unit, such as rime, is capable of determining early literacy development (Lundberg et al., 1980; Bradley & Bryant, 1983; Lenel & Cantor, 1981; Goswami & Bryant, 1990). As Duncan et al. argued, the point in which "small unit" and "large unit" studies are different regards the types of tasks used to measure phonological skills. Usually awareness of rhymes is measured by oddity tasks, whereas awareness of phonemes is assessed by segmentation tasks. These two tasks impose different cognitive demands upon children. The first type (rhyme oddity) requires the child's judgement on the basis of global similarity between words (Duncan et al., 2000), while the second type of phonological task requires the isolation of the sounds within the word. Duncan et al. concluded that these tasks are

different not only in the unit of sound (large, small) that is investigated, but also in the level of phonological awareness that is required.

The significance of phonological awareness in reading and spelling ability has been stressed by studies on dyslexia, which clearly showed that dyslexic participants (children and adults) have impaired phonological skills in comparison to same-age and younger reading-level matched controls (Olson, Kleigel, Davidson & Foltz, 1985; Campbell & Butterworth, 1985; Pennington, Orden, Smith, Green & Haith, 1990; Bruck, 1990; Manis et al, 1993).

Bruck's study (1992) shows characteristically the relationship between poor phonological awareness skills and dyslexia. This researcher sought to examine the association of age and reading level with the phonological awareness abilities of readers with dyslexia and normal readers with particular reference to the development of different types of sublexical unit (syllable, onset, rime and phoneme) awareness among readers with dyslexia and normal readers, as well as with reference to the extent to which children/participants with dyslexia use orthographic information when they make phonological judgments. The sample of the study included two sub-samples which formed the experimental groups and the control groups: (a) 36 school-age children/participants with dyslexia who were recruited from a dyslexia clinic (age range: 8-16 years), (b) 39 adults with childhood history of dyslexia who were identified from the patient files of the same clinic; half of them were university students and half had received no further formal education after completing school, and (c) four groups of good readers and spellers (13 first graders, 15 second graders, 15 third graders and 20 college students). All participants were tested on a word recognition subtest of the WRAT-R and

for the experimental groups there was available data on their verbal and nonverbal ability. The experimental tasks measuring phonological awareness skills included syllable and phoneme counting and phoneme deletion; all stimuli were nonwords. Two different patterns of results emerged. Children/participants with dyslexia showed poorer awareness of onset-rime than same-age and reading-age control children, whereas dyslexic adults were similar to normal college readers (ceiling effects). It was suggested that as children's/participants' with dyslexia reading skills improve, they master appropriate levels of onset-rime awareness. On the other hand results obtained from the phoneme awareness tasks suggest that phoneme awareness does not increase as word recognition skills improve, but phoneme awareness difficulties persist over time and cannot be attributed to a developmental delay. Nonetheless there was some evidence suggesting a developmental increase of phoneme awareness. In contrast, it was shown that normal readers' phoneme awareness improves as a function of reading ability, but not onset awareness, which is mastered at an early age. Additionally it was found that participants with dyslexia did not rely on orthographic information when making phonological judgments, suggesting that children's with dyslexia initial phonological deficit creates difficulties with learning to read; later on when their word reading skills are acquired, the interaction between orthographic and phonological codes is limited and therefore restricts the development of phoneme awareness. Overall the data of this study is consistent with the hypothesis that children/participants with dyslexia suffer from a pervasive phonological deficit that is evident throughout their lifetime.

A number of studies have explored the hypothesis that dyslexia is a consequence of problems in basic language processing skills. These studies used tests of speech perception and speech production, but their findings are not clear-cut (Brady, 1997;

McBride-Chang, 1996). The perception of stop consonants by children with dyslexia and normal readers was investigated in the study by Brandt and Rosen (1980). It was found that children/participants with dyslexia performed like children at an earlier stage in their development. A similar pattern of results was found by Godfrey, Syrdal-Lasky, Millay, and Knox (1981). On the other hand Hurford and Saunders' study (1990) revealed group differences in a syllable-pair discrimination task for second-graders, but not for fourth-graders. The studies by Adlard and Hazan (1997) and Manis, McBride-Chang, Seidenberg, Keating, Doi, Munson and Petersen (1997) reported slight differences between children/participants with dyslexia and control groups. The latter group of researchers showed that children's/participants' with dyslexia slope of the identification function on a categorical perception task was shallower than CA controls'. More detailed scrutiny of their data revealed that only seven out of the twenty-five children/participants with dyslexia appeared to have perceptual impairments. However the interpretation of the results on speech perception cannot be straightforward, as speech perception tasks require a high degree of attention, and children/participants with dyslexia with short attention span may find them difficult to attend to (Snowling, 2000). Additionally other cognitive skills may interfere in the completion of these tasks, such as verbal labeling. Children/participants with dyslexia who have these skills in their disposal are prone to perform accurately in speech perception tasks.

Readers' with dyslexia impaired reading of nonwords can be regarded as strong evidence in favour of the core phonological deficit hypothesis (Van Ijzendoorn & Bus, 1994; Manis et al, 1993). The pioneering studies by Snowling (1980, 1981) indicated children's/participants' with dyslexia nonword reading deficit in relation to younger normal readers. The first paradigm (1980) used was nonword matching. The stimuli were

monosyllabic nonwords of four letters that represented either three or four phonemes. The experiment included four conditions, and participants were presented with successive stimuli either visually or auditorily and were asked to decide if the nonwords were the same or different. In the visual-auditory condition, which was of particular interest to the study, normal readers' performance was found to improve as their reading age increased, whereas children's/participants' with dyslexia performance showed little improvement suggesting that they were learning to read by building up their sight vocabulary, but at the same time without developing their decoding ability. In the second experiment (1981) children/participants with dyslexia of varied reading skill and reading-age controls were asked to read aloud nonwords; half of the stimuli contained one syllable and half contained two syllables, and each syllable contained two consonant clusters the most. Accuracy and time were measured. The results supported those of the first study; children's/participants' with dyslexia nonword reading performance was less accurate and slower than normal readers'. In addition a significant effect of phonological complexity was found. Although children with dyslexia and control children differed in reading of two-syllable nonwords, they performed at the same level when they read monosyllabic nonwords. It was concluded that children/participants with dyslexia were able to use some phonological reading strategies and their nonword reading skill did show an improvement as their reading age increased.

The longitudinal study by Snowling, Goulandris and Defty (1996) showed that children/participants with dyslexia, who were originally marginally more accurate in nonword reading than the younger reading-level matched readers, were found two years later to be significantly impaired in nonword reading. This was in line with Snowling's findings (1980). Dyslexic decoding skills failed to develop over time.

Rack, Snowling and Olson (1992) conducted a thorough narrative review of a series of published studies that used the nonword reading paradigm in the context of the reading-level match design. It was shown that the majority of the reviewed studies had found significant differences in decoding skills between readers with dyslexia and normal readers, while the word recognition skills of the two groups were equivalent. This evidence was taken to fully support the phonological deficit hypothesis. With respect to the one third of the reviewed studies that had not found phonological ability differences between children/participants with dyslexia and normal children, it was suggested that these discrepant findings could be due to the differences in the age of the children/participants with dyslexia included in the studies, variations in IQ between the groups, the complexity of the nonwords used, and the reading remediation that children/participants with dyslexia might have received.

Rack et al's review was two years later supplemented by the quantitative meta-analysis conducted by Izjendoorn and Bus (1994). The 16 studies reviewed by Rack and colleagues were included in the meta-analysis in order to estimate the overall effect size of the studies, as well as the factors that contribute to the variability of effect sizes in separate studies. The meta-analysis revealed a difference of about half a standard deviation on nonword reading between children with dyslexia and younger normal readers, whereas no difference in word recognition skills was found between the groups. The authors strongly argued that their findings support the phonological deficit hypothesis to such an extent that it can be considered an established fact and that it would need 423 further studies with null results to prove the phonological deficit hypothesis of dyslexia implausible. Similarly to Rack et al's review the factors that determined the existence of group differences were the matching criteria: IQ, age, and reading level on

word recognition measures yielded more differences on the nonword reading tasks. However the absence of a relation between normal readers' age and size of decoding deficit contradicted Rack, Snowling and Olson's suggestions. In addition no effect of type of nonword stimuli and special remediation programmes that children/participants with dyslexia might have participated in was reported in the meta-analysis.

Finally, the phonological deficit hypothesis has found support in studies that investigated the biological origins of dyslexia. In 1925 it was proposed that family members of children/participants with dyslexia also had spoken language difficulties. Nowadays there is a significant body of evidence supporting the heritability of dyslexia (Pennington, 1994). Gilger, Pennington and Defries (1991) estimated that a male individual runs the risk of becoming dyslexic by 40 per cent when his father is dyslexic, and by 36 per cent when his mother is dyslexic. A female individual runs a slighter risk of 20 per cent either when the father or the mother is dyslexic.

Olson's and his colleagues' influential studies have examined the heritability of reading subskills, namely phonological decoding skill, orthographic reading skill and phonological skills that underlie reading. In their 1989 study Olson, Wise, Connors, Rack and Fulker assessed a twin sample on a nonword reading task that measured both accuracy and speed, and a task in which participants had to decide which of two letter strings sounds like a word; for assessing orthographic skills they used an orthographic choice task, whereby children had to decide which of two homophones is a real word, and an exception word reading measure. Rhyme and phonemic segmentation were used to assess segmental language skills. They found that phonological coding and not orthographic coding was significantly heritable. Additionally it was shown that

phonological coding shared genetic variance with segmental language abilities. However, a recent study by Gayan and Olson (2003) reported that both phonological and orthographic coding skills in word recognition had significant common, as well as significant independent, genetic effects.

Studies using brain-imaging techniques, such as PET scans, have explored children's/participants' with dyslexia deficits in phonological processing (Paulesu et al, 1996). A recent important study on the neuro-cognitive universality of dyslexia was conducted by Paulesu and other researchers (2001) from different European countries (England, France and Italy). As expected participants with dyslexia reading a shallow orthography like Italian were found to perform more accurately on reading tasks than their English and French counterparts; nonetheless all participants were found to have the same degree of impairment on reading latencies and phonological tasks when compared to their controls. Participants with dyslexia from all countries showed reduced brain activity in a region of the left hemisphere during reading, with the maximum activation peak observed in the middle temporal gyrus, and further peaks in the inferior and superior temporal gyri and middle occipital gyrus.

The behavioural and biological evidence reported so far clearly suggests that individuals with dyslexia have impaired phonological processing skills and therefore is consistent with the phonological deficit hypothesis. Even though the phonological deficit hypothesis fits well with the strategies and processes used in typical reading development (Frith, 1985; Rack, Snowling and Olson, 1992), as well as with findings across the life-span (Bruck, 1992, Pennington et al, 1990; Snowling et al, 1997), it has a number of limitations.

Snowling (1998, 2000) pointed out that the core phonological deficit hypothesis does not provide an answer to the important question of whether the phonological deficit in dyslexia that is related to high IQ is the same or different to that related to low IQ. Some phonological processing tasks, such as nonword repetition, are not correlated with IQ, and naming tasks are closely associated to vocabulary skills. On the other hand complex metalinguistic tasks are more closely related to IQ.

The core phonological deficit model of dyslexia has also been acknowledged to be limited to phonology and the development of decoding ability (Snowling, 1998). Proficiency in reading is associated with decoding, as well as linguistic comprehension abilities (Gough & Tunmer, 1986). Nation and Snowling (1998b) found stronger effects of context on single-word reading for children/participants with dyslexia than younger normal readers, suggesting that, although children/participants with dyslexia have decoding difficulties, their reading comprehension ability can be normal and serves as a compensatory process.

The core phonological deficit hypothesis has also been criticized on the basis that it is not consistent with empirical findings that showed that reading difficulty was not linked to phonology. Indeed there is increasing support for the view that children/participants with developmental dyslexia are not a homogenous population, but fall into distinct subtypes (Boder, 1973; Mattis, French and Rapin, 1975; Marshall, 1984). There are children/participants with dyslexia who seem to have mastered alphabetic skills; these children are referred to as children/participants with developmental surface (or morphemic) dyslexia (Coltheart, Masterson, Byng, Prior and Ridloch, 1983; Seymour, 1986; Castles and Coltheart, 1993). Coltheart and Jackson (Coltheart and Castles, 1993)

have stressed that it is possible to find severely children/participants with dyslexia who read non-words as well as age-matched controls. Hence, their disagreement to the 'proposal that dyslexia should be restrictively designated as a purely phonological disorder' could be correct (Seymour, 1998, p.22).

These authors have attempted to define dyslexia in terms of the proximal (i.e., the component processes involved in reading), rather than the distal (i.e., biological, environmental or cognitive causes that affect reading performance indirectly via their impact on the reading system) causes of this disability. According to their view the cognitive functions that are developed for supporting literacy have an internal modular structure of high complexity. The analysis of reading difficulties should be seen as a matter of identifying the subset of reading processes that have failed to develop (Coltheart, 1978). However the identification of the component processes that can be the candidate proximal causes of dyslexia can be problematic, since different theorists will identify different processes (Seymour, 1998).

Research on acquired dyslexia has provided support for the dual route model in that the symptom patterns displayed by some individuals with acquired dyslexia appear to reflect specific damage to one or the other of the two procedures (Marshall and Newcombe, 1973; 1981; Patterson, 1981; Patterson, Marshall and Coltheart, 1985). These studies report cases of participants with acquired dyslexia who could read aloud non-words and regular words, but had difficulty with irregular words. These errors are referred to as 'regularization' errors: irregular words are pronounced according to the traditional grapheme-phoneme conversion rules, e.g., the word 'yacht' is pronounced /jɒt/ (Bud et

al, 1985). This pattern of symptoms indicates a selective damage to the lexical process of reading aloud and is defined as surface dyslexia.

On the other hand, some children/participants with dyslexia are able to read aloud both regular and irregular words, but find it difficult to read non-words (Patterson, 1982). This specific difficulty is defined as phonological dyslexia, since it appears to reflect damage to the sublexical process of reading aloud.

Individual case studies of children/participants with developmental dyslexia provide support for the existence of two distinct types of developmental dyslexia. Holmes (1973) and Coltheart et al (1983) have identified similarities between the symptoms displayed in certain cases of developmental surface dyslexia and those of acquired surface dyslexia. In contrast to these findings, other researchers (Campbell and Butterworth, 1985; Temple, 1984; Temple and Marshall, 1983) have identified a pure case of developmental phonological dyslexia.

Castles and Coltheart's large-sample study (1993) on the reading patterns of children/participants with dyslexia showed that there are at least two varieties of developmental dyslexia, one of which is characterized by a specific difficulty using the lexical procedure (a deficit in whole word recognition), and the other one is characterized by a difficulty using the sublexical route (a deficit in letter-to-sound rules). These specific reading difficulties were found in a large proportion of the children/participants with developmental dyslexia studied. Nevertheless, it has been argued that conceptual and statistical interpretation of the Castles and Coltheart data is problematic in the sense that it did not include reading-level controls. The comparison of children/participants with

dyslexia only with age-matched controls cannot provide any information as far as the relationship between their behaviour and that of younger normal readers is concerned (Manis et al., 1996, Stanovich et al., 1997).

Manis et al's study (1996) examined the hypothesis that there are different types of developmental dyslexia. For this purpose they tested three groups of children: 51 children/participants with dyslexia, 51 age-matched normal readers and 27 younger normal readers who scored in the same range as the children/participants with dyslexia on word recognition. They identified two subgroups, which fit the profiles of surface and developmental dyslexia. Children/participants with phonological dyslexia were poorer in reading nonwords compared to exception words; children/participants with surface dyslexia displayed the opposite pattern. However, most children/participants with dyslexia were impaired on both nonwords and exception words compared to chronological age-matched controls. These authors provide a different account of these patterns from that of Castles and Coltheart's, within the Seidenberg and McClelland (1989) connectionist model. This model has a single mechanism mapping from orthography to phonology, which utilizes weighted connections between units encoding distributed representations. This mechanism is used in reading both nonwords and regular and exception words. Hence, it follows that the model predicts that with a sufficiently severe impairment in phonological representations reading regular and exception words will be affected as well. According to Manis et al the model provides an explanation for the existence of children/participants with dyslexia who are impaired in reading nonwords and exception words.

The study conducted by Stanovich et al (1997) revealed 17 children/participants with phonological dyslexia and 15 children/participants with surface dyslexia from a sample of 68 reading-disabled 3rd-grade children by comparing them to chronological-age controls. However, when the dyslexic subgroups were defined by reference to reading-level controls, 17 children/participants with phonological dyslexia were identified and only 1 child/participant with surface dyslexia. These researchers concluded that surface dyslexia “may arise from a milder form of phonological deficit than that of the phonological dyslexic, but one conjoined with exceptionally inadequate reading experience” (Stanovich et al., 1997, p. 123). On the other hand it is suggested that the phonological dyslexic pattern may become more obvious when a more severe phonological impairment is conjoined with relatively high levels of reading experience.

Jackson and Coltheart (2001) described poor readers as possessing reading systems that are defective in a variety of ways. For example they suggested that some poor readers have a poorly functioning nonlexical route that affects word and nonword reading, or other poor readers that have trouble reading exception words, but are able to use the nonlexical route to read unfamiliar words, do not seem to be able to make the necessary links for building up the lexical route; although they are able to identify the pronunciation of a letter string, they do not seem able to add this orthographic string to their orthographic lexicon. In addition, poor readers who are impaired in both nonword and exception word reading appear to have defects in both lexical and nonlexical processes, or it means that nonword and exception word deficit could originate from a failure in operation of either route that may have a long-term effect on the efficient development of the other route.

Based on evidence which suggests that poor reading skills are influenced by the operation of multiple causal factors (Olson et al, 1994), and pointing out the great variation of individual differences in children's ability patterns (Berninger et al, 1999), Jackson and Coltheart (2001) proposed the need for a model of reading acquisition failure that will deviate from the standard subtyping analysis and will be able to simulate the variety of failure in reading acquisition processes. Such a model should incorporate developmental data on different affected reading components, including the core phonological deficit (Share & Stanovich, 1995a, b), orthographic lexicon impairments (Catts et al, 1999) and others. On the basis of the partial-alphabetic reading extension of the dual-route cascaded model (figure 3, chapter 1.3.), in which the abstract letter-unit component is connected to both the lexical and nonlexical route, a visual impairment is hypothesized to affect the developing system by interfering with the perception of an ordered string of letter-units and subsequently depress reading development; repeated failures of the reading system are proposed to result in delayed development of the system. It is also proposed that a child who could make adequate use of grapheme-phoneme-correspondence rules for pronouncing nonwords or unfamiliar words might not succeed in encoding this process appropriately for connecting the abstract letter-units to orthographic and phonological lexicon entries (Ehri & Saltmarsh, 1995). On the other hand a poor reader might fail to make adequate GPC connections, but his/her acquisition of complete letter-unit representations is under way and therefore appears to be little or not at all delayed in acquiring his/her orthographic lexicon.

There is a growing body of evidence, which indicates that the core phonological deficit hypothesis cannot account for the deficit in naming speed that many children/participants with dyslexia show on measures of rapid automatised naming. Although the supporters of

the phonological deficit theory treat children's/participants' with dyslexia naming speed difficulties as reflecting difficulties in phonological processing (Wagner & Torgesen, 1987; Wagner, Torgesen, Laughon, Simmons & Rashotte, 1993), other researchers have argued that naming speed problems form a second, but equally important, deficit that reflects cognitive processes that are also involved in reading (Catts et al, 1999; Wolf & Bowers, 1999). Evidence suggesting the separate involvement of naming speed in reading development and reading failure comes from studies that have tested diverse populations, studies that have investigated the predictors of reading ability, studies on different orthographies, as well as studies on subtyping of individuals with dyslexia.

Studies that compared discrepancy-based children/participants with dyslexia to garden variety poor readers have shown that children's/participants' with dyslexia naming speed was significantly slower than that of the non-discrepant group (Ackerman & Dykman, 1993; Badian, 1994, 1995, 1996a, 1996b; Biddle, 1996; Wolf & Obregon, 1992).

Rapid naming deficits have been found to have independent contributions to later reading attainment (Catts et al, 1999; Manis, Seidenberg & Doi, 1999; Scarborough, 1998; see chapter 8.) and are related more to low performance on exception-word reading accuracy, word reading speed and text comprehension, than to difficulties in nonword reading (Wolf & Bowers, 1999).

Evidence from studies in transparent orthographies indicates that naming speed deficits are a persistent characteristic of poor readers (Wimmer, 1993; Wolf, Pfeil, Lotz & Biddle, 1994; Van den Bos, 1998; Novoa and Wolf, 1984). Yap and Van der Leij (1993, 1994) and Van den Bos (1998) found evidence of both phonological awareness and speed

deficits among children/participants with dyslexia. In particular the latter researcher showed that naming speed and phonological processing measures loaded onto separate factors affecting reading ability in Dutch with naming speed being the strongest predictor of word identification tasks.

The differential role of phonological deficits and naming speed deficits was reported by Lovett (1987), who classified children as reading-accuracy disabled and reading-rate disabled. The reading-accuracy disabled group exhibited difficulties with language and phonological processing, a rapid naming speed, as well as slow reading speed. On the contrary the reading-rate disabled group exhibited deficits in naming speed, word recognition speed, but were accurate in word reading and had good phonemic analysis skills. These findings could be taken to suggest that a naming speed deficit underlies the failure of reading fluency acquisition.

Bowers (1995) applied the subtyping scheme in a Canadian sample of school-aged children between kindergarten and 4th grade. Children were classified into four subgroups using a 35-percentile cutoff on the Auditory Analysis Test (Rosner & Simon, 1971) and on digit naming speed. Similarly Wolf (1997) classified US participants according to letter or digit naming speed and a variation of the phonological measure-phonological nonword decoding. In both studies four subgroups emerged: (a) a subgroup of average readers without a deficit, (b) a visual naming-speed deficit subgroup with intact phonological skills, (c) a phonological-deficit subgroup with intact naming-speed skills and (d) a subgroup with a double-deficit. Repeated measures MANOVA and regression analyses revealed that on the measures of rapid naming (numbers, objects and colors) the performance of the phonological-deficit group was similar to that of average readers,

whereas the performance of the visual naming-speed and the double-deficit groups was significantly poorer than that of the other two groups. On the measures of nonword reading the opposite pattern was found; the performance of the visual naming-speed deficit group was similar to the performance of the average readers, whereas the phonological-deficit and the double-deficit readers were significantly different from the other two groups. In addition the double-deficit group was the most impaired group on all the reading measures. On the other hand, the single-deficit groups were less impaired in reading. Analyses of IQ scores (based on the PPVT) eliminated the possibility that IQ factors affected subgroup membership. Moreover the independent contribution of phonological decoding and naming speed to reading attainment was investigated. It was shown that both factors made a significant independent contribution to reading performance. However the phonological decoding factor did not predict reading rate, and the naming speed factor did not predict reading comprehension. These findings were considered to clearly demonstrate the existence of two separate core deficits among children/participants with dyslexia.

The study by Bowers, Sunseth and Golden (1999), in which the phonological deficit group was defined as performing below the 35th percentile on the Auditory Analysis Test and the naming speed deficit group as performing below the 35th percentile on the digit RAN test, showed that the phonological deficit group had mild reading accuracy deficits (particularly for nonwords), while the naming speed deficit group had a deficit only in reading speed and in an orthographic choice task.

Wolf and Bowers (1999) have presented a model of letter naming for investigating the processes involved in visual naming, the role of phonological processing within naming,

and the correspondence between various components of naming and reading. The model postulates that rapid letter naming involves the following processes: (a) attentional processes to the target stimulus, (b) bihemispheric visual processes for executing initial feature detection, visual discrimination and letter and letter-pattern recognition, (c) integrational processes of visual feature and pattern information with orthographic representations, (d) integrational processes of visual information with stored phonological representations, (e) phonological access and retrieval of phonological labels, (f) access and retrieval of semantic information, and (g) motoric processes that lead to articulated names. Effective operations within each subprocess, as well as across them, depend upon precise rapid naming. On the basis of this multicomponential model Wolf and Bowers suggested that naming speed deficits could be the result of a specific disruption in the access and retrieval processes, or they could be the result of slower processing speed of one or more than one or even all of the lower level perceptual and motoric processes. A third hypothesis states that “whatever underlies the consistent perceptual and motoric timing deficits noted among dyslexic readers could also affect the speed of the lexical retrieval processes. Within the third scenario, naming-speed deficits would be a midlevel subset of deficits *within a cascading system of processing-speed effects*” (p. 430).

It is evident that some behavioural evidence supports the view that there are two independent underlying deficits related to reading failure. This assumption could have important theoretical and practical implications; theories of reading acquisition and dyslexia, as well as reading remediation programmes would have to incorporate the separate effects of phonological processing and naming speed processing on reading. However extensive research is needed for establishing the ways in which naming speed

deficits affect the various aspects of reading, before considering the double-deficit hypothesis as a theory that explains reading acquisition failure.

Chapter 4. Dyslexia in Regular Orthographies

A large number of studies on developmental dyslexia in the English language have established that children can fall into different types of reading impairment on the basis of their performance on tasks of nonword and exception reading. However, research on dyslexic subtypes in languages with consistent orthographies, such as German and Italian, showed that children/participants with dyslexia exhibit a low error rate for nonwords, but a massively impaired reading speed. This finding is not surprising if one considers the high degree of orthographic transparency of these languages where the mappings between graphemes and phonemes are largely consistent. It follows that children learning to read in such languages would hardly show significant difficulties in grapheme-phoneme coding and phonological assembly.

It has been suggested that the absence of a sizeable error rate for nonwords among children/participants with dyslexia in consistent orthographies and the dominance of a reading speed deficit could fit well with the conception of surface dyslexia, since children suffering from a lack of visual-orthographic word representations should be limited to slow phonological recoding of words. The study by Zoccolotti and colleagues (1999) examined the characteristics of surface dyslexia in Italian, a language with straightforward grapheme-phoneme correspondences. They measured the performance of four boys with dyslexia aged 11 years 10 months to 15 years 7 months old on a battery of

cognitive tasks including reading comprehension, reading accuracy, reading speed, grapheme recognition, discrimination of homophones, nonword reading and picture recognition. The results of the study revealed that the participants' main deficit was related to their reading speed. This marked reduction in participants reading speed was interpreted by the researchers as an indication of surface dyslexia. This assumption is supported by the fact that the children in the study made many errors in the homophone discrimination task, which required a visual analysis of the target word.

The importance of considering reading speed as a measure of reading ability and its diagnostic value in languages with consistent orthographies was stressed by another researcher who studied the existence of subtypes of dyslexia in German children (Wimmer, 1993; 1996a). Wimmer (1993) looked at the nature of developmental dyslexia among German-speaking children at grade levels 2, 3, and 4 by assessing their reading difficulties and cognitive impairments. Reading performance was assessed with a set of tasks that involved text reading, short content words reading, function words reading, compound words reading, pseudowords reading and naming of numerals. Children's cognitive skills were measured with tasks of pseudoword spelling, vowel substitution, rhyme oddity detection, pseudoword repetition, digit span, rapid naming of numerals, objects and colors, visual processing and nonverbal I.Q. Children's/participants' with dyslexia performance was compared to that of normal age controls and younger reading level controls. The analysis of the results did not confirm the authors' hypothesis that speed impairment would be the manifestation of an underlying phonological impairment and that children/participants with surface dyslexia would not have great difficulty with either accuracy or speed, but demonstrated that all children/participants with dyslexia suffered from a pervasive reading speed deficit for all types of words. However, as far as

reading accuracy is concerned, all participants exhibited a rather high one. It was concluded that these children could not suffer from decoding dyslexia- defined as a deficit in reading unfamiliar words via grapheme-phoneme conversion.

Wimmer's and colleagues' study (2000) on dyslexic subtypes in children speaking German as their native language provides further evidence for the hypothesis that a reading speed deficit and a high accuracy for nonword reading are the most salient findings among German children. Furthermore, analyses of children's performance on tasks measuring cognitive deficits showed that both the phonological and the surface dyslexic groups suffered from a rapid naming impairment, but none of the groups exhibited a visual processing or visual memory impairment. Another interesting finding was the existence of additional phonological problems with phonological awareness and phonological memory only in the phonological dyslexic group. The author concluded that the evidence is not in accordance with the phonological deficit explanation of dyslexia and tried to interpret them using the theoretical framework of Wolf and Bowers (Bowers & Wolf, 1993; Wolf & Bowers, 1999). The dual-deficit theory of these researchers postulates that the rapid naming deficit of children/participants with dyslexia provides an indication of a second cause of reading difficulties; this means that association formation between the letters of a word is prevented by slow activation of grapheme-phoneme associations (Bowers, Golden, Kennedy & Young, 1994).

Wimmer's findings are supported by Lovett's work (1987) who found that there are children learning to read in an inconsistent orthography (i.e. English) whose primary impairment is located in reading speed and not in phonological recoding. Lovett distinguished between a group of children who were reading accuracy disabled and also

suffered from language and phonological deficits, and a group of reading rate disabled children whose only cognitive impairment was naming speed.

However, in a previous longitudinal study, Wimmer, Mayringer and Landerl (1998) found evidence of a phonological deficit. They examined the phonological deficit hypothesis in contrast to the general automatization deficit hypothesis. Participants were assessed twice; first assessment took place at the beginning of first grade, while the second assessment was done at the end of second grade. At the second assessment children were classified in a group of twenty-seven children/participants with dyslexia and twenty age-matched controls. At the first time of testing children were administered phonological processing tasks, such as rhyme and alliteration detection tasks, nonword repetition, rapid naming and articulation speed, as well as the non-verbal tasks of peg moving and visual search. At the second time of testing children were assessed on speech perception, articulation speed, pseudoname learning, rapid naming, two balancing tasks, and a dual task whereby they had to perform a semantic categorization task while they were balancing on a beam. The results of the study were straightforward. The tasks that differentiated children/participants with dyslexia from control readers were the tasks of rapid naming and the phonological memory tasks (pseudoname learning and the two nonword repetition tasks). The balancing tasks and the non-verbal tasks of peg moving and visual search did not differentiate between poor and good readers. The authors argued that German children's/participants' with dyslexia difficulties lie within the phonological domain, but the transparency of the German orthography along with the intensive phonics-based literacy instruction moderates the degree of difficulties that German children/participants with dyslexia experience with linguistic processing and metalinguistic awareness measures (Landerl, 2003).

The importance of phonological decoding skills in reading German was stressed in a recent study that has used a cross-linguistic design. Ziegler, Perry, Ma-Wyatt, Ladner and Schulte-Körne (2003) examined whether the main English findings on dyslexia can be generalized to other more transparent orthographies. Thirty English-speaking children/participants with dyslexia from Australia and nineteen German children/participants with dyslexia were matched on chronological age, reading age and IQ scores. Each language group was matched onto two control groups, a same-age normal reading group and a younger reading-level matched group. It should be noted that the selection of the English participants with dyslexia was based on a reading accuracy measure, whereas the German participants with dyslexia were selected on the basis of a standardized reading test that takes both reading accuracy and speed into account. All participants were tested on eighty monosyllabic words and eighty monosyllabic nonwords. English and German words were equated for frequency of occurrence, number of syllables, number of phonemes, grapheme-phoneme correspondences (all regular), number of letters, and body-neighbour class (large or small; body-neighbours refer to words that share the same orthographic rime, such as *feet*, *street*, *meet*). Whenever matching on number of letters was not feasible, matching was based on word frequencies and stimuli had to be orthographically and phonologically similar across languages (e.g., *flight/frucht*). Nonword stimuli were identical in the two languages, and when this was not possible to achieve because of body-N constraints, they were as orthographically and phonologically similar as possible. The analyses showed that both English and German children's/participants' with dyslexia reading speed was similarly impaired compared to both same-age and reading-age control children's reading speed; however the reading accuracy scores were lower for the English dyslexic group, but none of the language groups were impaired in comparison to the reading-age control groups. The results of the

nonword reading data followed a similar pattern. Children/participants with dyslexia in both countries exhibited a severe deficit in phonological decoding. A significant effect of word length was observed among children/participants with dyslexia in both countries suggesting that the reading process employed by children/participants with dyslexia is serial and letter-by-letter based. Finally it was found that body neighbour effects were observed for children/participants with dyslexia and normally developing readers. German readers were less facilitated by body neighbours than English readers. This finding indicates that although German readers have available large-unit information, they show a marked preference for small-unit processing. The authors concluded that the causes and consequences of dyslexia appear similar across consistent and inconsistent orthographies and that “the bottleneck of the dyslexic children in both countries seems to lie in the establishment of *basic* phonological recoding procedures” (p. 188)

A research study (Nikolopoulos, Goulandris & Snowling, 2003) examining the cognitive predictors of reading and spelling ability and the manifestation of developmental dyslexia in the Greek language, which has a highly transparent orthography, provided strong evidence to support the hypothesis that children with dyslexia learning to read in a consistent writing system like Greek, appear to have more difficulty with reading speed than reading accuracy. Twenty-eight children/participants with dyslexia (16 second grade and 12 fourth grade children) were matched on twenty-eight same-age normal readers and twenty-eight younger children who were reading at the same age. The participants were classified into groups on the basis of both their reading accuracy and speed on a word reading test containing 131 items. Children were classified as average readers if their reading speed and/or reading accuracy fell within the 16th and 84th percentile ranks, and as children/participants with dyslexia if their reading speed and/or accuracy was below the

16th percentile. Children were administered a battery of literacy, linguistic and cognitive tasks that included word and nonword reading, word spelling, phonological awareness tasks, phonological processing tasks, and syntactic awareness tasks. Greek children's/participants' with dyslexia word and nonword reading accuracy ability was highly accurate and similar to same-age control children. Qualitative analyses of the few reading errors that children/participants with dyslexia produced, revealed lexical substitution errors or unsuccessful sounding-out attempts, especially in the case of low-frequency polysyllabic words of great orthographic complexity (e.g., words containing difficult consonant clusters). It was suggested that despite the high levels of reading accuracy achieved by Greek children/participants with dyslexia, there is significant variability among same-age children and the reading strategies they employ are indeed inadequate. In contrast to the findings concerning reading accuracy scores children's/participants' with dyslexia reading speed was impaired. Children/participants with dyslexia read both words and nonwords significantly slower than average readers.

When children's/participants' with dyslexia spelling skills were assessed the following pattern was observed. Children's/participants' with dyslexia spelling performance was significantly poorer than that of chronological-age control children's. Their spelling errors were of orthographic nature and there was no instance of a phonological spelling error. Children/participants with dyslexia had no problems with representing the phonological structure of words, but had problems representing the vowel-phonemes with the appropriate graphemes. Additionally they were found to have difficulties with the spelling of multi-letter inflectional morphemes, but not with the single-letter morphemes, reflecting their lack of knowledge about spelling patterns that are underpinned by morphology.

With respect to Greek children's/participants' with dyslexia phonological awareness skills the authors reported no evidence of difficulty with completing phonological awareness tasks, such as phoneme and syllable counting and deletion. What discriminated participants with dyslexia from average readers was performance on the complex metalinguistic awareness tasks of consonant segmentation and spoonerisms, as well as the time taken to complete these tasks. It was suggested that this finding reflects poor quality of underlying phonological representations that affects the rate of access to them. This finding is consistent with Landerl et al's results (1997) according to which German and English children/participants with dyslexia aged 10 to 12 years performed poorer than same-age and reading-age control children on a spoonerisms task. However a later study (Landerl & Wimmer, 2000) using a less strict scoring system on the spoonerisms data that reduced verbal short-term memory demands, showed that participants' with dyslexia number of errors significantly decreased; children/participants with dyslexia performed similarly to reading-age control children, but yet again they were found to perform less well than same-age control children.

Moreover the children/participants with dyslexia in the study by Nikolopoulos and his colleagues (2003) performed worse than younger reading-level matched children on speech rate and articulatory fluency. The performance on rapid naming, verbal short-term memory and syntactic awareness was lower than that of the reading-age control children, but failed to reach conventional statistical significance. The authors argued that overall their findings show that Greek children/participants with dyslexia have a specific phonological impairment similar to the impairment suffered by English children/participants with dyslexia. The study supports the orthographic depth hypothesis since it was shown that the transparency of the Greek orthography facilitates

children's/participants' with dyslexia acquisition of literacy skills, and it is consistent with theories and studies supporting the universality of dyslexia (Frith, 1997; Snowling, 2000; Paulesu et al, 2001).

The existing literature on the domain of spelling difficulties has demonstrated that children/participants with dyslexia learning to read and spell in more transparent orthographies than English experience significant and persistent difficulties with spelling (Alegria & Mousty, 1994; Bruck & Waters, 1988; Wimmer, 1996b). Studies in different languages have provided evidence for a developmental lag of children's/participants' with dyslexia conventional spelling abilities, as well as evidence that children/participants with dyslexia also have phonological spelling difficulties.

Alegria and Mousty (1994, 1996) showed that children/participants with dyslexia could spell words containing highly consistent and context-independent graphemes as accurately as normal reading-level matched children. The pattern was different when children's/participants' with dyslexia inconsistent spellings were compared to those of normally developing children: their performance did not improve as their reading age increased, whereas normally developing children's performance followed a developmental improvement. The authors argued that French children/participants with dyslexia appear not to have phonological awareness deficits, but rather have poorly specified word representations that do not allow lexical spelling development. However an obvious limitation of these studies is that children's phonological awareness abilities were not assessed, leaving room for criticism on the speculation that participants with dyslexia were not phonologically impaired. A subsequent study conducted by the same authors (1997) extended the results of the previous studies; the spelling of the inconsistent

and non-dominant graphonemes ‘c’ /s/ and ‘z’ /z/ was retested, whereas the graphonemes ‘qu’ /k/ and ‘ain’ // were added to the spelling assessment. The correct spelling of these graphonemes requires the use of orthographic knowledge, as there are alternative graphemes for the representation of the same phoneme. For example, the sound /s/ can be spelled with the grapheme ‘c’, which is nondominant (i.e., a less frequent transcription of the phoneme /s/) or with the dominant grapheme ‘s’, which is dominant (i.e., more frequent transcription of the phoneme /s/). Thirty-eight reading disabled children (age range: 10;10 to 12;9) and seventy-five normally developing children (age range: 7;4 to 9;9) were matched on their reading level on a force-choice sentence completion test, which is a measure incorporating both word identification processes and comprehension abilities. The two groups were tested on a spelling task of twenty words of high and low frequency of occurrence included in sentences. Six (or four) words, half of which were high-frequency and the other half low-frequency, were selected for each of the four inconsistent graphonemes: ‘c’ /s/, ‘z’ /z/, ‘qu’ /k/ and ‘ain’ //. Participants with dyslexia were found to perform significantly lower than the younger reading-level control children. It was suggested that these children had not developed efficient orthographic representations and that more exposure to print would enable the development of their orthographic lexicon.

However there is evidence that children/participants with dyslexia have conventional as well as phonological spelling impairments, to support the phonological deficit account. According to this theory children with poor phonological recoding skills fail to develop efficient phonological spelling skills, which in turn prevent them from acquiring adequate spelling skills (Caravolas, Hulme & Snowling, 2001). Caravolas, Bruck and Genesee’s cross-linguistic study (2003) provided empirical support for this hypothesis. Nine

English-speaking monolingual poor spellers and nine French-speaking monolingual poor spellers were matched on their scores on a word-spelling test at the end of third grade. They were assessed on word and nonword spelling dictation tasks that measured children's knowledge of conventional spelling, as well as their ability to represent phonological information in their spellings. Poor spellers' performance was also compared to age-matched good spellers. The word-spelling test contained one-, two-, and three-syllable words. The French and English versions of the test were equated, with minor differences, for number of letters, number of syllables, number of graphemes and syllable structure; additionally all stimuli represented regular spelling patterns that are taught in first, second and third grades in Anglophone and Francophone schools. The nonword spelling test was analogous to the real word spelling test. The stimuli derived from the words by substituting one to three consonants and were matched on syllable structure and number of phonemes across languages. The analysis revealed that English good and poor spellers were less accurate than their French counterparts. Both language groups were less accurate than the control groups. The analysis of the whole word and nonword accuracy confirmed the previous results; English and French poor spellers performed less accurately than good spellers and English poor spellers were poorer in spelling words and nonwords than their French counterparts. The analysis of the phonological acceptability of word spellings showed that English poor spellers made significantly more phonological spelling errors than the English good spellers and the French poor spellers. However the nonword analysis showed that, compared to their normally developing controls, both English and French poor spellers were impaired to a similar extent. That is, phonological spelling poses a similar degree of difficulty to such people, regardless of the orthographic complexity of their language. This finding is supported by the study of Caravolas and Volín (2001), which showed that Czech

children/participants with dyslexia as old as 11 years continue to make phonological spelling errors relative to their age peers. It was suggested that the effect of orthographic depth on the manifestation of dyslexia may not be as strong as as been indicated from previous studies (e.g., Wimmer & Landerl, 2000).

The analyses on the phonological structure of misspelled words and nonwords (i.e., if the segmental structure of consonants and vowels was preserved) showed that English poor spellers were significantly less accurate than English good spellers and French poor spellers. On the nonword measure French poor spellers were not significantly poorer than French and English good spellers. Finally the analysis on consonant and vowel omissions, as well as omissions of stressed versus unstressed vowels indicated that English poor spellers have additional difficulties with the representation of consonants and vowels (especially vowels included in unstressed syllables). Overall the present findings are consistent with previous evidence that poor spellers have conventional spelling difficulties (Alegria & Mousty, 1994, 1996, 1997), and that orthographic transparency facilitates children's acquisition of spelling skills (Landerl et al, 1997).

In summary, the evidence from studies in languages with transparent alphabetic orthographies suggests that children with dyslexia who learn to read and write in more consistent orthographies seem to suffer a milder form of dyslexia than English children with dyslexia, as they produce less reading errors and show unaffected performance on less demanding phonological awareness tasks. Nonetheless their reading speed and spelling performance is similar to that of English children with dyslexia. The cognitive profile of children with dyslexia learning to read and spell in transparent orthographies is characterized by deficits in phonological processing skills that in some aspects do not

appear as amplified as those of English children with dyslexia. It is important to note that there is no indication that children with dyslexia learning to read either shallow or deep (English) orthographies suffer deficits in short-term retention of visual information (Sprenger-Charolles et al, 2000) nor in visual processing speed measures (Landerl, 2001). Further research in transparent orthographic systems that employ a longitudinal scheme could explain findings, which suggest that the underlying causes of the literacy difficulties of children with dyslexia learning to read in transparent orthographies are not related to phonology (Wimmer, 1993, 1996a).

Chapter 5. Greek Orthography

The English orthographic system has been characterised as complex and highly irregular (Treiman, 1993). Three types of grapheme-phoneme patterns are involved: variant – predictable, variant – unpredictable and invariant (Venezky, 1995). On the other hand, the Greek language has consistent or variable, but predictable relations between graphemes and phonemes and there are no irregular words (Treiman, 1993). However the high orthographic regularity of the Greek alphabetic system is evident only in the case of reading and not in spelling. The sound system of Greek consists of twenty-five distinct segments or phonemes: (a) five vowels (i, e, a, o, u) and (b) fifteen consonants (p, t, k, f, θ, x, v, δ, γ, s, z, l, r, m, n) (Holton et al, 2002). The vowel sounds /a/ and /u/ have only one graphemic rendition (α and ου respectively). The remaining three vowels have two or more possible graphemic representations. In particular, (a) the vowel phoneme /e/ can be represented either by ε or αι, (b) the vowel phoneme /o/ can be spelled as ο or ω, and (c) the vowel phoneme /i/ has the following six alternative spellings: ι, η, υ, ει, οι, υι. On the contrary, consonants have only one graphemic representation. The written form of

modern Greek has preserved its original form from antiquity, whereas the spoken form has changed considerably. In modern spoken Greek length in vowels is not distinctive. When a vowel is stressed, it may be slightly longer than an unstressed vowel, but this is an allophonic (phonetic) difference and not a distinctive (phonemic) one. In ancient Greek long and short vowels were distinctive and they were represented by different graphemes. For example, the long vowel /o/ was represented by the grapheme ω , and the short vowel /o/ was spelled with the grapheme o . Thus modern Greek spelling does not reflect the present spoken form of words, but rather their phonetic etymology (Harris & Giannouli, 1999).

The higher degree of variability of the Greek phoneme-to-grapheme correspondences in spelling, its considerable ambiguity and the highly inflectional nature of the Greek language require from Greek children not only to have a sound knowledge of the phonological structure of words, but also to incorporate other types of linguistic information such as orthographic, morphological and grammatical (Nikolopoulos, 1999).

5.1. Inflectional and Derivational Morphology: The case of nouns and adjectives

Spelling in Greek is governed by the extensive system of morphological word ending rules that vary according to the grammatical status of a word. Nouns and adjectives have invariant stems, but a variety of different endings depending on their case, number, and gender. Greek nouns belong to a variety of declensions, i.e., the system of endings that serve to indicate number and case: singular and plural number, and nominative, genitive, accusative and vocative cases. Declensions are dependent on the gender of a given noun: masculine, feminine, common gender (this refers to nouns that can be either masculine or

feminine), and neuter. Greek nouns can therefore be classified by their gender, the declension, as well as by the position of the stress of the nominative singular: oxytone nouns have the stress on the ultimate syllable, paroxytone on the penultimate and proparoxytone on the antepenultimate syllable. The following table shows the inflectional endings of Greek nouns.

Table 5.1
Inflectional endings of Greek nouns (Holton et al, 2002)

Parisyllabic ¹ Masculine Nouns	Imparisyllabic ² Masculine Nouns	Parisyllabic Feminine Nouns	Imparisyllabic Feminine Nouns	Neuter Nouns
-ας /as/	-άς /as/	-α /a/	-α /a/	-ο /o/
-ης /is/	-ας /as/	-η /i/	-ού /u/	-ί /i/
-ος /os/	-ής /is/	-ος /os/	-ω /o/	-ι /i/
-εας /eas/	-ης /is/	-η /i/ plural -εις /is/		-ος /os/
	-ές /es/			-μα /ma/
	-ούς /us/			-μο /imo/
				-ς /s/
				Other ending in vowels
				Other ending in -v /n/
				Ending in consonants other than -v /n/, -ς /s/

Greek nouns undergo inflectional changes according to their different grammatical functions in a specific context (declension). However, they can undergo changes in order to form new words by means of various morphological processes. One way of forming derivatives is the addition of a suffix to the end of the word stem (derivational suffixation;

¹ A noun whose plural forms have the same number of syllables as the corresponding singular ones is defined as parisyllabic.

² A noun whose plural forms have one more syllable than the corresponding singular ones is defined as imparisyllabic.

e.g., παράγω ‘produce’ → παραγωγή ‘production’). A large number of different suffixes are used to form diminutives (they express small size, affection, familiarity, or even depreciation, e.g., κόσμος ‘people’ → κοσμάκης ‘the common herd’), augmentatives (they express large size or admiration, e.g., κεφάλι ‘head’ → κεφάλια ‘big head’), and to create nouns (e.g., διαβάζω ‘read’ → διάβασμα ‘reading’).

The characteristics of inflectional and derivational morphology also affect the behaviour of Greek adjectives. In the same manner as nouns, adjectives are classified in terms of the gender into masculine, feminine and neuter, can be declined and always agree with the nouns they modify in number, gender and case. However some adjectives are indeclinable and have a single form. Unlike nouns, adjectives tend to retain the stress on the same syllable throughout the declension. The table that follows illustrates the inflectional endings of Greek adjectives. In addition a number of different derivational suffixes are used to create adjectives (συζητώ ‘make conversation’ → συζητήσιμος ‘conversational’), or change the meaning of existing ones (e.g., καλός ‘good’ → καλούτσικος ‘fairly good’).³

Table 5.2
Inflectional endings of Greek adjectives (Holton et al, 2002)

Inflectional Classes of Adjectives	Masculine	Feminine	Neuter
1.	- ος /os/	- η /i/	- ο /o/
2.	- ος /os/	- α /a/	- ο /o/
3.	- ος /os/	- ια /ia/	- ο /o/
4.	- ύς /is/	- ιά /ia/	- ύ /i/
5.	- ύς /is/	- εία /ia/	- ύ /i/

³ The present study examined the spelling of derivational suffixes that created new adjectives and nouns and also changed the meaning of existing adjectives.

6.	- ής /is/	- ιά /ia/	- ι /i/
7.	- ης /is/	- ης /is/	- ες /es/

5.2. The Morphology of Verbs

The highly inflectional nature of the Greek orthographic system is also evident in the behaviour of verbs. Verbs are generally acknowledged as the most complex part of the Greek morphological system, as they are inflected for person, number, tense, voice and mood. For this reason Greek verbs may have a variety of different forms. It is necessary to make a distinction between the stem and the endings of verbs since they carry different morphological information. The stem indicates whether the verb is in imperfective or perfective aspect, whereas the ending indicates the person, number, tense, and voice of the verb.

Aspect is a grammatical category that refers to the way an action is viewed by the speaker at the time of utterance and presented to the listener. The imperfective aspect is used when the action or state expressed by the verb is seen as a single but continuous event or as a habitually repeated one. The perfective aspect on the other hand presents an action, which is viewed as a single and complete event. The tense of a verb is defined as the grammatical category concerned with the time when an action occurs and the action is seen as being either in the past or not in the past.

The grammatical category of voice differentiates Greek verb forms into two sets of personal endings (active and passive voice). The characteristic use of the active voice is to indicate that the subject of the verb acts. The typical use of the corresponding passive

voice is to show that the subject undergoes or is affected by the action conveyed by the verb.

Mood is a grammatically marked verbal category associated with a distinct characteristic function. Indicative, subjunctive and imperative are the three moods. The imperative mood is distinguished from the other two by either specific verbal endings or the choice of verbal particles that precede and modify the verb forms (e.g., the particle “*να*” that precedes the verb distinguishes the subjunctive mood by the indicative mood in which the particle “*δεν*” is used).

Greek verbs fall into two categories according to their regularity: regular and irregular verbs. Regular verbs fit into recognizable patterns in the way they construct their perfective stems. Verbs that form their perfective stem in ways that do not conform to these patterns or present irregularities in the formation of other form(s), e.g., the imperative, are classified as irregular verbs. Appendix VIII includes a table of the Greek irregular verbs (Holton, Mackridge & Philippaki-Warburton, 2002). The first column of the table presents the active present tense or the passive present tense in the case of deponent verbs (i.e., verbs that have only passive forms even though they may be active in meaning). In the second column a single basic meaning of the verb is provided. The third column presents the first person singular of the active simple past; the fourth column includes the first person singular of the passive simple past and finally the fifth column provides the passive perfect participle.

Based on the position of the stress in the first person singular of the present active, Greek verbs are distinguished into two categories: a. paroxytone (stressed on the penultimate

syllable) or first conjugation, e.g., γράφω ‘I write’, and b. oxytone (stressed on the ultimate syllable) or second conjugation, e.g., αγαπώ ‘I love’. The second conjugation verbs are subdivided into two categories according to the vowel system that characterises their endings. The most commonly used endings for these main types of verbs in the active and passive voice are shown in table 5.3 below.

Table 5.3
Endings of main types of Greek verbs in active and passive voice

	Person	1 st conjugation		2 nd conjugation type A		2 nd conjugation type B	
		Sg.	Pl.	Sg.	Pl.	Sg.	Pl.
Active voice :							
Present	1 st	´-ω	´-ουµε	-ώ	-άµε	-ώ	-ούµε
	2 nd	´-εις	´-ετε	-άς	-άτε	-εις	-είτε
	3 rd	´-ει	´-ουν	-άει	-ούν	-εί	-ούν
Imperfect	1 st	´--α	´-αµε	-ούσα	-ούσαµε	-ούσα	-ούσαµε
	2 nd	´--εις	´-ατε	-ούσεσ	-ούσατε	-ούσεσ	-ούσατε
	3 rd	´--ε	´--αν	-ούσε	-ούσαν	-ούσε	-ούσαν
Simple/ Continuous Future	1 st	´-ω	´-ουµε	´-ω	´-ουµε	´-ω	´-ουµε
	2 nd	´-εις	´-ετε	´-εις	´-ετε	´-εις	´-ετε
	3 rd	´-ει	´-ουν	´-ει	´-ουν	´-ει	´-ουν
Simple past	1 st	´--α	´-αµε	´--α	´-αµε	´--α	´-αµε
	2 nd	´--εις	´-ατε	´--εις	´-ατε	´--εις	´-ατε
	3 rd	´--ε	´--αν	´--ε	´--αν	´--ε	´--αν
Perfect		(auxiliary verb “έχω” + infinitive ´-ει)		(auxiliary verb “έχω” + infinitive ´-ει)		(auxiliary verb “έχω” + infinitive ´-ει)	
	1 st	´-ω	´-ουµε	´-ω	´-ουµε	´-ω	´-ουµε
	2 nd 3 rd	´-εις ´-ει	´-ετε ´-ουν	´-εις ´-ει	´-ετε ´-ουν	´-εις ´-ει	´-ετε ´-ουν
Pluperfect		(auxiliary verb “είχα” + infinitive ´-ει)		(auxiliary verb “είχα” + infinitive ´-ει)		(auxiliary verb “είχα” + infinitive ´-ει)	
	1 st	´--α	´-αµε	´--α	´-αµε	´--α	´-αµε
	2 nd 3 rd	´--εις ´--ε	´-ατε ´--αν	´--εις ´--ε	´-ατε ´--αν	´--εις ´--ε	´-ατε ´--αν
Imperfective imperative	2 nd	´--ε/´-ε	´-ετε	´-α	-άτε	- - - - -	-είτε
Perfective imperative	2 nd	´--ε/´-ε	´-(ε)τε	´--ε	´-τε	´--ε	´-τε
Gerund		´-οντας		-ώντας		-ώντας	
Passive voice:		Sg.	Pl.	Sg.	Pl.	Sg.	Pl.
Present	1 st	´-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/ Continuous 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 ΄--εξ ΄-ατε ΄--ε ΄--αν	(auxiliary verb "είχα" + infinitive ΄-ει) ΄--α ΄-αμε ΄--εξ ΄-ατε ΄--ε ΄--αν	(auxiliary verb "είχα" + infinitive ΄-ει) ΄--α ΄-αμε ΄--εξ ΄-ατε ΄--ε ΄--αν
Imperfective imperative		-----	-----	-----
Perfective imperative	2nd	΄-ου -είτε	΄-ου -είτε	΄-ου -είτε

Chapter 6. The Goal of the Present Thesis

The research evidence from studies that have investigated the literacy and cognitive deficits experienced by children/participants with dyslexia who read and write in more transparent languages than English, has established that the similarities between children/participants with dyslexia who learn to read in languages like German, Greek or Italian, and English children/participants with dyslexia are more common than their differences (Ziegler et al., 2003). Children/participants with dyslexia from different countries have impaired word but mainly nonword reading speed, they all show difficulties with phonological processing – though the degree of the severity of these difficulties seems to be a function of orthographic complexity – and they experience persistent spelling deficits. However there are still areas that need further research, as well as there are some discrepant findings among studies on dyslexia in transparent orthographies that the present thesis has attempted to address.

On this basis the purpose of the present thesis was to achieve a better understanding of the nature of developmental dyslexia and dysgraphia in transparent orthographies, and particularly in Greek, in relation to normal development. More specifically the present thesis sought to examine the nature of literacy problems (reading and various aspects of spelling), the nature of cognitive deficits experienced by Greek children/participants with dyslexia with particular reference to phonological awareness and naming speed deficits, and investigate whether the degree of children's/participants' with dyslexia deficits in relation to normally developing children depends on the complexity of the orthography in which children learn to read and spell.

Many studies have reported that the role of phonological skills is limited to the first years of literacy acquisition (Landerl & Wimmer, 2000; Oney & Goldman, 1984; Wimmer, 1993). On the other hand other studies have shown that the effect of phoneme awareness exceeds the first years of schooling (Kozminsky & Kozminsky, 1995; Muller & Brady, 2001), and that the strongest long-term predictor of reading rate is rapid naming skill (Wimmer, Mayringer & Landerl, 2000). Therefore one of the aims of the thesis was to examine the role of phoneme awareness and rapid naming skills in the reading and spelling ability of dyslexic and normal readers.

There is evidence that German children/participants with dyslexia and normal readers are faster than English readers when they read words (Landerl et al., 1997). However Ziegler et al (2003) showed that the reading speed deficit was not significantly different across language groups, especially with reference to nonword reading. Based on this discrepancy the present thesis sought to investigate whether Greek and English children/participants with dyslexia are similarly impaired in reading speed or whether Greek children/participants with dyslexia are faster than their English counterparts.

It has been widely reported that children/participants with dyslexia who spell in transparent orthographies show impairments in representing conventional spelling patterns (Alegria & Mousty, 1996, 1997), as well as the phonological structure of words in their spellings (Caravolas et al., 2003). However research in the Greek language produced no evidence of a phonological spelling deficit among children/participants with dyslexia (Nikolopoulos et al., 2003). Moreover spelling in Greek is a demanding task, since it is underpinned by orthographic and morphological knowledge. Based on this evidence the goal of the thesis was to explore the orthographic, phonological and

morphological spelling skills of Greek dyslexic and normal readers and examine the quantitative and qualitative differences between the spellings of these groups.

In order to explore these issues three studies were conducted: a cross-linguistic study that compared language group performance on equivalent measures and stimuli, a longitudinal study on Greek children's/participants' with dyslexia and normal children's literacy skills, and a detailed cross-sectional study on Greek children's morphological spelling skills.

It is believed that the cross-linguistic study can be very informative, as it allows direct comparisons of literacy and cognitive deficits suffered by children/participants with dyslexia who read and write in shallow versus deep orthographies. In general research on dyslexia in Greek is needed, as there is lack of test instruments for the assessment and diagnosis of children with dyslexia. Often the existing assessment and instructional materials are translations of materials devised for English-speaking children with dyslexia and therefore they do not accommodate the linguistic characteristics of the Greek language and the true nature of the deficits that Greek children with dyslexia experience (Goulandris, 2003).

Chapter 7. A Cross-linguistic Comparison of Reading and Spelling Difficulties between Greek and English Children with Developmental Dyslexia.

7.1. Introduction

There is now strong evidence to support the hypothesis that dyslexia has a universal neurocognitive basis (Smith et al., 1998) and that the differences in the manifestation of reading and spelling difficulties among children/participants with dyslexia reading in different languages are explained in terms of the differences in orthographic systems (Landerl et al., 1997). Paulesu and colleagues (2001) examined both the neurophysiological and behavioral similarities and differences among adults with dyslexia and normal adult readers in languages with a deep orthographic system (English and French) and a shallow one (Italian). They concluded that dyslexia is a disorder with a universal neuro-anatomical basis and that the same phonological processing deficits are detected in participants with dyslexia reading different orthographies.

The universality of developmental dyslexia has been investigated mainly by behavioural studies, which have also shown that the nature and prevalence of the syndrome differs across languages. These studies share the following characteristics: (a) they used a group of English-speaking children as a benchmark against which children reading other orthographies were compared and (b) word and nonword reading tests were used as the outcome measures (Lindgren et al., 1985; Thorstad, 1991; Bruck et al, 1997; Landerl et al., 1997; Durgunoglu et al., 1999; Ellis and Hooper, 2001).

One of the early direct cross-cultural comparisons with children/participants with dyslexia was the study by Lindgren, De Renzi and Richman in the 80's (1985). Samples of fifth-

grade reading disabled children in Italy (N=448) and the United States (N=1,278) were tested on a battery of cognitive and reading measures in order to determine whether the phonetic regularity of a language can have a significant effect on the pattern and prevalence of developmental dyslexia. The criteria for matching the two groups were the level of educational experience and socioeconomic status. The mean chronological age of the groups differed by six months, as there were small differences in the birth-date guidelines for starting school in each country. Children were classified as children/participants with dyslexia if they were poor readers ($SS < 85$) but were of average intelligence on the short form of the WISC. Reading ability was measured using a test of reading comprehension. However, since there were no international normative standards, “local norms” were developed for each country by standardising the reading and IQ test scores of seventy randomly selected children in each sample. Experimental assessment measures were not developed for this study, but instead tests with established validity and reliability for distinguishing among clinical populations were used. A reading test that was developed as part of the International Association for the Evaluation of Educational Achievement cross-national study of academic achievement was used for this study (Thorndike, 1973). A few slight modifications were made to the reading passages in order to improve the correspondence between the English and the Italian versions of the test. A different test was used for each language to assess children’s decoding skills. Auditory-verbal ability was tested using the Multilingual Aphasia Examination (Benton & Hamsher, 1976) that was designed to permit comparisons of language disorders in different countries. For assessing articulatory coordination the Sound Blending subtest of the Illinois Test of Psycholinguistic ability was used for the American children and a similar blending task was developed for the Italian children.

The results of this study revealed significant differences between children from the United States and children from Italy, with dyslexia being more prevalent in the former country than in the latter, at least among fifth graders. In addition, a strong association between reading disabilities and disorders of verbal processing was found for both language groups, but the association between reading comprehension and decoding was more apparent in English than in Italian.

A fairly recent cross-linguistic study on developmental dyslexia included English-speaking and German-speaking children (Landerl, Wimmer & Frith, 1997). English and German participants were matched on chronological age in order to have almost equal difficulties with reading, and show equivalent problems observed among populations with dyslexia. The selected children had an age of 11-12 years, they were delayed by around 3-4 years in relation to their peers and their reading problems had persisted over years. English children's current reading ability was assessed by the British Ability Scales Word Recognition Test (Elliot et al., 1983), whereas German children's reading skills were assessed by a word recognition test that was standardised only up to 4th grade; however this test was considered more appropriate for the purposes of the study, since existing standardized reading tests for older children measured reading comprehension. Reading speed (for a short text and a list of complex compound words) was the main diagnostic criterion, as the literature demonstrates that older German children do not produce many reading errors. Experimental tests included a single word and nonword reading test (speed and accuracy) and a spoonerisms task. For word and nonword reading 192 stimuli were used comprising one-, two-, and three-syllable words and nonwords derived from these words. English and German stimuli were identical in meaning and very similar in terms

of spelling and pronunciation. The task of spoonerisms comprised words that were similar in the two languages.

The findings of the study showed that the English children/participants with dyslexia suffered significantly more severe impairments in reading than their German counterparts. The extent of the impairment was dependent on the stimuli. For high frequency words the difference was relatively small, but for low frequency and three-syllable words, as well as for nonwords, English children/participants with dyslexia read few items correctly. English children/participants with dyslexia had also severe difficulties with word and pseudoword reading speed. However, on the spoonerisms task, that measures phonological processing deficits, both language groups had significant difficulties even in comparison to the younger reading-age control groups.

The cross-linguistic studies presented so far investigated the effect of different orthographic systems on children's/participants' with dyslexia reading and phonological skills. A significant number of research studies have explored the influence of different orthographies on the literacy acquisition of typically developing children. A cross-linguistic study that matched two groups of children who were native monolingual speakers of different languages was that by Durgunoğlu and Öney (1999). The development of phonological awareness was directly compared between English-speaking and Turkish-speaking kindergarten and first-grade children (N=138). Participants were presented with the following tasks: letter recognition, letter usage, syllable tapping, initial phoneme deletion and final phoneme deletion. For the tasks of letter recognition and usage Turkish and American groups were presented with all the letters in their respective language; for the tasks tapping children's phonological

awareness they were given pseudowords that were pronounceable across the two orthographies. However, for assessing children's decoding abilities the US group received the Woodcock Word Identification subtest, whereas the TR group was tested on a list of 16 one- and two-syllable real words. In order to make the two groups more similar a cutoff point of 37 words was adopted for the US group.

The findings of this study supported the hypothesis that children's phonological awareness levels increase as they become literate and that the linguistic properties of different orthographies may affect the development of phonological awareness. For both language groups the performance of first grade children on phonological awareness tasks was better than the performance of kindergarten children. The comparison between American and Turkish children yielded an advantage for the latter group. Turkish children were significantly more accurate than the US children in manipulating both syllables and phonemes.

Ellis and Hooper (2001) compared the rate of literacy acquisition in the orthographically inconsistent English language and the orthographically consistent Welsh language using measures of reading. Twenty Welsh-educated second-grade bilingual children and twenty English second-grade monolingual children comprised the groups of the study. The groups were matched on their exposure to reading and on their academic level based on the results from the Key stage 1 maths (the exams were translation equivalents of the same problems with possible grades ranging from level 1 through to level 3). A reading test was administered to the two groups and comprised a list of 80 words ranging from high to low frequency. Stimuli were matched on frequency of occurrence across

languages [English word frequencies were found in the CELEX Lexical Database (Baayen, Piepenbrock, & van Rijn, 1995). The Welsh word frequencies were taken from the CEG corpus (Ellis, O' Dochartaigh, Hicks, & Morgan, 1999)]. The random selection of the words resulted in there being no significant difference in word length, although controlling for word length was not intended.

The findings of the study revealed a significant effect of the orthographic transparency of a spoken language on the rate of acquisition and style of reading adopted by its speakers. Welsh readers were able to read approximately 61% of the written tokens of their language, whereas English readers at the same level of development could read 52% of the written tokens. These differences were not found to be associated with reading comprehension skills. Moreover it was suggested that the reading strategy employed by Welsh children relied more on alphabetic decoding: reading latency was more clearly a function of word length in Welsh (70%) than in English (only 20%), and Welsh reading errors tended to be nonword mispronunciations in contrast to English errors that were mainly real word substitutions and null attempts.

The effect of orthographic regularity on literacy acquisition was investigated by Thorstad's rather poorly designed study (1991) that compared the performance of English and Italian children on a test of reading and spelling. Ninety-five English children learning traditional orthography, thirty-three English children learning the initial teaching alphabet, and seventy Italian children were matched on chronological age and intellectual ability (age range: 6-11;5, mean age: 9;2). All participants attended small country schools and according to their teachers they came from a stable home environment where the majority of the fathers were fully- or semi-skilled workers and most of the mothers did

not work. Although English children's ability was within the average range (IQ between 85 and 115), similar information was not available for the Italian children. The author argued that, although verbal reasoning measures provide the highest predictive values of literacy skills, the transferability of a translated form of an English verbal test to Italian could not be assumed. Therefore Italian children's (over seven years) non-verbal logical reasoning ability was decided to be assessed on the NFER Non-Verbal Test BD (Pidgeon, 1964); the Plan of a House Test (Thorstad, 1974), which assesses visuo-motor skills, and the Draw-a-man test (Harris, 1963) were given to children below seven years (the latter test assesses general emotional and social development, as well as intellectual development). The Spar reading comprehension test (Young, 1976) and the Schonell spelling test (Schonell and Schonell, 1950) were administered to English children learning traditional orthography to compare their progress on literacy with that of other English children. A passage of 56 words to read and spell, taken from an Italian journal of adults was given to Italian children. An English translation of the passage was given to the English children.

This study also provided evidence in favour of the hypothesis that the regularity of orthography can affect the acquisition of children's literacy skills. It was shown that English children read inaccurately but fast, whilst Italian children read accurately but slowly using a systematic phonological strategy until the age of 10, when they begin to read faster and more accurately. In spelling, it was found that both groups employed a phonological strategy leading to greater accuracy in Italian than English.

The cross-linguistic design of directly comparing the literacy development of children who read and write in different alphabetic languages was employed by a group of

researchers in Canada (Bruck et al, 1997). The aim of Bruck, Genesee and Caravolas's study was to determine the degree to which current models of early reading acquisition generalize to children learning non-English alphabetic languages. Therefore, 94 French and 105 English kindergarten children were tested on tasks tapping their phonological awareness, letter knowledge and non-verbal cognitive abilities. Both groups were attending French-medium and English-medium schools respectively [although there were curriculum differences between the French (phonics-based approach) and the English (whole language approach)] and they were nonreaders as indicated by parental information provided on a background questionnaire and a reading screening test. Children were retested when they were in the first grade. At this time children's word and nonword reading skills were assessed.

The phonological awareness tasks that were administered when the groups were in kindergarten included syllable counting and phoneme deletion. The stimuli of all the tasks were phonologically legal nonwords and were matched across languages on number of syllables and phonemes, as well as phonological structure.

To assess word and nonword reading skills experimental measures had to be devised due to the lack of standardised measures in French. The word recognition task in both languages consisted of 27 monosyllabic high frequency words. The words were among the most frequent in the Kučera and Francis Word Frequency Count, which is available in both languages (Kučera and Francis, 1967). Moreover the stimuli in the English and French versions of the task were matched on regularity (i.e., they could all be read correctly using spelling-sound correspondences), number of grapheme-phoneme correspondences and finally number of letters. The nonword task was constructed by

altering the first letter of each item on the word recognition test in order to form a nonword.

As in the case of other studies reviewed so far, the study by Bruck, Genesee and Caravolas (1997) provided further supportive evidence for the hypothesis that language-specific characteristics of children learning to read and write different orthographic systems are responsible for the differences in their performance on tasks of phonological awareness and reading. The comparison between the French and the English kindergarten children revealed differences in performance on the phonological tasks: French children scored higher on syllable counting and English children were better at onset-rime and phoneme items. It is suggested that two factors explain this pattern. Firstly it is concluded that these patterns of performance are consistent with the phonological structures of each language, and secondly that the preliteracy skills of the French children are less emphasised by their parents, the curriculum and the children's media. The two groups' performance on measures of word and nonword reading at the end of grade 1 was consistent with the hypothesis of the orthographic transparency. English children made twice as many errors as their French counterparts on the tasks of word recognition (48% English errors vs. 24% French errors) and nonword reading (64% English errors vs. 37% French errors). Finally it was found that the most significant predictors of early reading acquisition –irrespective of language- are phonological awareness and letter name knowledge.

A group of researchers from 13 European countries (England, Finland, Spain, Greece, Italy, France, Germany, Sweden, Portugal, Norway, Iceland, Netherlands and Denmark) (Seymour et al., 2003) investigated the differences in rates of acquisition of the

components of foundation literacy in languages of significantly varied orthographic complexity using measures of letter knowledge, familiar word reading and simple nonword reading. Participants consisted of grade 1 and grade 2 primary school children. Samples were recruited from effective schools in non-deprived areas so that the children were not held back by social disadvantage. Although children were matched on years of formal schooling across languages, a variation in their mean ages was indicated as a result of national differences in the age of commencement of schooling.

The familiar word reading test included two lists of content words (mainly imageable nouns) and two lists of function words (grammatical morphemes); all stimuli were very familiar words of high frequency of occurrence in the reading materials used in the early stage of primary schooling in each language. The simple nonword reading test included two sets of nonwords one of which comprised of monosyllables of a CV, VC and CVC structure and bisyllables of VCV, CVCV and VCVC structure. The pseudowords were constructed by sampling consistent and dominant grapheme-phoneme correspondences in each orthography (one letter, one sound).

The results of this study indicated that children from a majority of European countries- with the exception of France, Portugal, Denmark, and especially England- become accurate and fluent in foundation level reading before the first year at school. It was suggested that the effects are not attributable to differences in letter knowledge or age of commencing school, but to differences in orthographic depth and syllabic complexity. Additionally it was shown that the rate of development in shallow orthographies is twice as fast as in English. The authors suggested that shallow orthographies implement a single

foundation, whereas deeper orthographies implement a dual foundation (logographic and alphabetic) that needs twice as much time to be established.

The effects of phonemic and graphemic consistency on decoding for American and German children were studied by Näslund (1999). Eighty-eight German and eighty-seven American first and second grade primary school children were assessed using tasks of phonemic awareness (phoneme segmentation and manipulation) and word and nonword reading. All participants were receiving a phonics-based instruction and were familiar with phonetic decoding of print.

The stimuli of the phoneme segmentation task were matched on number of CVCC and CCVC items for each language group, whereas the stimuli of the phoneme manipulation task were bisyllabic pseudowords, which were identical for both groups. The majority of the words used in the word reading task (measuring both reading accuracy and speed) were taken from Stanovich and his colleagues (1984). The English words were translated in German and formed the stimuli of the German version of the task. These words conformed to the official list of words to be taught and used by first grade children in the State of Bavaria. Although all the test items were highly frequent for both language groups, there were a number of differences in terms of consistency; the German word list was consistent in grapheme to phoneme correspondence, whereas the English list included many inconsistent words. The nonwords used in the two languages were identical, and all items were consistent in grapheme-phoneme correspondence.

Analyses revealed that German children performed significantly better than American children only in the tests of pseudoword decoding across grades. The type of errors that

American children committed in decoding accuracy and speed were mainly word substitutions and vowel errors. In contrast, German children's decoding accuracy and speed in the first grade was explained by nonword and consonant errors. However in the second grade, the types of errors committed by German children resembled those of American children. Even though there were differences between the two language groups in decoding skills, their phonemic awareness abilities appeared to be at the same level over both grades. The authors concluded that successful reading in English depends on more complex grapheme to phoneme correspondence rules than reading in German.

Based on this evidence about the universality of dyslexia as a neurocognitive disorder, a direct comparison (using tests that are equivalent in both languages) of developmental reading and spelling difficulties among children/participants with dyslexia who learn to read and write a deep orthography (English) and those who learn to read and write a shallow orthography (Greek) was conducted to investigate the ways in which different orthographies determine the manifestation of literacy impairments.

The aim of the present study was to investigate the ways in which different orthographic systems may affect the manifestation of reading, spelling and other cognitive disabilities among children/participants with dyslexia. Therefore a direct comparison between children/participants with dyslexia learning to read an inconsistent orthography (English) and their counterparts who learn to read and write a consistent orthography (Greek) was conducted. More specifically the aims of the present study were as follows:

1. To carry out a direct comparison of reading and spelling difficulties in children who learn to read an inconsistent orthography (English) and children who learn to read a consistent orthography (Greek).

2. To investigate how reading and spelling disabilities are manifested in two languages with different orthographic systems and the underlying cognitive deficits associated with these disabilities.

3. To investigate what role orthographic and morphological knowledge play in spelling development, considering that Greek is inconsistent for spelling and highly inflected in comparison to English.

Therefore the following hypotheses were formulated:

1. English children/participants with dyslexia will be inaccurate and slow readers, especially when reading nonwords, whereas Greek children/participants with dyslexia will read both words and nonwords accurately, but they will be slower than their controls.

(Landerl et al., 1997)

2. Both English and Greek children/participants with dyslexia will perform poorly in the spelling tests because of the different orthographic demands of the two languages (Goulandris, 2003).

3. English children/participants with dyslexia will perform worse on the tasks of phonological awareness, which measure children's metacognitive ability to tap the organization of the phonological system (Snowling, 2000), in comparison to Greek children/participants with dyslexia.

7.2. Method

7.2.a. Participants

The study involved six groups of participants:

- (i) the group of Greek children/participants with dyslexia (twenty-five 9–12 year-old children; this age range was selected because children in these age groups have reached a reasonable level of mastery in their literacy skills),
- (ii) twenty-nine Greek chronological-age controls,
- (iii) twenty-eight Greek younger normal readers (reading-age controls),
- (iv) the English group of children/participants with dyslexia (seventeen 9–12 year-old children),
- (v) seventeen English chronological-age controls and
- (vi) sixteen English younger normal readers.

The children/participants with dyslexia had a reading ability of 1.5 SD below the control's mean, but they had a verbal and non-verbal IQ within the normal ranges (a standard score of 85 or above). Children with a history of sensory deficits, behavioural or emotional difficulties, irregular school attendance and bilingual children were excluded from the sample. Children/participants with dyslexia were matched with reading-age control children on the basis of similar group means for reading and they were matched with chronological-age control children on the basis of similar group means for age and IQ. The Greek participants were recruited from three State Primary schools located in the centre of Thessaloniki. These schools educate children of different socio-economic and ethnic background. A large number of pupils attending these schools were children of Albanian and Russian immigrants. More specifically, in the first school that was used in the study fifty percent of the children belonged to ethnic minorities. Due to the limited number of children whose native language was Greek, the study had to be conducted in three schools in order to find the appropriate sample. The chronological-age and the gender of the Greek participants are shown in table 7.1.

The English sample included pupils attending Primary schools in London. The children/participants with dyslexia were recruited from a Private school that is specialized in educating children with dyslexia (middle-to-high socio-economic background), and a State school. The participants comprising the control groups were recruited from two State primary schools. The State schools that accommodated the present study educated children of several socio-economic and ethnic backgrounds. It should be noted that the majority of the children included in the reading-age control group were of Caribbean-black or African-Black origin. Table 7.1 demonstrates the mean chronological age and gender of the English participants. Greek and English children/participants with dyslexia were matched on chronological age, short-version IQ and reading ability.

Table 7.1
Age and Gender Characteristics of the Greek & English samples

	Greek CA Controls	Greek RA Controls	Greek Children with dyslexia	English CA Controls	English RA Controls	English Children with dyslexia
Chr.Age	9;11 (1.19)	7;8 (0.46)	10;5 (1.17)	9;9 (1.46)	8 (0.89)	9;11 (1.4)
Min-max	8;2-11;10	7-8;9	8;6-12;10	7;8-13;3	6;9-9;8	7;10-12;6
N	29	28	25	17	16	17
Boys	13	14	17	9	11	13
%	44.8	50	68	52.9	68.8	76.5
Girls	16	14	8	8	5	4
%	55.2	50	32	47.1	31.3	23.5

Note. Chr. Age, chronological age; CA, chronological age; RA, reading age; standard deviations are in parentheses.

7.2.b. Tests and Materials

A test battery was divided into two parts. In the first part a test of reading was administered to a large number of children in order to select the experimental group, the group of chronological age controls and the group of reading-age controls. The

experimental battery included tasks of word and nonword reading, spelling, a number of phonological tasks tapping reading-related language skills and tasks tapping cognitive abilities. All tests were constructed in English and Greek in order to be equivalent. Stimuli were matched on word frequency, syllable length, imageability and phoneme whenever feasible.

Due to the lack of word counts in Greek for children, a word frequency table was devised using primary school textbooks. The procedure was the following: at first we collected the textbooks that are used during the literacy hour at grades 1, 2, 3, 4, 5 and 6. The same textbooks are used at all schools across Greece and the same phonics-based reading instruction is implemented. Twenty-two reading books were collected, four from each grade with the exception of the first grade textbooks that were just two. The next step was to use a computational programme for scanning the texts included in the books. The pages of Greek text were scanned using optical character recognition, which produced word documents of the texts. Following that, a computer programme was written, which at first identified every word included in the documents, and then the number of instances of each of these words. The computational programme produced frequency lists. The frequency table contains 8,335 words arranged by frequency of occurrence. The maximum frequency is 1470 and the minimum is 1. The words that have the highest frequencies are monosyllabic articles, prepositions or pronouns. The words with the lowest frequencies are mainly polysyllabic verbs, nouns and adjectives. In order to obtain the frequencies of the words used in the Greek tests we used the Greek frequency list we devised. High frequency words included those with 1470-70 appearances in 8,334, medium frequency words included those with 69-10 appearances in 8,334, and low frequency words included those with 9-1 appearances in 8,334. The items included in the

tests were of decreasing frequency, beginning from low- to medium- to low- frequency words.

For obtaining the frequencies of the words included in the English tests we used the frequency count by Francis and Kučera (1982).

Selection Measures

The selection of the English reading disabled group and the control groups was based on children's performance on the TOWRE Sight Word Efficiency Test (Torgesen, Wagner & Rashotte, 1999). It is a test of single word reading comprising a list of 104 words. The examinee is required to read as many words as possible within 45 seconds.

The selection of the Greek children/participants with dyslexia, the chronological-age controls and the reading-age controls was based on their performance on a Greek sight word efficiency test that was devised on similar lines to the TOWRE test. The selection of words was based on criteria involving number of syllables, complexity of syllables, orthographic complexity and frequency of occurrence in printed school texts of primary school level. Very high frequency words occur at the beginning of the word list, with words becoming less frequent as the list progresses. For the purpose of obtaining normative data one hundred fifty one Greek children attending grades 1 to 6 were tested on this measure (between October and December 2001). Table 7.3 demonstrates the mean chronological age and reading score of each grade group.

Table 7.2
Mean chronological age and reading score of each grade group

	Chronological Age	Reading Score (number of words read correctly)
Grade 1 Children (N=8)	6.31 (0.2)	14.12 (11.45)
Grade 2 Children (N=27)	7.49 (0.3)	53 (9.64)
Grade 3 Children (N=25)	8.42 (0.28)	61.2 (10.04)
Grade 4 Children (N=18)	9.39 (0.24)	65.16 (10.32)
Grade 5 Children (N=38)	10.42 (0.23)	75.29 (7.26)
Grade 6 Children (N=35)	11.26 (0.31)	75.28 (7.24)

Note. N, Number of participants; standard deviations are in parentheses.

For selecting the three groups of participants one hundred children were tested on the Greek version of the TOWRE Word Efficiency Test and on the Wechsler Intelligence Scale for children (between January and March 2002). A total of 82 children were eventually selected as participants of the Greek portion of the study.

WISC-III: Greek Children were screened on the subtests of Block Design and Similarities of the Greek version of the Wechsler Intelligence Scale for children to ensure that their IQ was within normal limits. English children were screened on the same subtests of the English version of the Wechsler Intelligence Scale for children. Both Greek and English children who obtained a score of less than 85 were excluded from the sample.

Experimental Test Battery

Phonological Awareness

Phoneme deletion of Words. In this task children (Greek & English) were asked to ‘take away’ a phoneme from a set of words and provide the experimenter with the remainder (e.g., *broccoli* (/brɒkəli/) – *μπριζόλα* (/brizɔla/), *pony* (/pəʊni/) – *πίτα* (/pita/)). In

eight cases of the Greek version the phoneme that had to be deleted belonged to a CV (consonant-vowel) structure and in the remaining six the deleted phoneme belonged to a CC (consonant cluster) structure. The position of the deleted phoneme was initial, medial or final. In three cases the phoneme that had to be deleted had an initial position and belonged to a CV structure; in three cases it had a final position of a CV structure and in the remaining two cases it had a medial position of a CV structure. In three cases the phoneme that had to be deleted had a final position and belonged to a CC structure; in the remaining three cases it had a medial position of a CC structure. In the English version of the task children had to take away the phoneme of nine consonant cluster words and eight CV words. In three cases the phoneme that had to be deleted had an initial position and belonged to a CV structure. In three cases the phoneme that had to be deleted had a final position of a CV structure and in the remaining two cases it had a medial position of a CV structure. In three cases the phoneme that had to be deleted had an initial position and belonged to a CC structure; in three cases it had a final position of a CC structure and in the remaining three cases it had a medial position of a CC structure. The unequal number of CC words between the Greek and the English task is due to the fact that in Greek there is no word ending with a consonant cluster. Children received practice on five items. The number of correct answers was calculated for each child. This task is particularly difficult for English speakers (Perin, 1983), but relatively easy for Greek speaking children (Nikolopoulos, 1999).

Phoneme deletion of Pseudowords. In this task children (Greek & English) were asked to ‘take away’ a phoneme from a set of nonwords and provide the experimenter with the remainder (e.g., *floty/φλέκω, μων/πον*). In eight cases of the Greek version the phoneme that had to be deleted belonged to a CV (consonant-vowel) structure and in the remaining

six the deleted phoneme belong to a CC (consonant cluster) structure. The position of the deleted phoneme was initial, medial or final. In three cases the phoneme that had to be deleted had an initial position and belonged to a CV structure. In other three cases the phoneme that had to be deleted had a final position and belonged to a CV structure and in the remaining two cases it had a medial position and belonged to a CV structure. In three cases the phoneme to be deleted had a final position and belonged to a CC structure and in the remaining three cases it had a medial position and belonged to a CC structure. In the English version of the task children had to take away the phoneme of nine consonant cluster nonwords and eight CV nonwords. In three cases the phoneme that had to be deleted had an initial position and belonged to a CV structure; in three cases it had a final position and belonged to a CV structure and in the remaining two cases it had a medial position and belonged to a CV structure. In three cases the phoneme that had to be deleted had an initial position and belonged to a CC structure; in other three cases the phoneme that had to be deleted had a final position and belonged to a CC structure and in the remaining three cases it had a medial position and belonged to a CC structure. Children received practice on five items. The number of correct answers was calculated for each child.

Spoonerisms. The task consisted of twelve pair of words and required English and Greek children to transpose the initial sound of two spoken words. For the first six pairs children had to transpose the initial sounds that belonged to a CV structure (e.g., tuna fish (/tʌnə/ /fɪʃ/ - τυρί φέτα /tɪrɪ/ /feta/), whereas for the other six they had to transpose the initial sounds from pairs of words in which one word started with a consonant cluster (CC) and the other one with a consonant-vowel (CV) (e.g., fresh cake (/fref/ /keɪk/)

φρεσκο κεικ (/freskɔ/ /keɪk/). Children received practice on three pairs of words. The number of correctly transposed items was calculated for each child. This task was chosen because it is a sensitive and challenging measure, like phoneme deletion, for assessing phonological awareness (Mc Dougall, Hulme, Ellis and Monk, 1994; Snowling, 2000).

Phonological Processing

Phonological Short-Term Memory/Digit Span. Greek and English children's memory span was tested on the Digit Span subtest of the Greek and English WISC-III respectively. On each trial children had to recall and repeat two trials of an increasing number of digits. The test was discontinued when both items in a block were failed. This test was chosen because it is a reliable measure for assessing phonological processing skills (Snowling, 2000).

Rapid Naming. The task of rapid automated naming involves naming highly familiar objects under speeded conditions. The test (for both Greek & English participants) included a subtest of rapid digit naming. This task was included in the test battery because there is extensive evidence that children/participants with dyslexia who read in different orthographies, as well as adult children/participants with dyslexia, show rapid naming deficits (Felton and Wood, 1989; Pennington, Order, Smith, Green, and Haitl, 1990; Wolf, 1986)

Rapid Naming of Digits. The task was devised on similar lines to the Digit Naming subtest of the Comprehensive Test of Phonological Processing (Wagner, Torgesen & Rashotte, 1999). It included a practice form and two test forms. The practice form

displayed six digits in a row on an A4 page. The test form consisted of six digits (2, 3, 5, 6, 7, 8) displayed six times each in four rows on an A4 page (thirty six digits in total). The children were asked to name the digits as fast as possible. The task was repeated with a different arrangement of digits and the overall naming time was the score of this subtest. Digits were matched on number of phonemes across the two languages. However, it should be mentioned that the Greek names of five digits exceeded their English counterparts by one phoneme.

Reading Assessment

Word reading efficiency in Greek was assessed by two subtests:

Single Word Reading. The test consisted of a practice form with five regular words and a test form containing a list of twenty-five regular words with a gradually increasing number of syllables but decreasing frequency of occurrence displayed vertically on an A4 page. The list consisted of one one-syllable word, three two-syllable words, six three-syllable words, seven four-syllable words, five five-syllable words and one six-syllable word; thirteen words had a CV structure and twelve words contained a consonant cluster either at the beginning of the word or in the middle of the word. The words were either nouns or adjectives with the exception of one article. Since stimuli were matched on syllable length across the two languages (English & Greek), the limited number of one-syllable and six-syllable words used in the test can be explained by the fact that there are few one-syllable words in the Greek language and these are either articles, adverbs or conjunctions, whereas six-syllable words are infrequent in the English language. Stimuli were also matched on syllable structure, phonemic similarity, grammatical class and frequency of occurrence. Children were asked to read the words as quickly as possible. Their reading time was recorded and the number of words read correctly was calculated.

Single Nonword Reading. This test consisted of a practice form with five pseudo-words and a test form containing a list of twenty-five pseudo-words with a gradually increasing number of syllables displayed vertically on an A4 page. Pseudowords were derived from the words in the word reading task by swapping the letters within each word, by substituting one letter with another (e.g., μητέρα→σητέρα, παλάτι→λαπάτι) or by doing both. The grapho-phonemic structure and the length of each word stimulus were retained in the case of the nonwords. Children were instructed to read the nonwords as quickly as possible. Accuracy of nonword reading and speed rate was recorded.

Spelling Assessment

The spelling efficiency of the Greek children was assessed by the following tests:

1. Spelling of suffixes (correct spelling requires grammatical knowledge),
2. Orthographic proof spelling (correct spelling requires orthographic knowledge),
3. Morphological proof spelling of words and
4. Morphological proof spelling of nonwords (correct spelling requires knowledge of the morphology of language).

Spelling of Suffixes. This test was designed to assess children's ability to spell word suffixes. Children's correct spelling of word endings requires the integration of morphological knowledge because of spelling patterns which represent morphemes in such a way that cannot be reduced to phonology. For example, many Greek words end in the sound /v/ that can be represented by four alternative spelling patterns. The grammatical status of a given word that ends in the sound /v/ will determine the spelling of the word's suffix. Children who do not take morphology into account when spelling word suffixes are expected to represent word endings with the wrong spelling pattern. For instance, feminine singular nouns end in the sound /v/ which is spelled with the letter η.

Misrepresentations of this sound would be the graphemes *ι*, *ει*, or *οι* which are spelling alternatives for representing the same phoneme.

Children were required to complete the suffixes of nonwords with the correct spelling. The task consisted of two practice sentences (presented on the class's black board) and 36 test sentences, half of which were priming sentences and the other half the sentences containing the nonword with the incomplete suffix. Pseudo-words were used instead of real words in order to ensure that the test measured children's grammatical knowledge and not their knowledge of spellings by sight.

The pseudo-words were analogous to real words; they were derived by changing some of the letters of the stem of the word and using the same ending. For example the nonword "blurch" derived from the word "church". The stimuli of the English and Greek version of the test were matched on word class, i.e., noun, verb and degree of visual and phonological similarity with real words. More specifically, the nonwords representing nouns in both languages were matched on form (singular or plural), and case (nominative or genitive). The nonwords representing main verbs were matched on type (regular or irregular), voice (active or passive), tense (present or past), form (singular or plural) and person (1st, 2nd or 3rd) across languages. The meaning of the priming and test sentences was the same or similar in both languages wherever feasible (due to grammatical or syntactical constraints).

Greek Version

The Greek version of the test consisted of the following items: Four nonwords representing nouns, five representing adjectives, and nine representing main verbs. Three out of nine verbs were irregular and the remaining six were regular. Nonwords based on

nouns and adjectives were masculine, feminine or neuter, both were used singular or plural and they were in nominative or genitive case. One noun was masculine, one feminine and two neuters. Two nouns were in nominative case and two in genitive case. One noun was singular and three were plural. Two adjectives were masculine, one feminine and two neuters. Three adjectives were in nominative case and two in genitive case. All the adjectives were plural.

The nonwords based on verbs were either in present or past tense, active or passive voice, singular or plural and first, second and third person. Four verbs were in the present tense and five in the past tense. Six verbs were in the active voice and three in the passive voice. Seven verbs were singular and two plurals. Four verbs were in the first person, two in the second person and three in the third person.

Most of the sentences contained one incomplete nonword when the nonword was a noun or a verb, but when the nonword represented an adjective, the suffix of the article and the noun to which the adjective referred to were also missing (e.g., Ο σκύλος του γείτονα μας είναι *βεχικός*. Οι *βεχικ*__ σκύλ__ σε αφήνουν να παίζεις μαζί τους. Our neighbour's dog is *vehicos*. The *vehiki* dogs let you play with them). It should also be mentioned that in some cases of verb-nonwords there were two incomplete spellings within the same nonwords, as both spellings reflected on children's grammatical knowledge (e.g., Ο διευθυντής του εργοστασίου κάθε χρόνο *στερύει* κάποιον εργάτη. Πέρσι *στέρ*__*σ*__ δυο εργάτες. Every year the manager of the factory *oteriee* a worker. Last year he *oterise* two workers).

The sentences were printed in 'New Times Roman' font, in 14 font size and were displayed in rows on three A4 pages. The task was administered to whole classes as a group test and children were instructed to fill in the spaces with the correct spelling. Number of correct spellings was recorded.

English Version

The English version of the test consisted of the following items: nine nonwords representing nouns, and nine nonwords representing main verbs. The nonwords based on nouns were either singular or plural and they were in nominative or genitive case. Five of the nouns were in nominative case and four in genitive case. One noun nonword was singular and the remaining eight were plural. At this point it should be mentioned that the absence of nonwords based on adjectives in the English version of the task was due to the fact that English adjectives are used only in singular and not in plural and they are not in agreement with the noun they refer to. On the contrary, the grammatical form of adjectives in the Greek language is similar to that of nouns. Specifically, adjectives have a gender (masculine, feminine and neuter), they have two forms (singular and plural) and they have cases (nominative, genitive, accusative and vocative). Adjectives are always found in verbal or written form having the gender, form and case of the noun they refer to.

The number of nonwords based on main verbs that comprised the English version of the task and their grammatical characteristics were the same as the stimuli in the Greek version of the task. The procedure for administration and scoring of this task was identical to that used in the case of the Greek version.

Orthographic Proof Spelling. Children's orthographic knowledge was assessed by a proof spelling task, which required the child to select the correct spelling out of a selection of four choices all of which when decoded, sounded like the word (e.g., δάχιλα-δάχτηλα-δάχτυλα-δάχτειλα). The task consisted of two trial items (presented on the class's black board) and twenty groups of one target word with three pseudohomophones of decreasing frequency (from high frequency words to moderate and low frequency) printed in 'Times New Roman' font, 14 font size and presented in twenty rows on an A4 page. The task was administered to whole classes as a group test and children were instructed to tick the word they thought was written with the correct spelling. Number of correct words chosen was recorded.

Morphological Proof Spelling of Words. Children's morphological knowledge was assessed by a proof-spelling task. The task consisted of two trial items (presented on the class's black board) and fifteen groups of one target word with three pseudohomophones printed in 'Times New Roman' font, 14 font size and presented in fifteen rows on two A4 pages. The part of the word in each group that was manipulated by using a different spelling option was the prefix (e.g., επιτρέπω-επυτρέπω-επητρέπω-επειτρέπω). Four prefixes were used, two of which were monosyllabic and the remaining two were bisyllabic. The two monosyllabic prefixes were of higher frequency than the two bisyllabic ones. The words that included the four prefixes were low frequency words. The Greek prefixes were the following: *συν-*, *δια-*, *επι-*, *υπο-*. The English Prefixes were: *dis-*, *re-*, *auto-* and *anti-*. Prefixes were matched on syllable length, frequency of occurrence in words and word frequency across the two languages (English & Greek). The stimuli were randomly ordered on the test sheets. This task differed from the orthographic proof spelling task in that the part of the word that was manipulated was the prefix (correct

spelling of prefixes requires morphological knowledge), whereas in the orthographic proof spelling task the word part that was manipulated was the stem (correct spelling of word stems requires orthographic knowledge). The task was administered again to whole classes as a group test and children were instructed to tick the word, which they thought was written with the correct spelling. Number of correct words chosen was recorded.

Morphological Proof Spelling of Nonwords. Children's morphological knowledge was assessed once more by using a proof-spelling task, but this time the stimuli were pseudo-words (e.g., σινακελώ-σοινακελώ-συνακελώ-σηνακελώ). The task consisted of two trial items (presented on the class's black board) and twelve groups of one target nonword with three pseudohomophones printed in 'Times New Roman' font, 14 font size and presented in twelve rows on an A4 page. The prefixes that were used in this test were the same as those in the version of the test with real words. The prefixed nonwords were derived from real words by substituting the letters of the stem of the word with different ones; the ending of each nonword resembled the ending of a real word. The stimuli were randomly ordered on the test sheets. The task was administered to whole classes as a group test and children were instructed to tick the nonword they thought was written with the correct spelling. Number of correct nonwords chosen was recorded. This additional measurement for assessing children's morphological knowledge was used for the purpose of ensuring that children's choice of the correct spelling of a word was based on the application of their morphological knowledge and not because they were aware of the spelling of this word by sight.

7.2.c. Procedure of Task Administration

Greek participants were recruited from three different State Primary Schools in inner Thessaloniki. They were assessed individually in an empty classroom of the school, apart

from the case of four proof-spelling tests that were administered to whole classes due to time limitations. Children were seen on three separate occasions (thirty–forty minutes each session). In the first individual session participants were administered the Similarities and Block Design subtests of the WISC for children and the Greek version of the TOWRE Word Efficiency test. In the second individual session the phonological and reading measures were administered. In the third session, which was a whole-class session, the spelling measures were administered. The order of administration of tests was counterbalanced. It should be mentioned that there is a small number of missing data points on a couple of variables due to absence or missing records.

7.3. Results

7.3.a. Comparison between Greek children/participants with dyslexia and normal readers.

Means and standard deviations for chronological age, reading ability and performance on standardised measures of the group of children/participants with dyslexia and the two comparison groups are shown in table 7.3.

Table 7.3
Mean scores for children/participants with dyslexia and comparison groups on standardized measures

	Chronological-Age Controls (N=29)	Reading-Age Controls (N=28)	Participants with Dyslexia (N=25)
Chronological Age (in months)			
Min-max	119.45(14.28)	91.54 (5.57) 7-8;9	125.08 (13.79) 8;6-12;10
	8;2-11;10		
<i>Reading Ability (number of words)</i>			
Min-max	72.24 (8.02) 54-86	55.60 (7.40) 41-69	54.92 (9.64) 31-68
Items	104	104	104
WISC-III IQ	116.14 (16.88)	111.85 (17.33)	105.40 (16.23)
Min-max	92-147	89-155	85-155
WISC-III Digit Span (raw scores)	14.41 (2.37)	10.50 (1.57)	11.68 (2.32)
Min-max	7-20	8-14	7-16

Note. N, Number of participants; standard deviations are in parentheses.

A One-Way Analysis of Variance revealed that there was no significant difference in the performance of the three groups (chronological-age controls, reading-age controls & children/participants with dyslexia) on the Wechsler Intelligence Scale (n.s). Post Hoc Tests (LSD) showed that there was no significant difference in the IQ of reading-age controls and both chronological-age controls and children/participants with dyslexia (n.s), but the performance of the chronological-age controls on the WISC-III was significantly higher than the children's/participants' with dyslexia performance ($p < 0.05$).

The difference between the groups in the Digit Span Subtest of the Wechsler Intelligence Scale was highly significant [$F(2, 79) = 25.66, p < 0.001$]. Post Hoc Tests (LSD) confirmed that chronological-age controls scored higher than children/participants with dyslexia and reading-age controls ($p < 0.001$) and children/participants with dyslexia performed significantly better than reading-age controls ($p < 0.05$).

A One-Way Analysis of Variance was also conducted to investigate the differences in the performance of the three groups on the following experimental measures: Spoonerisms, Orthographic Proof Spelling Task & Spelling Task of Suffixes. Descriptive statistics are demonstrated in Table 7.4.

Table 7.4
Participants' mean scores on spoonerisms, orthographic proof spelling task & spelling task of suffixes

	Chronological- Age Controls (N=29)	Reading-Age Controls (N=28)	Children/Participants with Dyslexia (N=25)
Spoonerisms	22.65 (1.32)	13.32 (5.52)	13.72 (5.41)
Min-max	19-24	2-23	2-23
Items	24	24	24
Rapid Digit Naming	29.79 (4.5)	37.78 (6.52)	36.76 (7.49)
Min-max (seconds)	21-37	29-60	25-57
Orthographic Proof Spelling	15.76 (2.13)	11.86 (2.32)	11.72 (3.26)
Min-max	11-20	4-16	5-18
Items	20	20	20
Spelling Task of Suffixes	28.72 (3.04)	21.53 (4.99)	21.80 (6.02)
Min-max	22-34	8-30	5-32
Items	32	32	32

Note. N, Number of participants; standard deviations are in parentheses.

A highly significant difference was found between the groups on spoonerisms [$F(2, 79) = 39.35, \eta^2 = .509, p < 0.001$] and rapid digit naming [$F(2, 79) = 14.20, \eta^2 = .259, p < 0.001$]. Post Hoc Tests (LSD) showed that the chronological-age controls scored significantly higher on both tasks than both the reading-age controls and the children/participants with dyslexia ($p < 0.001$ in both cases). The reading-age control group and the clinical group did not differ.

A highly significant difference was also found between groups on the orthographic proof-spelling task [$F(2, 79) = 22.086, \eta^2 = .359, p < 0.001$], as well as on the task of spelling suffixes [$F(2, 79) = 20.490, \eta^2 = .342, p < 0.001$]. On the orthographic proof-spelling task, Post Hoc Tests (LSD) showed that the chronological-age controls scored

significantly higher than both the children/participants with dyslexia ($p < 0.001$) and the reading-age controls ($p < 0.001$). However, no significant difference was found between the children/participants with dyslexia and the reading-age controls.

Post Hoc Tests (LSD) showed that both children/participants with dyslexia and reading-age controls performed significantly worse than the chronological-age controls on the spelling task of suffixes ($p < 0.001$ in both cases). Once more there was no significant difference between children/participants with dyslexia and reading-age controls on this task.

A Two-way Mixed ANOVA design was used to analyse group performance on the rest of the experimental measures: a. Phoneme Deletion with two levels: words and nonwords, b. Reading Accuracy with two levels: word reading and psuedoword reading, c. Reading Speed with two levels: word reading speed and psuedoword reading speed and d. Morphological Proof Spelling Task with two levels: morphological proof spelling task of words and morphological proof spelling task of nonwords. Mean scores on these measures are illustrated in Table 7.5.

Table 7.5
Participants' mean performance on the remaining experimental measures

	Chronological- Age Controls (N=29)	Reading-Age Controls (N=28)	Children/Participants with Dyslexia (N=25)
Phoneme Deletion of Words	13.69 (0.5)	12 (1.4)	11.92 (1.70)
Min-max	13-14	9-14	9-14
Items	14	14	14
Phoneme Deletion of Nonwords	13.59 (0.7)	11.57 (1.87)	11.40 (2.22)
Min-max	11-14	7-14	6-14
Items	14	14	14
Word Reading Accuracy	24.34 (0.8)	23.14 (1.43)	22.54 (2.080)
Min-max	23-25	19-25	17-25
Items	25	25	25
Nonword Reading Accuracy	23.14 (1.48)	20.18 (2.82)	19.44 (2.78)

Min-max	20-25	14-25	14-23
Items	25	25	25
Word Reading Speed	19.89 (5.11)	33.21 (8.03)	34.42 (13.76)
Min-max	12-30	19-49	14-73
Nonword Reading Speed	38.82 (10.69)	55.36 (12.07)	59.48 (15.14)
Min-max	22-56	37-87	35-94
Morph. Proof Spelling/Words	13.17 (1.62)	7.82 (3.41)	9.56 (3)
Min-max	9-15	2-15	4-15
Items	15	15	15
Morph. Proof Spelling/Nonwords	10.20 (1.70)	5.78 (2.35)	6.56 (2.06)
Min-max	6-12	1-10	3-12
Items	12	12	12

Note. N, Number of participants; standard deviations in parentheses.

A. Phoneme Deletion.

The analysis revealed a highly significant main effect of group [$F(2,79)=19.66$, $\eta^2 = .332$, $p<0.001$]. The chronological-age controls scored higher in the two tasks of phoneme deletion than both the children/participants with dyslexia and the reading-age controls. However the mean scores of the reading-age controls and the children/participants with dyslexia on the tasks of phoneme deletion of words and phoneme deletion of nonwords were similar.

There was also a significant main effect of phoneme deletion [$F(1,79) = 4.84$, $\eta^2 = .058$, $p<0.05$], whereby children performed slightly higher in the phoneme deletion of words than nonwords. The interaction group by phoneme deletion was not significant [$F(2,79) = 0.64$, N.S], indicating that group performance was similar across the two levels of phoneme deletion.

B. Reading Accuracy

A highly significant main effect of group was found [$F(2,78) = 23.01$, $\eta^2 = .492$, $p<0.001$]. Chronological-age controls were more accurate than the groups of children/participants with dyslexia and reading-age controls. It was also shown that

children/participants with dyslexia were less accurate readers in comparison to the chronological-age control children, but performed similarly to the reading-age controls.

A highly significant main effect of reading accuracy was also found [$F(1,78) = 75.53, \eta^2 = .371, p < 0.001$], whereby children were more accurate when reading words than when reading nonwords. The group by reading accuracy interaction was found to be significant [$F(2,78) = 5.045, \eta^2 = .115, p < 0.01$]. The interaction was due to the greater difference in reading accuracy between the groups when reading nonwords than regular words. Post Hoc Tests (LSD) showed that children/participants with dyslexia were significantly less accurate readers than the chronological-age controls when reading both words ($p < 0.001$) and nonwords ($p < .001$), but they did not differ significantly from the reading-age controls at both levels (N.S). In comparison to the reading-age controls, the chronological-age controls were significantly more accurate readers when reading both words ($p < 0.005$) and nonwords ($p < 0.001$).

The Interaction of Group by Reading Accuracy

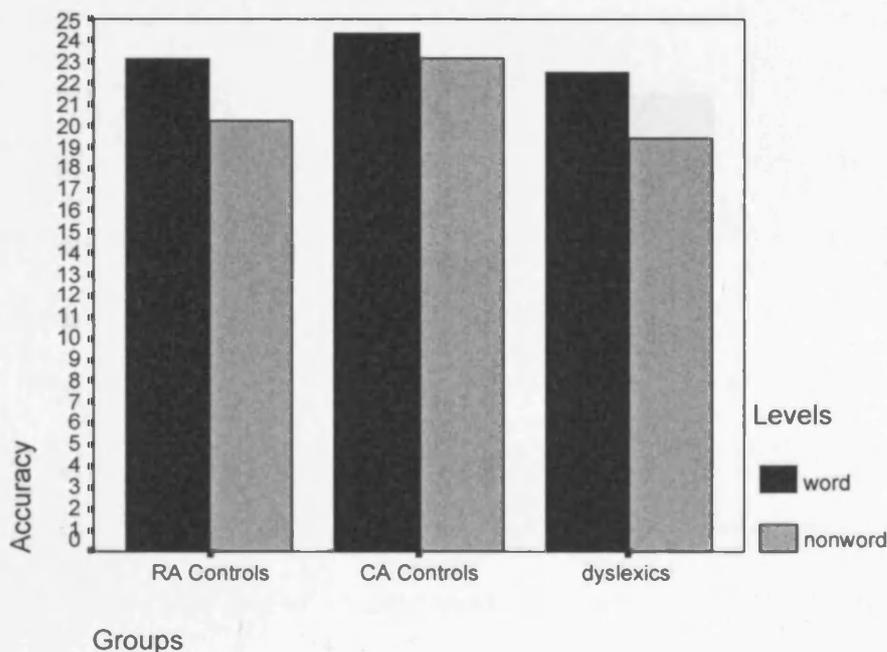


FIG. 7.1. Means for the interaction of group by reading accuracy.

C. Reading Speed

The analysis showed a highly significant main effect of group [$F(2,78) = 23.59, \eta^2 = .377, p < 0.001$]. Reading speed was found to have a highly significant main effect [$F(1,78) = 501.18, \eta^2 = .865, p < 0.001$], indicating that children were slower when reading nonwords than when reading words.

The interaction group by reading speed was significant [$F(2, 78) = 3.28, \eta^2 = .078, p < 0.05$], since the reading speed of the clinical group and the two control groups differed between words and nonwords. Post Hoc Tests (LSD) showed that the group of children/participants with dyslexia was significantly slower than the chronological-age control group when reading both words ($p < 0.001$) and nonwords ($p < 0.001$), but they did not significantly differ from the reading-age controls (N.S). In relation to the reading-age controls, chronological-age controls were significantly faster readers when they read both words ($p < 0.001$) and nonwords ($p < 0.001$).

The Interaction of Group by Reading Speed

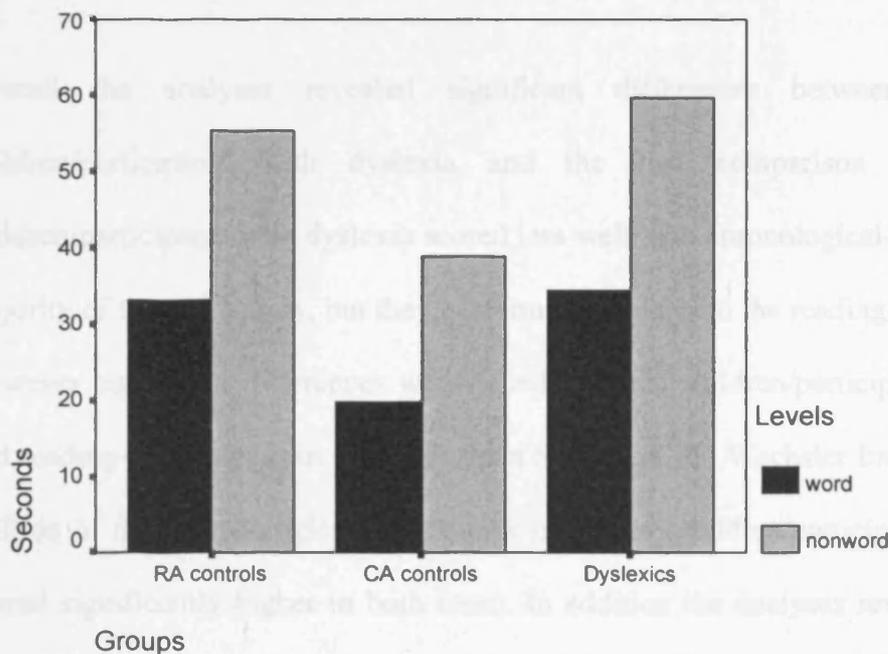


FIG. 7.2. Means for the interaction of group by reading speed.

D. Morphological Proof Spelling Task

The analysis produced a highly significant main effect of group [$F(2,79) = 39.93$, $\eta^2 = .503$, $p < 0.001$]. Post Hoc Tests (LSD) showed that chronological-age controls performed significantly better than children/participants with dyslexia and reading-age controls on both word and nonword morphological proof spelling tasks ($p < 0.001$ in both cases). Children/participants with dyslexia were found to perform significantly better than the reading-age controls on the morphological proof spelling task of words ($p < 0.05$), but their performance on the nonword version of the task was not significantly different to the RA controls (n.s).

The main effect of the morphological proof-spelling task was significant [$F(2,79) = 8.85$, $\eta^2 = .101$, $p < 0.005$], indicating that all groups scored higher in the task of words than in the task of nonwords. The interaction group by morphological proof-spelling task was not significant [$F(2,79) = 1.14$, N.S], indicating that group performance did not change between words and nonwords.

Overall the analyses revealed significant differences between the group of children/participants with dyslexia and the two comparison groups, whereby children/participants with dyslexia scored less well than chronological-age controls in the majority of the test battery, but they performed similarly to the reading-age control group. However significant differences were found between children/participants with dyslexia and reading-age controls in the Digit Span Subtest of the Wechsler Intelligence Scale, as well as in the morphological choice task of words (children/participants with dyslexia scored significantly higher in both tests). In addition the analyses revealed a lexicallity effect. Words were read more accurately and faster than nonwords. Children were also

found to perform better in the word phoneme deletion task than in the nonword version, as well as in the morphological choice task of words than in the nonword version of the task.

7.3.b. Comparison between English children/participants with dyslexia and normal readers.

Means and standard deviations for chronological age, reading ability and performance on standardised and experimental measures of the English experimental group and the two comparison groups are shown in table 7.6.

Table 7.6
English children's/participants' with dyslexia and control children's mean performance on the standardized & experimental measures

	English Chronological-age Controls (N=17)	English Reading-age Controls (N=15)	English Children/ Participants with Dyslexia (N=17)
Chronological Age	9.78 (1.4)	8.08 (0.9)	9.88 (1.4)
Min-max	7.67-13.25	6.75-9.67	7.83-12.50
TOWRE Sight Word Efficiency score	69 (8.2)	56.40 (15.39)	55.41 (15.58)
Min-max	52-81	34-82	26-79
WISC-III IQ	105 (17)	107.33 (15)	100.40 (11.15)
Min-max	85-134	85-131	85-119
WISC-III Digit Span	14.47 (2.34)	11.6 (3.15)	10.94 (3.34)
Min-max	12-20	7-19	6-21
Phoneme Deletion of Words	13.82 (2.12)	12.14 (3.34)	9.41 4.52
Min-max	11-17	4-17	2-15
Items	17	17	17
Phoneme Deletion of Nonwords	14.17 (2.5)	11.76 (3.76)	9.23 3.68
Min-max	9-17	5-17	3-14
Items	17	17	17
Spoonerisms	20.47 (2.55)	16.3 (5.6)	14.06 (5.59)
Min-max	16-24	4-22	4-21
Items	24	24	24
Rapid Digit Naming	31.7 (5.6)	37 (9.66)	36.76 (7.07)
Min-max (seconds)	26-43	24-63	29-53
Regular Word Reading Accuracy	19.47 (4.53)	16.7 (5.7)	12.47 (5.720)
Min-max	10-25	7-25	2-20
Items	25	25	25
Nonword Reading Accuracy	18.17 (5.16)	14.57 (5)	8.94 (6.36)
Min-max	9-24	7-23	0-21
Items	25	25	25
Regular Word Reading Speed	48.17 (27.14)	87.6 (47.14)	83.23 (50.75)
Min-max (seconds)	21-115	27-174	30-204

Nonword Reading Speed	61.76 (20.31)	107.28 (54)	83.06 (31.50)
Min-max (seconds)	35-115	42-214	35-137
WORD Graded Spelling Test (spelling age)	12.23 (2.88)	9.38 (2.7)	8.53 (1.2)
Min-max	7.50-17	6.75-15.50	6.75-11
Orthographic Proof Spelling	16.25 (3.3)	13.54 (3)	12.06 (3.41)
Min-max	10-20	9-19	7-19
Items	20	20	20
Spelling Task of Suffixes	9.56 (2.3)	5.07 (4.5)	5.17 (3.3)
Min-max	7-15	0-13	0-12
Items	18	18	18
Morph. Proof Spelling/Words	11.93 (3.97)	7.54 (4.17)	8.29 (4.17)
Min-max	3-15	2-13	3-15
Items	15	15	15
Morph. Proof Spelling /Nonwords	8.7 (2.46)	6.2 (2.4)	5.47 (2.50)
Min-max	3-12	3-10	2-12
Items	12	12	12

Note. N, Number of participants; standard deviations are in parentheses.

A One-Way Analysis of Variance revealed that there was no significant difference in the performance of the three groups (chronological-age controls, reading-age controls & children/participants with dyslexia) on the Wechsler Intelligence Scale ($F(2, 48) = 0.47, n.s.$).

The difference between the groups on the Digit Span Subtest of the Wechsler Intelligence Scale was significant [$F(2, 50) = 6.93, p < 0.005$]. Post Hoc Tests (LSD) confirmed that chronological-age controls scored higher than children/participants with dyslexia and reading-age controls ($p < 0.001$ and $p < 0.01$), but children/participants with dyslexia and reading-age controls did not differ.

A One-Way Analysis of Variance was also conducted to investigate the differences in the performance of the three groups on the following experimental measures: Spoonerisms, Orthographic Proof Spelling Task & Spelling Task of Suffixes.

A highly significant difference was found between the groups on spoonerisms [$F(2, 47) = 7.67, \eta^2 = .259, p < 0.001$]. Post Hoc Tests (LSD) showed that the chronological-age controls scored significantly higher than both the reading-age controls and the children/participants with dyslexia. The reading-age control group and the experimental group did not differ. The groups' performance on the task of rapid digit naming was not significantly different [$F(2, 47) = 2.63, ns$].

A highly significant difference was also found between groups on the orthographic proof-spelling task [$F(2, 46) = 6.92, \eta^2 = .243, p < 0.005$], as well as on the task of spelling suffixes [$F(2, 47) = 9.48, \eta^2 = .301, p < 0.001$]. On the orthographic proof-spelling task, Post Hoc Tests (LSD) showed that the chronological-age controls scored significantly higher than both the children/participants with dyslexia ($p < 0.001$) and the reading-age controls ($p < 0.05$). However, no significant difference was found between the children/participants with dyslexia and the reading-age controls.

Post Hoc Tests (LSD) showed that both children/participants with dyslexia and reading-age controls performed significantly worse than the chronological-age controls on the spelling task of suffixes ($p < 0.001$ in both cases). Children/participants with dyslexia and reading-age controls did not differ on this task.

A Two-way Mixed ANOVA design was used to analyse group performance on the rest of the experimental measures: a. Phoneme Deletion with two levels: words and nonwords, b. Reading Accuracy with two levels: word reading and pseudoword reading, c. Reading Speed with two levels: word reading speed and pseudoword reading speed and d.

Morphological Proof Spelling Task with two levels: morphological choice task of words and morphological choice task of nonwords.

The analysis of data from the phoneme deletion tasks revealed a highly significant main effect of group [$F(2,45)=9.24, \eta^2 = .291, p<0.001$]. Post hoc comparisons (LSD) revealed that children/participants with dyslexia performed significantly less accurately on the tasks of phoneme deletion of words and phoneme deletion of nonwords than same-age normal and younger normal readers.

There was no significant effect of item type [$F(1,45) = 0.28, ns$]; deletion performance was similar across word and nonword items. The group by item type interaction was also not significant [$F(2,45) = 0.81, ns$], indicating that phoneme deletion scores were similar across the three groups for both word and nonword items.

A two-way analysis of variance on reading accuracy showed a highly significant main effect of group [$F(2,46) = 10.97, \eta^2 = .323, p<0.001$]. Post Hoc Tests (LSD) showed that children/participants with dyslexia were significantly less accurate readers than the chronological-age controls and the reading-age controls when they read both words ($p<0.001$ & $p<0.05$) and nonwords ($p<.001$ & $p<0.005$). The reading-age controls and the chronological-age controls did not differ.

A highly significant main effect of item type was also found [$F(1,46) = 17.43, \eta^2 = .275, p<0.001$], whereby children were more accurate when reading words than when reading nonwords. The group by item type interaction was not significant [$F(2,46) = 1.69, ns$],

showing that the reading performance of the clinical group and the two control groups was similar across both word and nonword items.

The analysis of reading speed data showed a highly significant main effect of group [F (2,45) = 5.16, $\eta^2 = .187$, $p < 0.001$]. Post Hoc Tests (LSD) showed that the group of children/participants with dyslexia was significantly slower than the chronological-age control group when reading words ($p < 0.05$), but they did not significantly differ in nonword reading speed. Children/participants with dyslexia and reading-age controls did not differ. In relation to the reading-age controls, chronological-age controls were significantly faster readers when they read both words ($p < 0.05$) and nonwords ($p < 0.005$).

There was a highly significant main effect of item type [F (1,45) = 12.25, $\eta^2 = .214$, $p < 0.001$], indicating that children were slower when reading nonwords than when reading words. The group by item type interaction was not significant [F (2, 45) = 0.77, *ns*], showing that the reading speed of the clinical group and the two control groups was similar across both words and nonwords.

The analysis of data from the morphological proof spelling task produced a highly significant main effect of group [F (2,43) = 6.17, $\eta^2 = .223$, $p < 0.005$]. Post Hoc Tests (LSD) showed that chronological-age controls performed significantly better than children/participants with dyslexia and reading-age controls on both word and nonword morphological choice tasks. The performance of the children/participants with dyslexia was not significantly different to the RA controls on both tasks.

The main effect of the item type was significant [$F(1, 43) = 5.51, \eta^2 = .114, p < 0.05$], indicating that performance with words was better than with nonwords. The group by item type interaction was not significant [$F(2, 43) = 0.54, ns$], indicating that group performance was similar across both word and nonword items.

Inspection of effect sizes in each language revealed that the effect of group was stronger in Greek than in English when children performed the spoonerisms task and the task of orthographic proof spelling. On the contrary, the effect sizes in the case of the spelling of suffixes task and the phoneme deletion tasks were almost of similar magnitude. The effect of group was stronger in Greek than in English in the case of reading accuracy, since Greek chronological-age controls were significantly more accurate readers than reading-age controls, whereas English chronological-age and reading-age controls did not differ in reading accuracy. Similarly, the effect of group was stronger in Greek than in English in the case of reading speed, due to the fact that Greek children/participants with dyslexia were significantly slower than Greek chronological-age controls when they read nonwords, whereas English children/participants with dyslexia did not differ in nonword reading speed from chronological-age controls. Finally, the effect of group was stronger in Greek than in English in the case of the proof-spelling task of word and nonword prefixes.

7.3.c. Comparison between Greek and English children/participants with dyslexia

Table 7.7 shows the performance of the English and the Greek children/participants with dyslexia on standardised tests of reading and general intelligence, verbal short-term

memory, their mean chronological age, and the test-retest reliability for the Greek version of the TOWRE Sight Word Efficiency Test. As mentioned earlier in the methodology section, it was decided to match the two comparison groups on their chronological age, their IQ measured on a short version of the WISC-III (Similarities and Block design) and their reading level. It can be seen (table 7.7) that the two language groups' mean chronological age and overall IQ scores are similar as is their mean performance on the standardised reading measure and the digit span subtest. One-Way ANOVAs confirmed the absence of significant differences between the groups on these measures.

Table 7.7
Participants' mean performance on standardised measures

	English Children/ Participants with Dyslexia (N=17)	Greek Children/ Participants with Dyslexia (N=25)	F	p	Test-Retest Reliability (Pearson's r)
Chronological Age	9.88 (1.4)	10.41 (1.17)	1.71	ns*	
Min-max	7.83-12.50	8.50-12.83			
TOWRE Sight Word Efficiency score	55.41 (15.58)	54.92 (9.64)	0.05	ns	0.88 ($p < 0.001$)
Min-max	26-79	31-68			
WISC-III IQ	100.40 (11.15)	105.40 (16.23)	1.10	ns	
Min-max	85-119	85-155			
WISC-III Digit Span	10.94 (3.34)	11.68 (2.32)	0.71	ns	
Min-max	6-21	7-1			

Note. Standard deviations are in parentheses; *ns, not significant.

Means and standard deviations for the performance of the English and Greek groups of children/participants with dyslexia on the experimental measures and comparisons of the two groups are displayed in table 7.8. In order to investigate the possible differences between the two groups One-Way and Repeated Measures Analyses of Variance were conducted.

Table 7.8
Participants' mean performance on the experimental measures and comparisons

	Greek Children/ Participants with Dyslexia (N=25)	English Children/ Participants with Dyslexia (N=17)	<i>p</i>
Phoneme Deletion of Words %	85.14 (12.18)	55.36 (26.63)	<0.05
Min-max	64-100	11-88	
Items	14	17	
<i>a</i>	.61	.86	
Phoneme Deletion of Nonwords %	81.42 (15.83)	54.32 (21.6)	<0.05
Min-max	42-100	17-82	
Items	14	17	
<i>a</i>	.68	.82	
Spoonerisms	13.72 (5.41)	14.06 (5.59)	ns*
Min-max	2-23	4-21	
Items	24	24	
<i>a</i>	.91	.88	
Rapid Digit Naming	36.76 (7.49)	36.76 7.07	ns
Min-max (seconds)	25-57	29-53	
Rapid Letter Naming		38.64 (6.45)	
Min-max (seconds)	-----	30-53	-----
Regular Word Reading Accuracy	22.54 (2.080)	12.47 (5.720)	<0.001
Min-max	17-25	2-20	
Items	25	25	
<i>a</i>	.54	.89	
Nonword Reading Accuracy	19.44 (2.78)	8.94 (6.36)	<0.001
Min-max	14-23	0-21	
Items	25	25	
<i>a</i>	.68	.91	
Regular Word Reading Speed	34.42 (13.76)	83.23 (50.75)	<0.001
Min-max (seconds)	14-73	30-204	
Nonword Reading Speed	59.48 (15.14)	83.06 (31.50)	<0.001
Min-max (seconds)	35-94	35-137	
Orthographic Proof Spelling	11.72 (3.26)	12.06 (3.41)	ns
Min-max	5-18	7-19	
Items	20	20	
<i>a</i>	.75	.80	
Spelling Task of Suffixes (%)	63.35 (17.78)	34.51 (21.88)	<0.001
Min-max	14-99	0-80	
Items	34	18	
<i>a</i>	.85	.79	
Morph. Proof Spelling/Words	9.56 (3)	8.29 (4.17)	ns
Min-max	4-15	3-15	
Items	15	15	
<i>a</i>	.82	.88	
Morph. Proof Spelling /Nonwords	6.56 (2.06)	5.47 (2.50)	ns
Min-max	3-12	2-12	
Items	12	12	
<i>a</i>	.72	.69	

Note. *a*, Cronbach's alpha; standard deviations are in parentheses; *ns, not significant.

7.3.d. How do Greek children/participants with dyslexia perform on phonological processing tasks in comparison to English children/participants with dyslexia?

The prediction that English children/participants with dyslexia would perform more poorly on phonological awareness tasks than their Greek counterparts was examined by comparing scores obtained on tasks of phoneme deletion from words and nonwords and on a spoonerisms task. Repeated Measures ANOVAs were performed to analyse group performance on the task of phoneme deletion with two levels: words and nonwords¹. There was a significant main effect of group ($F(1, 40) = 18.691, p < 0.001$), with Greek children/participants with dyslexia performing better – with a small difference- at both levels than English children/participants with dyslexia. However neither the effect of item type ($F(1, 40) = 1.242, ns$), nor the group by item type interaction were significant ($F(1, 40) = 0.365, ns$) indicating that both groups attained higher scores in the task that included real words than nonwords.

One-Way Analysis of Variance revealed that Greek and English children/participants with dyslexia did not differ significantly when they performed the spoonerisms task ($F(1, 40) = 0.03, ns$).

The hypothesis that both English and Greek children/participants with dyslexia would perform similarly on the rapid digit-naming task was examined by conducting One-Way ANOVA. As predicted, there was no significant difference between the groups on this measure ($F(1, 40) = 0.000, ns$).

¹ Percentages were used instead of raw scores due to the unequal number of stimuli between the Greek and English versions of the phoneme deletion tasks.

7.3.e. Do Greek children/participants with dyslexia read both words and nonwords more accurately and faster than English children/participants with dyslexia?

The prediction that English children/participants with dyslexia would be less accurate and slower readers than their Greek counterparts who would demonstrate higher levels of reading accuracy but low reading speed, was examined by comparing scores obtained on tasks of single regular word and nonword reading. Repeated Measures ANOVA showed that there was a highly significant main effect of group, with Greek children/participants with dyslexia reading both regular words and nonwords more accurately and faster than the English children/participants with dyslexia ($F(1, 39)=70.21, p< 0.001$ & $F(1, 38)=17.48, p< 0.001$ respectively). The effect of item type was significant in reading speed analyses ($F(1, 38)=28.70, p< 0.001$), as was the interaction between group and item type ($F(1, 38)=8.58, p< 0.01$) indicating that there was a greater difference in reading speed between the groups when reading regular words than nonwords. The effect of item type was also significant in the reading accuracy analyses ($F(1, 39)=29.51, p< 0.001$), but the interaction between group and item type was not significant ($F(1, 39)=0.08, ns$)

The Interaction of Group by reading Speed

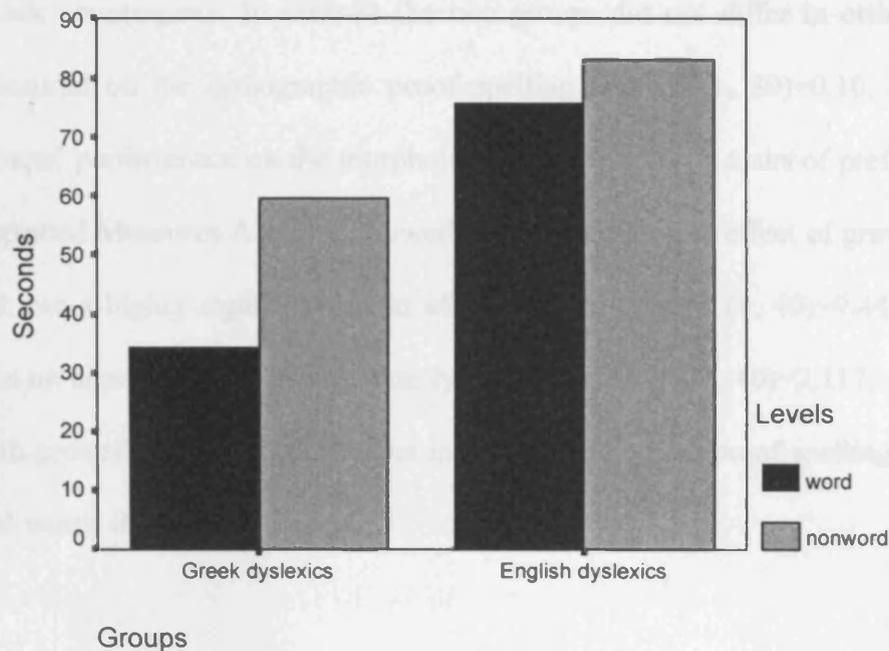


FIG. 7.3. Means (in seconds) for the interaction of group by reading speed.

7.3.f. Do both Greek and English children/participants with dyslexia perform poorly in the spelling tests because of the different orthographic demands of the two languages?

The prediction that both Greek and English children/participants with dyslexia would perform poorly on tasks that tap their orthographic and morpho-grammatical spelling skills, but that there would be language specific differences between the kinds of difficulty experienced by the two groups was investigated by comparing their scores on the spelling task of suffixes, the orthographic proof spelling task and the morphological proof spelling tasks. There was a highly significant difference between the language groups on the spelling task of suffixes, with English children/participants with dyslexia scoring less well than their Greek counterparts ($F(1,39)=39.38, p<0.001$)². English

² Percentages were used instead of raw scores due to the unequal number of stimuli between the Greek and English versions of the spelling task of suffixes.

children/participants with dyslexia appear to have more difficulty with suffixes than their Greek counterparts. In contrast the two groups did not differ in orthographic skills, as measured on the orthographic proof spelling task ($F(1, 39)=0.10, ns$). As far as the groups' performance on the morphological proof spelling tasks of prefixes is concerned³, Repeated Measures ANOVA showed no significant main effect of group ($F(1, 40)=0.11, ns$), but a highly significant main effect of item type ($F(1, 40)=9.442, p < 0.01$). There was no significant group and item type interaction ($F(1, 40)=2.117, ns$), indicating that both groups attained higher scores in the morphological proof spelling task that included real words than nonwords.

7.4. Discussion

The aim of the present study was to gain an insight in the ways that different orthographies affect the manifestation of cognitive and literacy impairments among children/participants with dyslexia. In order to address our research questions a cross-linguistic comparison between Greek and English children with developmental dyslexia was employed. A careful attempt was made to devise tasks with comparable linguistic material and also to match the two language groups on their intellectual ability, chronological age and reading level. The comparison between the two language groups revealed similarities, as well as differences.

³ Percentages were used instead of raw scores due to the unequal number of stimuli between the morphological proof spelling task with words and the morphological proof spelling task with nonwords.

In line with the study by Landerl, Wimmer and Frith (1997), which found that both English and German children/participants with dyslexia had severe difficulties with the phonological awareness measure of spoonerisms, the Greek and English children/participants with dyslexia of the present study were indistinguishable in their performance on the spoonerisms task and similarly impaired to the chronological-age control groups. This finding could be taken to suggest that both groups have phonological processing difficulties. However Greek children/participants with dyslexia performed significantly more accurately on the two phoneme deletion tasks and were impaired only in relation to the same age normal readers. On the contrary English children/participants with dyslexia were impaired to both control groups. It could be argued that the transparency of the Greek orthography along with the phonics-based reading instruction facilitates the development of children's/participants' with dyslexia phonological skills to the extent that only "difficult" tasks can capture their underlying phonological difficulties.

An important finding of the study was that Greek children/participants with dyslexia performed similarly to English children/participants with dyslexia on the task of rapid digit naming. The Greek children/participants with dyslexia were significantly slower in rapid naming than same-age normal readers, whereas English children/participants with dyslexia performed similarly to same-age normal readers, indicating that English children/participants with dyslexia have efficiently developed rapid naming skills. The finding that Greek children/participants with dyslexia have delayed rapid naming skills compared to same-age normal readers, but perform similarly to normal English readers, is consistent with evidence in transparent languages that children/participants with dyslexia have naming speed difficulties. Studies in German found evidence of a naming speed deficit among poor readers (Van den Bos, 1998; Wimmer, 1993; Yap and Van der Leij,

1993). However our findings concerning the English children/participants with dyslexia contradict studies in English, which showed that individuals with dyslexia have rapid naming difficulties in relation to normal readers (Pennington, Orden, Smith, Green, and Haitl, 1990; Wolf, 1986).

With respect to Greek and English children's/participants' with dyslexia reading skills, the present study found that Greek participants with dyslexia were significantly more accurate readers of both words and nonwords than their English counterparts. However both groups were more accurate when they read words than when they read nonwords. In contrast to Greek children/participants with dyslexia, who were impaired in reading accuracy only in comparison to same-age normal readers (see chapter 8), English children/participants with dyslexia had a word and nonword reading accuracy deficit even in comparison to younger normal readers. This finding partly agrees with the study by Ziegler and colleagues (2003), which showed that both German and English children/participants with dyslexia were indistinguishable from reading level controls in terms of error rate. The present finding is also consistent with the Landerl's, Wimmer's and Frith's (1997) finding, according to which English children/participants with dyslexia read significantly less words and nonwords correctly than their German counterparts. High error rates in word and nonword reading have been reported to occur even among normally developing children (Bruck, Genesee and Caravolas, 1997; Ellis and Hooper, 2001; Näslund, 1999).

The results of Greek and English participants' with dyslexia word and nonword reading speed revealed a different pattern. Greek children/participants with dyslexia were significantly faster than English children/participants with dyslexia in both word and

nonword reading, but the difference was greater when they read regular words than nonwords. In comparison to control groups Greek children/participants with dyslexia were significantly slower than same-age normal readers, but similar to younger normal readers. Similarly English children/participants with dyslexia were significantly slower than same-age normal readers in regular word reading. A striking finding, which is inconsistent with evidence that English-speaking children suffer severe difficulties with pseudoword reading speed (Landerl, Wimmer and Frith, 1997; Ziegler et al., 2003), is that, although English children/participants with dyslexia were slower than same-age normal children in noword reading, the difference between the groups was not statistically significant based on post-hoc comparisons. It is suggested that the interpretation of this finding is specific to the present English children/participants with dyslexia group. Most of the children that were included in the sample were recruited from a private specialized school. These children had received intense specialized reading instruction, and as a result their decoding skills had been sufficiently developed. When we recruited these children we were aware of the potential “problems” in our findings. Nevertheless it was decided to include them in the clinical group due to the difficulty of recruiting individuals with dyslexia from London schools. Based on this finding one could argue that English children/participants with dyslexia did not have decoding difficulties. However such an interpretation would be problematic, since it was found that English children/participants with dyslexia were significantly less accurate in word and nonword reading and less accurate on the tasks of phoneme deletion than both control groups. This clearly suggests that the accuracy deficit does not derive from poor or inappropriate exposure to print, but rather from an underlying phonological deficit. It should also be noted that most of the participants included in the reading level control group were recruited from a state school in a socio-economically deprived area in East

London. In general the speed difficulties appeared to be of similar size across orthographies. Ziegler and his colleagues (2003) also showed that reading speed problems were of similar size across languages, but in contrast to our findings, they found that both language groups were impaired in relation to younger normal readers. On the other hand their error data did not distinguish children/participants with dyslexia from reading level controls.

The results of the comparison between Greek and English children's/participants' with dyslexia spelling difficulties showed that the degree of their orthographic and morphological spelling difficulties was similar across orthographies, as both language groups were impaired on all the spelling tasks in comparison to their chronological-age controls, and similar to their reading-age controls with one exception; Greek children/participants with dyslexia outperformed their reading level controls on the morphological proof spelling task containing real words.

According to our results the orthographic demands of the Greek and English language affected both language groups' spelling performance to the same extent, as they performed similarly on the orthographic proof-spelling task. It has been mentioned earlier in the thesis that the high consistency for reading in Greek does not apply in the case of spelling, whereby children have to choose from a number of alternative orthographic patterns for representing the same sound. Therefore it is not surprising that the inconsistency of the Greek orthography for spelling had the same effect on Greek children's/participants' with dyslexia orthographic skills, as the inconsistency of the English orthography had on English children's/participants' with dyslexia orthographic skills. These findings support previous findings in English, according to which

children's/participants' with dyslexia orthographic ability does not differ from that of younger normally developing children (Olson, 1985; Pennington, McCabe, Smith, Lefly, Bookman, Kimberling and Lubs, 1986). However our findings do not support the findings of the cross-linguistic study by Caravolas, Bruck and Genesee (2003), according to which French poor spellers made significantly less conventional spelling errors than English poor spellers.

Similarly Greek and English children's/participants' with dyslexia performance on the tasks of morphological proof spelling did not differ. Both language groups were similarly impaired to same-age normal readers. It seems that children with dyslexia who learn to read in different orthographies have a weak understanding of the morphology of prefixes and a difficulty in using morphological knowledge for the spelling of prefixes.

On the other hand the results of the study revealed that Greek children/participants with dyslexia were more accurate in the spelling of inflectional suffixes than their English counterparts. However both language groups were found to be similarly impaired to the same-age normal readers. This difference could be explained in terms of the morphology of the two orthographies, as well as in terms of the spelling instruction that the two language groups received. Greek is a highly inflectional language whereby the spelling of word suffixes is dependent on tense, number and person in the case of verb inflections, and on gender, number and case in the case of noun and adjectival inflections. Due to the highly inflectional morphology of Greek, children start to receive explicit and systematic instruction on the spelling of word inflections from an early age (from second grade through secondary school). On the other hand evidence from English studies has shown that that mastery of conventional spellings for morphemes depends on morpho-syntactic

awareness and occurs at the later spelling stages. Nunes et al (1997) assessed children who attended the second, third and fourth grade on spelling three categories of past tense verbs ending in /d/ and /t/: regular past-tense verbs, irregular past-tense verbs, and non-verbs. A five-stage model was used to investigate the developmental progress that children's spellings of past-tense verb suffixes followed. It was found that it is by stage 4 that children begin to realize the syntactic significance of the 'ed' suffix and generalize it to irregular verbs. At the final stage children are able to confine these suffixes to regular verbs. It can therefore be argued that English and Greek children with dyslexia display a developmental delay in the acquisition of morphological knowledge and in the application of this information in the spelling of suffixes.

To conclude the present study showed that Greek and English children's/participants' with dyslexia cognitive and literacy skills have both similarities and differences. Both language groups have phonological processing difficulties, as they performed similarly on the spoonerisms task and significantly poorer to their chronological-age control groups. Children's performance on the task of rapid digit naming revealed that only Greek children/participants with dyslexia had naming speed difficulties. In terms of the two language groups' reading skills, it was evident that the regularity of the Greek orthographic system moderates the degree of their reading difficulties, in contrast to the English orthography, which creates more opportunities for reading errors to occur. Finally it is suggested that the inconsistency of the Greek orthography for spelling affects children's/participants' with dyslexia orthographic skills in a similar way that the inconsistent English orthography affects English children's/participants' with dyslexia orthographic ability.

Chapter 8. Longitudinal Study

8.1. Introduction

An overwhelming body of research evidence suggests that phonological skills are one of the best predictors of reading ability (Bradley & Bryant, 1985; Goswami & Bryant, 1990; Rack, Hulme & Snowling, 1993; Wagner & Torgesen, 1987). Children's phonological processing skills, such as verbal short-term memory and serial naming tasks that are thought to tap underlying phonological representations directly (Hulme & Snowling, 1992; Wagner et al, 1994), as well as children's phonological awareness that requires conscious reflexion upon and explicit manipulation of the constituent speech sounds of language, are considered as a necessary requirement for the acquisition of the alphabetic principle (Byrne, 1996). When children have weak phonological skills, their reading ability is at risk (Elbro, 1996; Swan & Goswami, 1997; Snowling, 2000). Evidence from several studies relates phonological problems to developmental dyslexia to such an extent that has been proposed that dyslexia should be defined as a core phonological deficit (Stanovich, 1986). Children/participants with dyslexia have consistent difficulties with a range of phonological processing tasks, such as phoneme deletion, nonword repetition and nonword reading. The hypothesis that children/participants with dyslexia have poorly specified phonological representations provides an account for their cognitive, as well as reading deficits (Snowling & Hulme, 1994).

Wagner and his colleagues (1997) were interested in examining the influences of individual differences in phonological processing abilities (when children have moved to skilled reading) and whether the direction of these influences may reverse in the course of reading development. The 5-year longitudinal correlational study involved 216 children who were originally randomly recruited from kindergarten classrooms in six elementary

schools, and were each year assessed on tasks of phonological awareness (analysis and synthesis tasks), phonological memory, serial naming, word reading, verbal aptitude (Stanford-Binet Vocabulary), and letter knowledge (from kindergarten through fourth grade). The results of comparable analyses showed that individual differences in phonological awareness affect the subsequent development of individual differences in word-level reading. This finding indicates that the influence of phonological awareness is not developmentally limited to beginning reading in contrast to letter knowledge that was found to be related only to subsequent individual differences in phonological awareness and serial naming, but not to individual differences in word reading. The hypothesis that word reading would have an effect on later phonological processing abilities was not supported. In addition it was found that rapid naming and vocabulary influence early reading abilities, but they failed to intrigue independent subsequent influences in word reading.

The predictive relationship that children's phonological processing skills have with reading ability was also investigated by Parrila, Kirby and McQuarrie (2004). In a four-year longitudinal study (from kindergarten through third grade) measures of articulation rate, verbal short-term memory, naming speed (color naming), and phonological awareness (sound isolation and phoneme blending) administered in kindergarten and again in first grade were investigated as unique and joint predictors of word reading and text comprehension in first, second and third grade. Both regression and commonality analyses revealed that articulation rate, and verbal short-term memory, when measured in kindergarten or first grade, are not significant predictors of reading development. On the other hand, both kindergarten and first grade naming speed was found to be a unique predictor of third grade reading ability. Similarly both kindergarten and first grade phonological awareness accounted for unique variance in all reading measures after the

effect of other phonological processing measures was partialled out. First grade phonological awareness proved the strongest predictor of reading across the three years of schooling. The commonality analyses showed that the elements common to phonological awareness and naming speed were in all cases smaller than the unique contributions of these tasks and tended to decline over the years. Finally the effect of first grade word reading reduced the predictive power of naming speed and phonological awareness on third grade reading, when the effect of grade 1 was controlled; however they both kept accounting for significant unique variance.

The question of whether rapid naming skills constitute a separate factor in reading ability in young children has been investigated by Blachman (1984). This study established that prereading kindergarten phonological skills and rapid naming taken together account for significant variance in the reading of first graders, even though these two skills failed to correlate with each other. Felton and Brown's study (1990) produced similar results. The phonological awareness and rapid naming skills of eighty-one children, who were at risk for reading difficulties and were assessed at the end of kindergarten and in first grade, were not found to significantly correlate with each other; when the effect of IQ was partialled out, rapid naming was the single factor that contributed significant variance to first grade reading ability.

The role of phonological sensitivity and serial naming in predicting reading skill was examined in a longitudinal study by Cronin and Carver (1998). Ninety-five children from eastern Canadian middle-class public and private schools were assessed on measures of phonological awareness (initial consonant discrimination task, and rhyme matching task), rapid naming (naming of digits, letters and pictures), verbal IQ, and reading (Woodcock Reading Mastery test) in the fall and spring of the next year. The findings of the study are

in favor of the hypothesis that phonological awareness and rapid naming abilities play a separate role in reading attainment. Although these skills significantly correlated with each other, hierarchical regression analyses – controlling for PPVS scores and grade level- showed that each of them contributed unique variance to the prediction of reading. Furthermore, Mancova analyses were conducted with and without the early readers in order to establish whether the phonological sensitivity and serial naming tasks discriminated the different levels of reading achievement at the end of both first and second grade.

Recent interest in the relative contribution of phoneme awareness and rapid serial naming not only to reading, but also to spelling ability in two developmental periods (kindergarten to first grade and first grade to second grade) has been shown by Cardoso-Martins and Pennington (2004). It was investigated whether the contribution of phoneme awareness and rapid naming depends on the functions of familial risk for developmental dyslexia and developmental period. The participants were categorised into two groups: the group of sixty-seven children at high familial risk for developmental dyslexia and the group of fifty-seven children at low familial risk. The two groups were similar in age, IQ, gender composition, and socio-economic status. They were administered measures of IQ (Vocabulary and Block Design Weschler subtests), literacy skills (single word reading accuracy, nonword reading accuracy, single word spelling accuracy, reading comprehension, and accuracy and speed of text reading; all the measures were standardized), letter names, phoneme awareness (Initial Consonant Different Test, Supply Initial Consonant Tests, Strip Initial Consonant Test, the Roswell-Chall Test of Auditory Blending, the Lindamood Auditory Conceptualization Test; these tests were administered at the end of kindergarten and once again at the end of first grade. The Pig Latin Production Task, Phoneme Deletion and Phoneme Reversal Task along with the

Lindamood Test were administered at the end of second grade), and rapid serial naming (Denckla and Rudel's RAN test of letters, digits, colors and common objects). A series of correlational and hierarchical regression analyses revealed that among the low-risk group phoneme awareness significantly predicted reading and spelling at both developmental periods (the effect of IQ was controlled), whereas rapid naming failed to add significant variation to reading and spelling. Among the high-risk group the ability to name letters and digits (not colors and objects) at the end of kindergarten was uniquely related only to the measure of word recognition at the end of first grade; on the other hand the same ability measured at the end of first grade contributed significant variation to all literacy measures at the end of second grade. Phoneme awareness among the same group made a unique prediction of literacy skills at both developmental periods. In summary, the results indicated that phoneme awareness has a robust predictive power across literacy outcomes and ability levels, whereas the influence of rapid naming (only alphanumeric measures) is restricted to high-risk readers and specific literacy outcomes. The authors argued that the independent effect of rapid naming on spelling skills suggests that abilities other than phoneme awareness, such as visual skills, might be involved in the development of orthographic ability; however they also argued that the correlations found between rapid naming (digits and letters) and phoneme awareness at all times of the study dictate that the process underlying this relationship is phonological or visuo-phonological.

The longitudinal predictors of spelling ability were examined by Caravolas, Hulme and Snowling (2001). These authors aimed at investigating spelling development in order to identify the critical predictors of this ability in relation to reading over the first three years of formal schooling. Early reading skills, pre-conventional spelling skills, phonological abilities, as well as letter sound and letter name knowledge were explored as predictors of conventional spelling ability. One hundred fifty-three monolingual British-English

children attending Reception Year Classes at the beginning of the study participated. The mean group age at Time 1 was 5 years; 1 month. At initial testing children were administered measures of receptive vocabulary, nonverbal IQ, grapho-motor speed, letter knowledge, phonological processing (i.e., phoneme isolation and verbal memory span), visual memory (span), word reading and spelling. At Times 2 and 3 children were retested on the whole test battery apart from the measures of verbal and nonverbal IQ. At Time 4 of testing children were reassessed on verbal IQ, reading and spelling. The experimental spelling test contained 97 monosyllabic words representing common objects and actions and varying both in syllable structure and in phonemes and phoneme sequences. The scoring procedure of the test applied at the present study is of great interest. Since the main objective was to investigate spelling development from the earliest phase of learning, a graded scoring system, which was introduced by Treiman (e.g., Treiman & Zukowski, 1988) and allowed the assessment of partial spellings was considered as suitable to be employed. The analysis concerned children's ability to represent the phonological content of the words rather than their orthographic correctness and was applied on a scale of phonological acceptability of the spellings. A score of 4 was awarded when a plausible grapheme represented the target phoneme (e.g., c, k, ch, ck for /k/), and a score of 3 when the grapheme represented a phoneme that deviated by one phonetic feature from the target phoneme; a score of 2 was given when the correct grapheme was spelled with an extra adjacent grapheme, or the correct grapheme was spelled in an incorrect order, or when the target phoneme was partially represented. Finally, a score of 1 was awarded when the grapheme representing the target phoneme was implausible or when the grapheme deviated by one phonetic feature from the target phoneme and was adjacent to another grapheme; a zero point was awarded in the case of no grapheme being represented. On the other hand, the scoring of children's conventional

spellings was not analytical; simply, words were evaluated as units (not grapheme by phoneme) and were scored either as correct or incorrect.

The results of correlational analyses revealed that prior abilities in reading and spelling along with knowledge of letter sounds and phoneme isolation skills were the strongest predictors of spelling and reading over the first three years of schooling. The relative power of all the measures obtained at the different testing times as predictors of reading and spelling was further investigated by conducting path analyses. It was shown that phoneme isolation and letter sound knowledge were the precursor abilities of early phonological spelling skills; in turn phonological spelling, phoneme isolation and letter sound knowledge combined with reading ability were the strongest predictors of conventional spelling ability at the second year at school. By the third year of schooling reading proficiency and conventional spelling ability were the unique predictors of conventional spelling accuracy. The authors argued that their findings are consistent with the idea of a dual foundation of literacy development (Byrne, 1998); the ability to spell proficiently in English depends on phoneme awareness and letter sound knowledge and these skills form the foundation for the development of orthographic representations (Ehri, 1997). Moreover, it was suggested that experience and instruction in both reading and spelling could enable the learning of the complex orthographic patterns of the English language.

It is well documented in the English literature that phonological skills are strong long-term predictors of reading and spelling ability. In addition rapid naming skills have been found to have a long-term effect on reading rate. Studies in regular orthographies have shown that the strongest longitudinal predictor of reading rate is rapid naming and not phonological skills (Wimmer, Mayringer & Landerl, 2000). Based on this evidence the

aim of the present study was to investigate the predictive role of phonological awareness and rapid naming ability in the reading and spelling skills of Greek children/participants with dyslexia and younger and same-age normal readers both concurrently and longitudinally. We also aimed at investigating the cognitive and literacy difficulties that children/participants with dyslexia suffer at different points in time and whether they suffer a developmental deficit or delay. It was important to examine which difficulties persist and which improve over time, with particular reference to various aspects of spelling difficulty.

Based on the aims of the study the following hypotheses were formulated:

- (a) Phoneme awareness will be a longitudinal predictor of reading skill among younger normal readers;
- (b) Rapid naming skill will be a longitudinal predictor of reading rate;
- (c) Different patterns of correlations will emerge for children/participants with dyslexia, younger normal readers and same-age normal readers (Cardoso-Martins et al., 2004) and
- (d) Reading ability will be a longitudinal predictor of spelling skill.

8.2. Method

8.2.a. Participants

The study involved three groups of participants:

- (i) the Greek group of children/participants with dyslexia (twenty-five 9–12 year-old children),
- (ii) twenty-nine Greek chronological-age controls and

(iii) twenty-eight Greek younger normal readers (reading-age controls).

The participants of the present study were the ones that formed the Greek sample of the cross-linguistic study described in chapter 7. At the second time of testing approximately two years later the sample was reduced to twenty-three children/participants with dyslexia, twenty-seven younger reading-level matched readers, and twenty-three same-age normal readers. The chronological age of the Greek participants assessed at the first time of testing are shown in table 8.1.

Table 8.1
Chronological age of the Greek sample

	Chronological-Age Controls	Reading-Age Controls	Children/Participants with Dyslexia
Chronological Age	9;11 (1.19)	7;8 (0.46)	10;5 (1.17)
Min-max	8;2-11;10	7-8;9	8;6-12;10
N	29	28	25

Note. N, Number of participants; standard deviations are in parentheses.

8.2.b. Tests and Materials

At the first time of assessment children were administered the measures described in the method section of the cross-linguistic study (chapter 7).

At the second time of assessment children were administered the time 1 measures apart from the Greek Wechsler Intelligence Scale for children. At this point of testing we recorded the time taken for each participant to complete the phonological awareness tasks using a stopwatch. Additionally participants were assessed on the following measures:

Rapid Naming of Letters. A letter naming task was devised in similar lines to the Letter Naming subtest of the Comprehensive Test of Phonological Processing (Wagner, Torgesen & Rashotte, 1999). It included a practice form and two test forms. The practice form displayed six letters in a row on an A4 page. The test form consisted of six letters (τ , μ , φ , ρ , ν , π) displayed six times each in four rows on an A4 page (thirty six letters in total). The children were asked to say the names of the letters as fast as possible. The task was repeated with a different arrangement of letters and the overall naming time was the score of this subtest.

Graded Spelling Dictation Task. The graded spelling dictation task consisted of 47 words of graded orthographic difficulty and decreasing frequency of occurrence, and 47 sentences containing each word. The word-items were selected from the frequency table that was devised for the purposes of the studies of the present thesis. The first six items were of high frequency and it was made certain that they were included in the first-grade textbooks. Items 7 to 15 were of medium to low frequency and it was made certain that they were included in the second- and third-grade textbooks, and items 16 to 20 were of medium to low frequency and it was made certain that they were included in the fourth-, fifth- and sixth-grade textbooks. The remaining test-items were selected from the frequency table of the Hellenic National Corpus, which is an online corpus of Modern Greek developed by the Institute for Language and Speech Processing (Hatzigeorgiou et al., 2000). The frequency list comprises 3.000.000 words selected from books, newspapers, magazines and other texts, and therefore it is suitable for older children and adults. The selection of items 21-47 was based on the particular word frequency list, as it is the only available frequency count of Greek words to date. In addition it was intended to develop a spelling test, which would assess the spelling skills of primary, and

secondary school children. These items were carefully chosen on the criterion that their meaning would be familiar to children between the ages of 12 to 15 years.

Children were asked to write down the words dictated by the experimenter. Each word was orally presented in isolation, followed by a sentence that included the word; each word was presented in isolation once more. Children were instructed to spell every word. Two scores were calculated for each word item, a graphemic and a phonemic score. When the phonemic accuracy of the test was assessed each phoneme was awarded one score if it was correctly represented; the maximum score for each word was the total number of correct phonemes. One score was deducted when a phoneme/sound was missing or was misrepresented or misplaced. When evaluating the graphemic accuracy of the test items the same scoring system was applied; each grapheme was evaluated with respect to its conventional orthographic correctness. The test had a Cronbach's Alpha Coefficient of 0.94.

Consonant Clusters Spelling Dictation Task. A significant number of research studies have established that English-speaking children and especially children/participants with dyslexia experience difficulties with the representation of consonant clusters in spelling (Treiman, 1985b; Bruck & Treiman, 1990). A spelling dictation task comprising words that included consonant clusters was devised for determining whether children who learn to read and write a regular orthography such as Greek and more specifically Greek-speaking children/participants with dyslexia have difficulties of a similar nature. The consonant clusters spelling dictation task comprised thirty-two words that included consonant clusters in an initial and medial position and thirty-two sentences containing each word. One half of the words contained a consonant cluster of two consonants and the other half a consonant cluster of three consonants; the items were of two- to five-syllable

length. The words varied in frequency of occurrence [range = 0 to 3121, mean frequency: 218, according to the Hellenic National Corpus (Hatzigeorgiou et al., 2000)]. Children were asked to write down the words dictated by the experimenter. Each word was orally presented in isolation, and then in a sentence that included the word; each word was presented in isolation once more. Children were instructed to spell every word. One point was awarded for the correct spelling of each consonant cluster. The test had a Cronbach's Alpha Coefficient of 0.87.

The Test of Nonword Repetition for Greek Children. The Test of Nonword Repetition for Greek Children (NRGreek) by Maridaki-Kassotaki (2002) was used to assess children's nonword repetition skills. The test consisted of 40 nonwords comprising two, three, four and five syllables. The test was devised on the criterion that the stress and phonotactic structure of each Greek nonword was similar to the stress and phonotactic structure of Greek words of corresponding length. Children were asked to listen to a "funny" word on a cassette recorder and repeat the word. The repetition attempt of each child was immediately scored as either phonologically correct or incorrect.

8.2.c. Procedure of Task Administration

Children were assessed individually in an empty classroom of the school, apart from the case of the spelling tests that were administered to whole classes, at two test times approximately 1 year and a half apart. First assessment took place between March and June 2002 and second assessment took place between September and December 2003. At time 1 children were seen on three separate occasions (thirty–forty minutes each session). In the first individual session participants were administered the Similarities and Block Design subtests of the WISC for children and the Greek version of the TOWRE Word

Efficiency test. In the second individual session the phonological and reading measures were administered. In the third session, which was a whole-class session, the spelling measures were administered. At time 2 children were seen on two separate sessions of thirty to forty minutes. In the first individual session participants were administered the phonological and reading measures. In the second whole-class session the spelling measures were administered. The order of administration of tests at both testing times was counterbalanced.

8.3. Results

The comparison between children/participants with dyslexia and normal readers at time 1 is presented in chapter 7 (7.3.a).

8.3.a. Comparison between children/participants with dyslexia and normal readers at time 2

Means and standard deviations for the performance of the Greek children/participants with dyslexia on the standardized measures at test time 2 and the comparison between the groups are displayed in table 8.2.

Table 8.2
Mean scores for children/participants with dyslexia and comparison groups on standardized measures at testing time 2

Chronological-Age Controls Time 2 (N=23)	Reading-Age Controls Time 2 (N=27)	Children/Participants with Dyslexia Time 2 (N=23)	<i>p</i>
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Reading Ability	83.04 (7.24)	70.70 (5.86)	68.86 (8.07)	<0.001
Min-max	64-95	59-86	56-84	
Items	104	104	104	
WISC-III Digit Span	15.60 (2.44)	12.37 (2.04)	12.43 (2.40)	<0.001
Min-max	11-20	8-16	8-17	
Nonword Repetition	28.82 (5.01)	23.96 (5.72)	24.17 (4.73)	<0.005
Min-max	19-35	15-36	15-32	
Items	40	40	40	

Note. N, Number of participants; standard deviations are in parentheses.

One-way ANOVA was performed on the standardized tests of Word Reading Efficiency (Greek equivalent of TOWRE), Digit Span of the Greek WISC and Nonword Repetition. A highly significant difference was found between the experimental and the two control groups on these measures [$F(2, 70) = 26.99, p < 0.001$], [$F(2, 72) = 15.45, p < 0.001$] and [$F(2, 72) = 6.60, p < 0.005$]. Post-hoc comparisons (LSD) showed that children/participants with dyslexia and reading-age controls did not differ on any of the tests, but there were significant differences between the chronological-age controls and both the children/participants with dyslexia and the reading-age controls, with chronological-age controls performing higher on reading ($p < 0.001$), digit span ($p < 0.001$), and nonword repetition ($p < 0.05$).

Means and standard deviations for the performance of the Greek children/participants with dyslexia on the experimental measures and the comparison between the two groups are displayed in table 8.6. In order to investigate the possible differences between the experimental groups One-Way and Repeated Measures Analyses of Variance were conducted. The assumption of equality of variance was not met for a number of variables; therefore non-parametric tests were used to analyze possible differences.

Table 8.3
Participants' mean scores on experimental tasks at testing time 2

	Chronological- Age Controls Time 2 (N=23)	Reading-Age Controls Time 2 (N=27)	Children/participants with dyslexia Time 2 (N=23)	<i>p</i>
Spoonerisms (score)	21.86 (1.93)	18 (3.64)	16.39 (5.830)	<0.001
Min-max	16-24	10-23	2-24	
Number of Items	24	24	24	
Spoonerisms (time in seconds)	135.69 (61.12)	269.66	278.43 (142.15)	<0.001
Min-max	69-307	(114.76) 121-574	97-638	
Orthographic Proof Spelling	16.69 (3.02)	14.33 (2.49)	13.69 (3.32)	<0.005
Min-max	7-20	8-19	8-18	
Number of Items	20	20	20	
Spelling Task of Suffixes	29.34 (3.48)	24.77 (6.2)	23.56 (5.30)	≤0.001
Min-max	18-34	7-31	10-32	
Number of Items	34	34	34	
Phoneme Deletion of Words (score)	13.21 (0.95)	12.70 (1.13)	12.21 (1.53)	<0.05
Min-max	11-14	9-14	9-14	
Number of Items	14	14	14	
Phoneme Deletion of Words (time in seconds)	51.86 (9.39)	67.33 (14.04)	68.21 (21.53)	≤0.001
Min-max	41-70	46-104	43-126	
Phoneme Deletion of Nonwords (score)	13.21 (0.85)	12.44 (1.36)	11.45 (2.24)	<0.005
Min-max	11-14	9-14	3-13	
Number of Items	14	14	14	
Phoneme Deletion of Nonwords (time in seconds)	53.56 (10.66)	75.07 (18.18)	74.63 (22.44)	<0.001
Min-max	40-77	46-126	49-130	
Rapid Digit Naming (time in seconds)	24.43 (3.59)	29.62 (5.29)	30.13 (5.07)	<0.001
Min-max	19-31	19-41	22-41	
Rapid Letter Naming (time in seconds)	31.30 (6.91)	37.70 (8.65)	39.47 (11.90)	<0.05
Min-max	21-43	18-56	26-79	
Word Reading Accuracy	24.78 (0.51)	24.33 (1.00)	24.08 (0.94)	<0.05
Min-max	23-25	21-25	22-25	
Number of Items	25	25	25	
Nonword Reading Accuracy	23.69 (1.60)	22.14 (2.42)	20.56 (2.93)	<0.001
Min-max	19-25	16-25	15-25	
Number of Items	25	25	25	
Word Reading Speed (time in seconds)	15.69 (3.48)	23.07 (4.10)	23.43 (5.79)	<0.001
Min-max	9-21	16-31	12-34	

Nonword Reading Speed (time in seconds)	32.95 (8.80)	40.51 (7.07)	47.47 (11.54)	<0.001
Min-max	22-49	31-57	25-71	
Morph. Proof Spelling/Words	13.39 (2.79)	11.18 (2.73)	10.86 (3.67)	<0.05
Min-max	3-15	5-15	2-15	
Number of Items	15	15	15	
Morph. Proof Spelling /Nonwords	9.73 (2.13)	7.88 (2.65)	7.95 (2.97)	<0.05
Min-max	5-12	3-12	3-12	
Number of Items	12	12	12	
Graded Spelling Test (Orthographic Accuracy)	406.95 (11.47)	390.42 (16.55)	378.79	<0.001
Min-max	380-422	344-423	340-421	
Number of Items	57	57	57	
Graded Spelling Test (Phonemic Accuracy)	419.26 (1.09)	415.88 (5.74)	413.30 (6.07)	<0.001
Min-max	417-420	398-420	397-420	
Number of Items	57	57	57	

Note. N, Number of participants; standard deviations in parentheses.

One-way analysis of variance was carried out for the purposes of comparing the experimental group to the control groups on their orthographic accuracy on the graded spelling dictation test. A significant difference emerged between the groups [$F(2, 70) = 17.08, p < 0.001$]. Post-hoc analyses (LSD) were conducted further to establish the pattern of group differences. The orthographic spelling skills of the children in the group of children/participants with dyslexia were less proficient than those of both the reading-age ($p < 0.05$) and the chronological-age ($p < 0.001$) control groups. Chronological-age control children's performance was superior to that of the reading-age control children ($p < 0.001$). Children's performance is illustrated in figure 8.1.

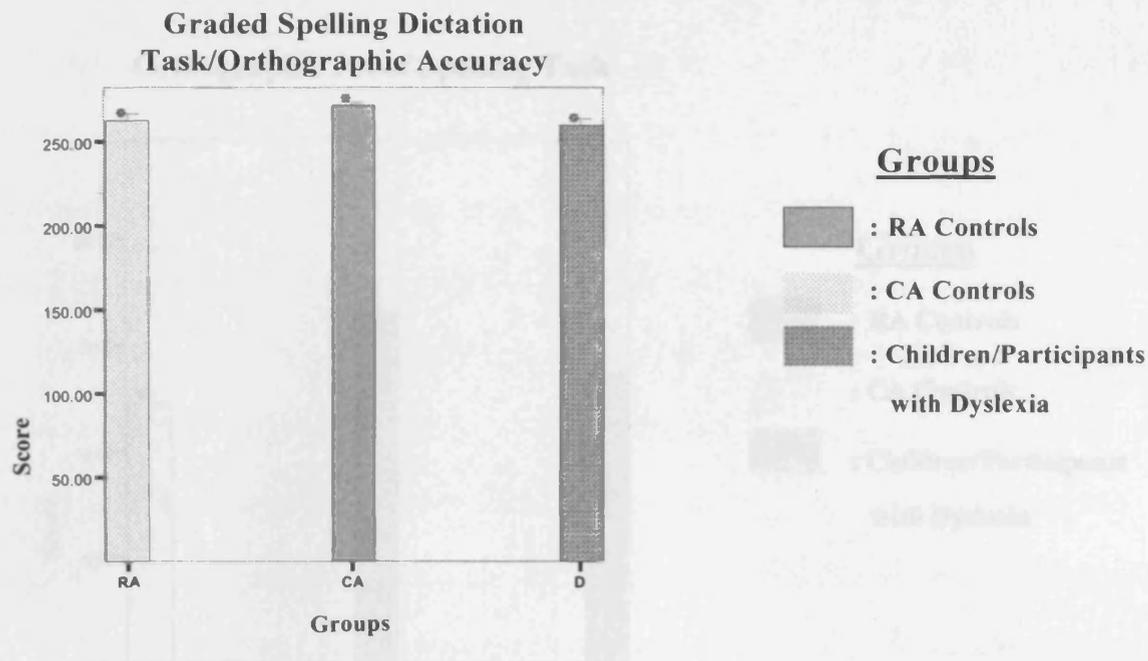


FIG. 8.1. Means (and standard errors) for the Graded Spelling Dictation Task/Orthographic Accuracy.

In order to examine the possible differences between the experimental and the two control groups on the orthographic proof spelling task and the grammatical spelling task of suffixes, one-way analysis of variance was carried out. There was a highly significant difference between the groups on both tests ($F(2, 72) = 6.71, p < 0.005$ & $F(2, 72) = 7.94, p < 0.001$ respectively). Post hoc comparisons (LSD) showed that the difference between children/participants with dyslexia and same-age controls on both measures was highly significant ($p < 0.005$ & $p \leq 0.001$ respectively). There was also a significant difference between the chronological-age and the reading-age control children ($p < 0.05$ & $p < 0.01$ respectively), but no significant difference was evident between the dyslexic and the reading-age control children on neither the orthographic proof-spelling task nor the grammatical spelling task of suffixes.

FIG. 8.2. Means (and standard errors) for the Spelling Task of Suffixes.

Orthographic Proof Spelling Task

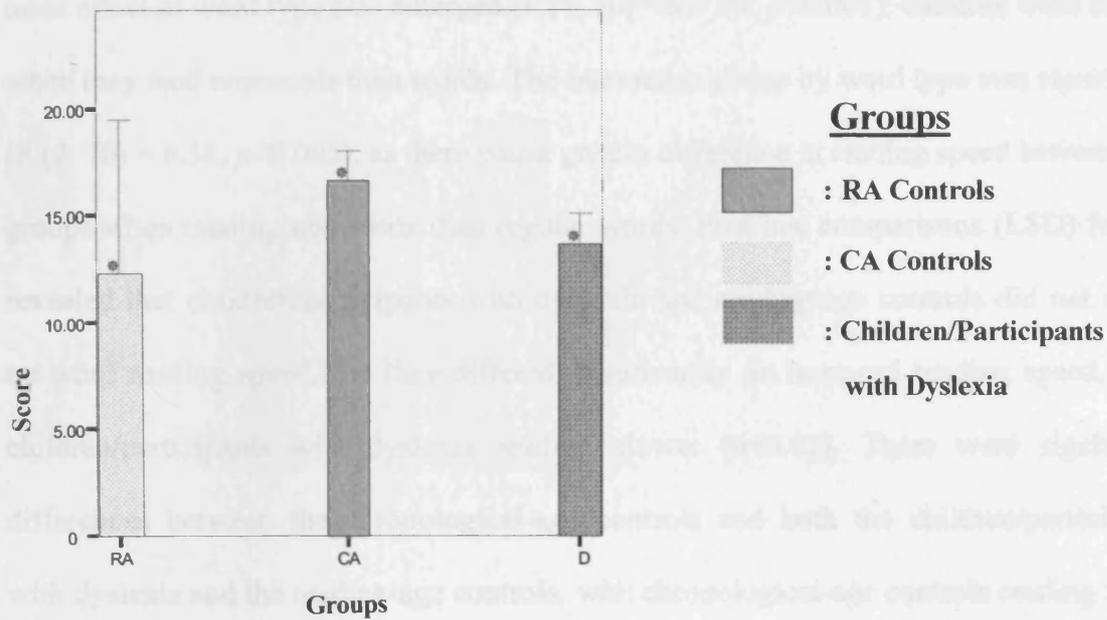


FIG. 8.2. Means (and standard errors) for the Orthographic Proof Spelling Task.

Spelling Task of Suffixes

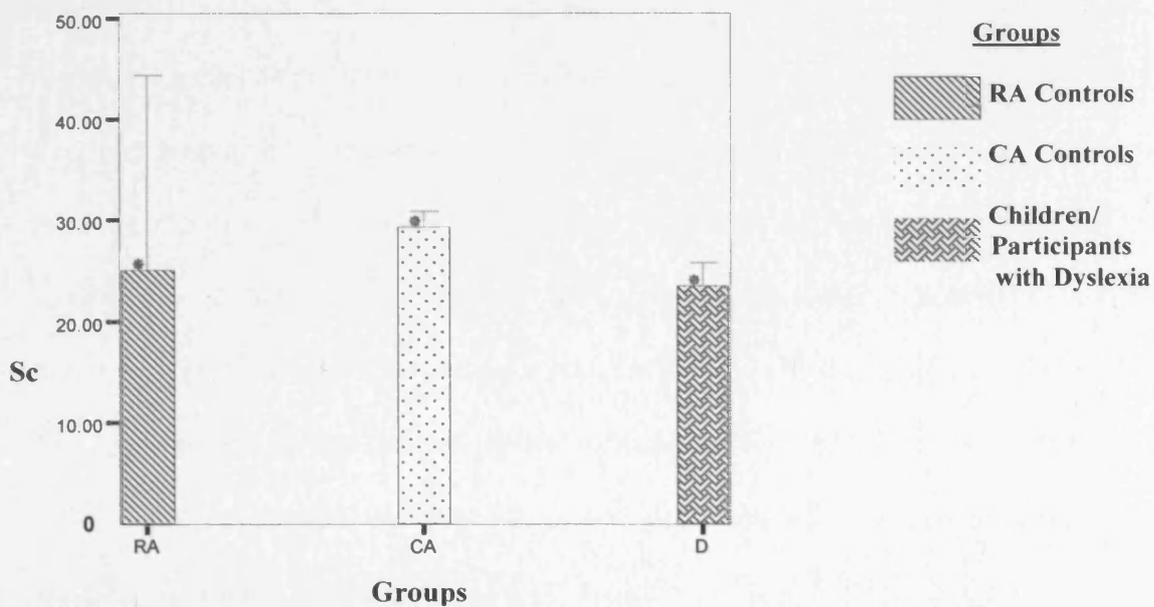


FIG. 8.3. Means (and standard errors) for the Spelling Task of Suffixes.

Two-way ANOVA was performed to analyse groups' reading speed performance. A highly significant effect of group was found ($F(2, 70) = 19.07, p < 0.001$). A significant main effect of word type also emerged ($F(1, 70) = 505.04, p < 0.001$); children were slower when they read nonwords than words. The interaction group by word type was significant ($F(2, 70) = 6.38, p < 0.005$), as there was a greater difference in reading speed between the groups when reading nonwords than regular words. Post-hoc comparisons (LSD) further revealed that children/participants with dyslexia and reading-age controls did not differ on word reading speed, but they differed significantly on nonword reading speed, with children/participants with dyslexia reading slower ($p < 0.01$). There were significant differences between the chronological-age controls and both the children/participants with dyslexia and the reading-age controls, with chronological-age controls reading faster on both word reading ($p < 0.001$) and nonword reading ($p < 0.005$).

The Interaction of Group by Reading Speed

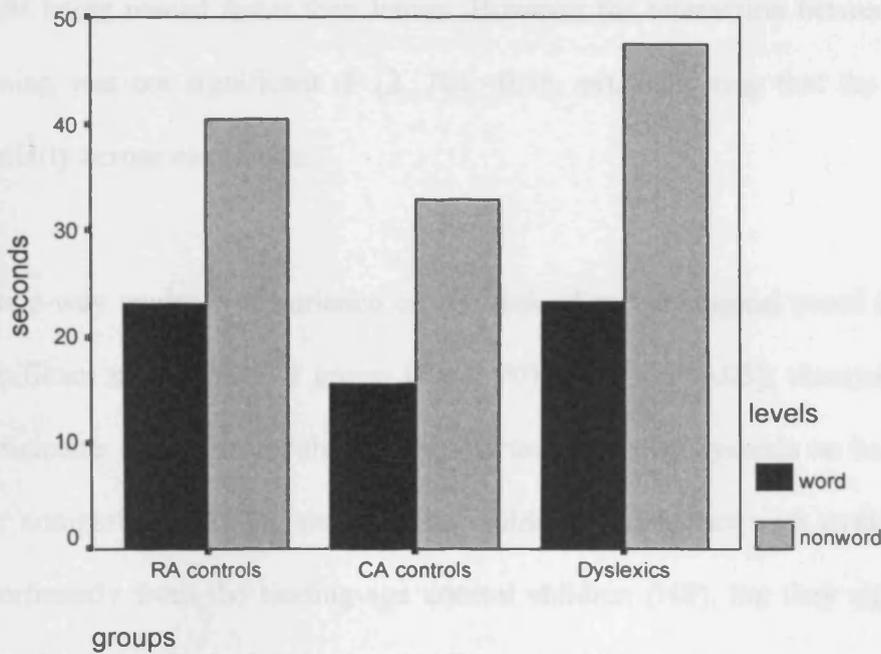


FIG. 8.4. Means (in seconds) for the interaction of group by reading speed.

Two-way mixed ANOVAs were performed to analyze group performance on the tasks of rapid naming and morphological proof spelling. A significant main effect of group was apparent [$F(2, 70) = 8.23, p < 0.001$], with chronological-age control children naming digits and letters faster than children/participants with dyslexia and reading-age controls. Post-hoc tests (LSD) showed that children/participants with dyslexia and reading-age controls did not differ significantly at the two levels of rapid naming. There was a significant difference between the chronological-age controls and the children/participants with dyslexia on both letter ($p < 0.05$) and digit naming ($p < 0.001$). The performance of the control groups differed significantly on the digit naming task ($p < 0.001$; chronological-age controls named digits faster), but their performance was similar on the letter naming task.

There was a significant main effect of rapid naming [$F(1, 70) = 75.40, p < 0.001$], with digits being named faster than letters. However the interaction between group and rapid naming was not significant ($F(2, 70) = 0.56, ns$), indicating that the groups performed similarly across conditions.

A two-way analysis of variance on the task of morphological proof spelling revealed a significant main effect of group [$F(2, 70) = 5.073, p < 0.05$]; chronological-age control participants outperformed the children/participants with dyslexia on both task levels. Post hoc comparisons (LSD) showed that children/participants with dyslexia did not differ significantly from the reading-age control children (NS), but they significantly differed from the chronological-age control children ($p < 0.05$).

A significant main effect of the morphological proof spelling task was found [$F(1, 70) = 142.723, p < 0.001$]; participants attained higher scores on the version of the task containing real words than nonwords. Nonetheless, the interaction between the morphological proof spelling task and groups did not reach significant levels [$F(2, 70) = 0.572, ns$].

Means and standard deviations for the performance of the Greek children/participants with dyslexia and the two control groups on the consonant cluster spelling measure are displayed in table 8.4.

Table 8.4
Mean scores for children/participants with dyslexia and comparison groups on the consonant clusters measure

	Chronological-Age Controls (N=23)	Reading-Age Controls (N=27)	Children/participants with dyslexia (N=23)
Two Consonants Score*	31.73 (0.54)	29.74 (2.48)	30.47 (1.62)
Min-max	30-32	21-32	25-32
Items	32	32	32
Three Consonants Score*	31.39 (1.03)	30.11 (3.17)	29 (3.42)
Min-max	29-32	19-32	17-32
Items	32	32	32
Consonant Score/Short Words*	39.56 (0.58)	38 (2.05)	37.70 (2.64)
Min-max	38-40	32-40	31-40
Items	40	40	40
Consonant Score/Long Words*	39.60 (0.72)	38.18 (2.74)	37.21 (2.840)
Min-max	38-40	30-40	30-40
Items	40	40	40

Note. Asterisks indicate the number of correct spellings; N, Number of participants; standard deviations in parentheses.

The first research question concerned the effects of number of consonants within a consonant cluster and syllable length on children's spelling performance. Three-way mixed analysis of variance was conducted for this purpose. The effect of three factors was investigated: group as the between-subjects factor; number of consonants as the first within-subjects factor with two levels: 1. two consonants and 2. three consonants; and syllable length as the second within-subjects factors with two levels: short words (including two- and three-syllable words) and long words (including four- and five-syllable words). The analysis revealed an insignificant effect of number of consonants ($F(1, 70) = 1.79, NS$); children performed similarly when they spelled consonant clusters that comprised either two or three consonants. On the contrary syllable length did affect significantly the spelling performance of the sample ($F(1, 70) = 6652.53, p < 0.001$). The participants spelled consonant clusters within long words more accurately than consonant clusters within short words.

In addition the analysis revealed a significant main effect of group ($F(2, 70) = 7.40$, $p < 0.001$). The CA control children were more accurate spellers than both the children/participants with dyslexia and the RA control children; the children/participants with dyslexia performed slightly less accurately than the RA controls. Post hoc comparisons (Games-Howell for unequal variances) showed that children/participants with dyslexia and younger reading-age controls performed significantly less well than the CA controls ($p < 0.001$, $p < 0.005$ respectively) when they spelled consonant clusters with two consonants. The children/participants with dyslexia and the RA controls did not differ significantly at this level. The children/participants with dyslexia performed significantly less accurately than the CA controls when they spelled consonant clusters with three consonants ($p < 0.005$). RA controls did not differ significantly from both children/participants with dyslexia and CA controls at this level. Moreover, the CA controls were significantly more accurate spellers when they spelled both short and long words in comparison to the dyslexic and the RA control groups ($p < 0.05$ & $p < 0.005$ respectively for short words, $p < 0.005$ & $p < 0.05$ respectively for long words). The differences between the children/participants with dyslexia and the RA controls were not significant.

The interactions group by number of consonants and group by syllable length were found not to be significant ($F(2, 70) = 2.973$, NS & $F(2, 70) = 1.49$, NS), indicating that group performance did not change at the two different levels of these factors. Similarly, the interaction syllable length by number of consonants did not reach significant levels ($F(1, 70) = 0.97$, NS); children's consonant cluster spelling performance did not change between short and long words.

Greek children/participants with dyslexia experienced some difficulties in spelling consonant clusters within words in comparison to same-age normally developing children, but they performed at the same level with younger reading-age control children. In addition, Greek children's spelling performance of words that contained consonant clusters did not appear to be affected by the number of consonants; however it was affected by the syllable length of the word items.

Due to the violation of equality of variance between the groups on some test variables, it was decided to conduct non-parametric analyses. Mann-Whitney tests were conducted, as they enable the experimenter to examine the differences between each group with another.

The comparison between the group of children/participants with dyslexia and the chronological-age control group revealed significant differences on all the measures (nonword reading accuracy: $U=88.5, p<0.001$; word reading accuracy: $U=153.0, p<0.005$; spoonerisms accuracy: $U=102.0, p<0.001$; spoonerisms time: $U=73.5, p<0.001$; nonword phoneme deletion accuracy: $U=81.5, p<0.001$; nonword phoneme deletion time: $U=87.5, p<0.001$; word phoneme deletion accuracy: $U=163.5, p<0.05$; word phoneme deletion time: $U=121.0, p<0.005$; graded spelling test (phonemic accuracy): $U=59.5, p<0.001$).

The comparison between the clinical group and the reading-age control group revealed significant differences on two measures (nonword reading accuracy: $U=207.5, p<0.05$ and nonword phoneme deletion accuracy: $U=192.5, p<0.05$). The children/participants with dyslexia and the younger normal readers did not differ on the other measures (word reading accuracy: $U=257.0, ns$; spoonerisms accuracy: $U=273.0, ns$; spoonerisms time: $U=296.0, ns$; nonword phoneme deletion time: $U=269.5, ns$; word phoneme deletion

accuracy: $U=258.5$, *ns*; word phoneme deletion time: $U=296.0$, *ns*; graded spelling test (phonemic accuracy): $U=212.0$, *ns*).

Finally, the comparison between the reading-age and the chronological-age control groups indicated significant differences on most of the measures (nonword reading accuracy: $U=176.5$, $p<0.01$; word reading accuracy: $U=233.0$, *ns*; spoonerisms accuracy: $U=106.0$, $p<0.001$; spoonerisms time: $U=70.5$, $p<0.001$; nonword phoneme deletion accuracy: $U=205.0$, $p<0.00$; nonword phoneme deletion time: $U=83.0$, $p<0.001$; word phoneme deletion accuracy: $U=226.0$, *ns*; word phoneme deletion time: $U=109.0$, $p<0.001$; graded spelling test (phonemic accuracy): $U=139.5$, $p<0.005$).

8.3.b Longitudinal predictors of reading and spelling skills

Results of correlational analyses of T1 and T2 data.

In this section, only partial correlations (with age and verbal IQ controlled) that reached statistical significance at $p < .01$ are reported. Full tables of all partial correlations can be seen in Appendix III. These significant partial correlations are presented under four headings: Word reading efficiency; Single word and nonword reading; Spelling; and Relations among cognitive processes. It was decided to present partial correlations by group and not combine the two control groups, because it was assumed that different skills might correlate with reading and spelling ability among younger reading-age control children and older chronological-age control readers. Evidence from studies in transparent orthographies has shown that phonological skills are predictive of literacy skills only in the first years of schooling (Oney & Goldman, 1984; Wimmer, 1993) and

that rapid naming skills are the strongest long-term predictor of reading ability (Wimmer, Mayringer & Landerl, 2000).

Word reading efficiency

Table 8.5
Significant partial correlations for each group at time 1 & 2

	T1			T2		
	CA	RA	D	CA	RA	D
TOWRE/word reading speed	*	*	*	*	*	*
TOWRE /nonword reading speed	*			*		
TOWRE/ RAN digits				*		
TOWRE/phoneme deletion accuracy words		*				
TOWRE / word reading accuracy		*				
TOWRE / morph. proof spelling words		*				
TOWRE / orthographic proof spelling		*				*
TOWRE / spelling suffixes		*				

Note. Asterisks indicate significant correlations; T1, time 1; T2, time 2; CA, chronological-age controls; RA, reading-age controls; D, children/participants with dyslexia.

There were significant partial correlations between reading efficiency on the TOWRE test and word reading speed for all groups at both T1 and T2. For the chronological age controls, the partial correlation with nonword reading speed was also significant at both T1 and T2, and the partial correlation with RAN digits was significant at T1. At T2, the partial correlation between reading efficiency on the TOWRE test and performance on the orthographic proof spelling test was significant for the group of children/participants with dyslexia. This partial correlation was significant for the reading age controls at T1. Thus, the group of children/participants with dyslexia were more like the reading age controls than the chronological controls in terms of the partial correlations shown in Table 8.5 above. From these data, their reading efficiency would seem to be delayed rather than deviant.

Single word and nonword reading

Table 8.6
Significant partial correlations for each group at time 1 & 2

	T1			T2		
	CA	RA	D	CA	RA	D
Word and nonword reading accuracy				*	*	
Word and nonword reading speed	*	*		*	*	
Word reading accuracy / phoneme deletion words					*	
Word reading accuracy / word morph. proof spelling		*				
Word reading accuracy/nonword morph. proof spelling				*		
Word reading accuracy/orthographic proof spelling				*		
Word reading accuracy/Greek spelling phonemes				*	*	
Word reading accuracy/Gk spell orthographic accuracy					*	
Word reading accuracy/ spelling suffixes					*	
Word reading speed/digit span			*			
Word reading speed /RAN digits				*		
Word reading speed/phoneme deletion accuracy nonwords			*			
Nonword reading accuracy / phoneme deletion accuracy words			*			
Nonword reading accuracy / Greek spelling phonemes					*	*
Nonword reading accuracy /spoonerisms accuracy						*
Nonword reading accuracy /digit span						*
Nonword reading speed/Gk. Spell. orthographic accuracy				*		
Nonword reading speed /RAN digits	*		*	*	*	

Note. Asterisks indicate significant correlations; T1, time 1; T2, time 2; CA, chronological-age controls; RA, reading-age controls; D, children/participants with dyslexia.

As shown in Table 8.6 above, word and nonword reading ability was more closely associated in the two control groups than in the group of children/participants with dyslexia, where no partial correlations between either speed or accuracy of word and nonword reading were significant.

At T1, word reading speed in the group of children/participants with dyslexia was associated with short-term memory as measured by digit span, and both word reading speed and nonword reading accuracy were associated with phonological awareness as measured by the word and nonword phoneme deletion tasks. This might be taken to indicate the close interdependence of reading and phonological processing abilities in the

group of children/participants with dyslexia at this time. This is in contrast to both the chronological age controls and the reading age controls, where no such associations were found. The group of children/participants with dyslexia did, however, share with the chronological age control group a significant association between nonword reading speed and RAN digit naming speed.

At T2, the profile of associations in the group of children/participants with dyslexia was also different from that of both control groups, and the profile of associations differed also across the two control groups. Nonword reading accuracy in the group of children/participants with dyslexia was now associated with short-term memory as measured by the digit span task, as well as with phonological awareness as measured by the spoonerisms task and the ability accurately to represent phonemes in spelling.

Spelling

Table 8.7
Significant partial correlations for each group at time 1 & 2

	T1			T2		
	CA	RA	D	CA	RA	D
Gk. Spell. orthographic accuracy / Greek spelling phonemes			*	*	*	*
Gk. Spell. orthographic accuracy / spelling suffixes				*	*	*
Gk. Spell. orthographic accuracy /orthographic proof spelling				*	*	*
Gk. Spell. orthographic accuracy /word morph. proof spelling				*	*	*
Gk. Spell. orthographic accuracy /nonword morphological proof spelling						*
Gk. Spell. orthographic accuracy /phoneme deletion accuracy words						*
Gk. Spell. orth accuracy/ Phoneme deletion accuracy nonwords/						*
Gk. Spell. orth accuracy /Phoneme deletion speed nonwords						*
Gk. Spell. orthographic accuracy /spoonerisms accuracy						*
Gk. Spell. orthographic accuracy /spoonerisms speed						*
Greek spelling phonemes/ phoneme deletion accuracy words						*
Gk. Spell phonemes/ phoneme deletion accuracy nonwords						*
Greek spelling phonemes/phoneme deletion speed words				*		
Greek spelling phonemes /spoonerisms accuracy						*
Greek spelling phonemes /spoonerisms speed				*		
Greek spelling phonemes /digit span						*
Greek spelling phonemes /word morph. proof spelling			*			
Greek spelling phonemes/nonword morph. proof spelling			*			*
Greek spelling phonemes/spelling suffixes				*		*
Greek spelling phonemes/nonword repetition						*
Greek spelling phonemes/ orthographic proof spelling			*			
Spelling suffixes /phoneme deletion accuracy nonwords	*			*		
Spelling suffixes /phoneme deletion speed nonwords				*		*
Spelling suffixes/digit span				*		
Spelling suffixes /spoonerisms speed				*		
Spelling suffixes / orthographic proof spelling	*	*				

Note. Asterisks indicate significant correlations; T1, time 1; T2, time 2; CA, chronological-age controls; RA, reading-age controls; D, children/participants with dyslexia.

As shown in Table 8.7 above, at T2, there was a significant partial correlation between orthographic accuracy on the Greek Spelling test and correct representation of phonemes in spellings for all three groups. This perhaps indicates the importance of phonological

processes to the development of orthographically correct spellings, which obtains across all three groups. A significant partial correlation was also found for the group of children/participants with dyslexia and the reading age control group, but not the chronological age control group, between orthographic accuracy on the Greek Spelling test and correct spelling of suffixes. This perhaps indicates that the morphological knowledge necessary to correct spelling of suffixes also contributes to the development of orthographically correct spellings. Consistent with this suggestion is the fact that morphological knowledge was significantly associated with orthographic accuracy in the dyslexic and reading age control groups, and with correct representation of phonemes in spellings in the dyslexic and chronological age control groups.

Significant partial correlations between orthographic accuracy and phonological awareness measures were found only in the group of children/participants with dyslexia. Correct representation of phonemes in spellings was also strongly related to both speed and accuracy phonological awareness measures in the group of children/participants with dyslexia, but only to speed phonological awareness measures in the reading age controls. In the chronological age control group, correct representation of phonemes in spellings was related to morphological rather than phonological measures. Phonological processes are clearly important to orthographically correct spelling in the group of children/participants with dyslexia, and, to a lesser extent, in the reading age control group. However, it should be noted that the low correlations between phonological awareness skills and spelling ability among control children could be the result of ceiling effects or restricted ranges on the phonological measures.

In contrast to this, in the reading age control group it was correct spelling of suffixes that was most clearly related to phonological awareness measures and to phonological short -

term memory as measured by digit span. In the group of children/participants with dyslexia, only one significant partial correlation was found with correct spelling of suffixes (that with speed of nonword phoneme deletion).

Relations among cognitive processes.

Table 8.8
Significant partial correlations for each group at time 1 & 2

	T1			T2		
	CA	RA	D	CA	RA	D
Word and nonword morph. proof spelling	*	*		*	*	*
Word morph. proof spelling / orthographic proof spelling	*	*	*		*	*
Morph. proof spelling nonwords /spoonerisms accuracy						*
Morphological proof spelling words/spoonerisms speed						*
Spoonerisms speed with accuracy					*	*
Digit span / spoonerisms accuracy					*	
Digit span / spoonerisms speed					*	
Digit span /orthographic proof spelling			*			
RAN digits/RAN letters				*		*

Note. Asterisks indicate significant correlations; T1, time 1; T2, time 2; CA, chronological-age controls; RA, reading-age controls; D, children/participants with dyslexia.

As shown in Table 8.8 above, at T1, associations between word and nonword morphological proof spelling were found in both control groups, but not in the group of children/participants with dyslexia; word morphological proof spelling was associated with orthographic proof spelling in all three groups.

At T2, associations between word morphological proof spelling and orthographic proof spelling were found for children/participants with dyslexia and reading age controls, but not for chronological age controls. In the group of children/participants with dyslexia, morphological proof spelling at T2 was also associated with phonological awareness as measured by the spoonerisms task. The reading age control group was the only group in

which short-term phonological memory as measured by digit span was associated with phonological awareness as measured by the spoonerisms task. The group of children/participants with dyslexia was similar to the chronological age controls in terms of an association between RAN digit and RAN letter naming speeds, which was not found in the younger reading age controls.

Results of correlational analyses between T1 and T2 data.

The longitudinal predictors of reading skills were investigated by conducting partial correlations. We controlled for the autoregressive effect of reading ability at time 1 on reading ability at time 2. For predicting children's reading performance on the Greek version of the TOWRE at time 2 we used the experimental reading measures (reading accuracy and speed) as the autoregressors at time 1. On the other hand, for predicting children's reading performance on the experimental reading measures at time 2 we used the Greek version of the TOWRE reading test as the autoregressor at time 1. Separate correlations for each group of participants are reported, as a different correlational pattern was produced for each group. The analyses revealed a clear pattern of results: phoneme awareness skills (based on z-mean scores derived by the z-scores on the measures of phoneme deletion of words and nonwords, and spoonerisms) were the strongest predictors of reading skills for the younger normal readers, but not for the older children/participants with dyslexia and the chronological age-matched readers. Rapid digit naming was a significant longitudinal predictor of nonword reading speed for the younger reading-level matched children, but not for the children/participants with dyslexia and for the same-age normal readers. This finding suggests that rapid naming influences children's reading skills up to fourth grade, but fails to predict subsequent reading attainment (Wagner et al.,

1997). In addition the speed with which the reading-level matched children read words and nonwords at time 1 predicted their nonword reading speed at time 2.

The pattern of correlations obtained for the children/participants with dyslexia and the same-age normal readers is quite similar. Word and nonword reading speed at time 1, as well as performance on the Greek version of the Towre Word Efficiency test, that combines reading accuracy and speed (i.e., number of words read correctly within 45 seconds) predicted both groups' performance on the measures at time 2. Moreover dyslexic and normal readers nonword reading accuracy was a longitudinal predictor of word reading accuracy, suggesting that decoding skills are important for later reading attainment. However, word reading accuracy at time 1 was a longitudinal predictor of word and nonword reading speed and reading performance on the Greek version of the Towre at time 2 only for the chronological age matched normal readers.

Table 8.9
Partial correlations (controlling for reading at time 1) between reading and phonological measures at time 1 and reading at time 2 for the reading-age control children

	Word Reading Accuracy T2	Word Reading Speed T2	Nonword Reading Accuracy T2	Nonword Reading Speed T2	Towre T2
Z-Phonological Score T1	.49**	-.43*	.27	-.45*	.19
Rapid Digit Naming T1	.04	.16	-.06	.43*	.27
Word Reading Accuracy T1	.14	-.33	.28	-.02	-.18
Word Reading Speed T1	.16	.24	-.15	.44*	-.07
Nonword Reading Accuracy T1	-.02	.17	.05	.15	-.25
Nonword Reading Speed T1	.19	.25	.06	.61***	-.10
Towre T1	.19	-.26	.36	-.15	-.13

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 8.10
Partial correlations (controlling for reading at time 1) between reading and phonological measures at time 1 and reading at time 2 for the chronological-age control children

	Word Reading Accuracy T2	Word Reading Speed T2	Nonword Reading Accuracy T2	Nonword Reading Speed T2	Towre T2
Z-Phonological Score T1	.15	-.21	.20	-.08	-.09
Rapid Digit Naming T1	.15	.09	-.04	.27	-.32
Word Reading Accuracy T1	.17	-.61**	.27	-.52*	.60**
Word Reading Speed T1	-.07	.72***	-.07	.54**	-.81***
Nonword Reading Accuracy T1	.48*	-.24	.42	-.34	.20
Nonword Reading Speed T1	-.07	.41	-.31	.71***	-.57**
Towre T1	.05	-.53*	-.03	-.49*	.74***

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 8.11
Partial correlations (controlling for reading at time 1) between reading and phonological measures at time 1 and reading at time 2 for the children/participants with dyslexia

	Word Reading Accuracy T2	Word Reading Speed T2	Nonword Reading Accuracy T2	Nonword Reading Speed T2	Towre T2
Z-Phonological Score T1	-.13	-.10	.14	-.36	.39
Rapid Digit Naming T1	-.08	-.15	-.15	.05	-.27
Word Reading Accuracy T1	.27	-.07	.06	.06	.22
Word Reading Speed T1	-.03	.64***	-.04	.41	-.64***
Nonword Reading Accuracy T1	.47*	-.24	.46*	.19	-.08
Nonword Reading Speed T1	-.33	.44*	.03	.78***	-.39
Towre T1	-.09	-.69***	-.19	-.46*	.69***

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

The correlations that were performed between the measures at time 1 and phonological and orthographic spelling at time 2 showed that phonological awareness skills significantly predicted later phonological and conventional spelling ability (in the case of the reading-age control children phoneme awareness predicted only phonological spelling skills). This finding stresses the important role of phonology in the development of spelling skills (Caravolas et al, 2001). All three groups' performance on the orthographic proof spelling task and the spelling task of suffixes at first assessment significantly predicted children's phonological and conventional spelling skills at second assessment.

Reading ability at time 1 was found to be a longitudinal predictor of spelling ability at time 2 but not to the same extent for all the groups. Participants' performance on the Greek version of the Towre reading test at time 1 was predictive only of the phonological and conventional spelling ability of the reading-age control group. Moreover the conventional spelling skills of this group at time 2 were predicted by their word reading accuracy score at time 1. Nonword reading accuracy at time 1 significantly correlated with the phonological and conventional spelling ability of the group of children/participants with dyslexia and the conventional spelling ability of the same-age control group. Additionally word reading accuracy at time 1 predicted children's/participants' with dyslexia phonological spelling skill at time 2 and word and nonword reading speed at time 1 predicted the phonological and conventional spelling ability of this group. Nonword reading accuracy and rapid digit naming at time 1 were longitudinal predictors of conventional spelling skills of the same-age normal readers.

Table 8.12

Correlations between reading, phonological and spelling measures at time1 and spelling at time 2 for the reading-age control children

	Phonological Spelling T2	Conventional Spelling T2
Z-Phonological Score T1	.52***	.31
Rapid Digit Naming T1	.09	.35
Word Reading Accuracy T1	.25	.41*
Word Reading Speed T1	-.22	-.28
Nonword Reading Accuracy T1	.32	.04
Nonword Reading Speed T1	-.01	-.11
Towre T1	.50**	.60***
Orthographic Choice Task	.53**	.71***
Spelling Task of Suffixes	.46*	.53**

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 8.13

Correlations between reading, phonological and spelling measures at time1 and spelling at time 2 for the chronological-age control children

	Phonological Spelling T2	Conventional Spelling T2
Z-Phonological Score T1	.52*	.45*
Rapid Digit Naming T1	.08	-.51*
Word Reading Accuracy T1	-.15	.25
Word Reading Speed T1	.04	-.41
Nonword Reading Accuracy T1	.35	.46*
Nonword Reading Speed T1	-.12	-.39
Towre T1	.00	.32
Orthographic Choice Task	.65***	.57**

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 8.14
Correlations between reading, phonological and spelling measures at time 1 and spelling at time 2 for the children/participants with dyslexia

	Phonological Spelling T2	Conventional Spelling T2
Z-Phonological Score T1	.57**	.56**
Rapid Digit Naming T1	-.02	.13
Word Reading Accuracy T1	.52**	.39
Word Reading Speed T1	-.44*	-.48*
Nonword Reading Accuracy T1	.43*	.42*
Nonword Reading Speed T1	.03	-.10
Towre T1	.02	.15
Orthographic Choice Task	.48*	.75***
Spelling Task of Suffixes	.65***	.74***

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

8.4. Discussion

At the first time of testing children/participants with dyslexia appeared to perform quite accurately on the tasks of phoneme deletion and word reading (accuracy score), even though they were significantly poorer than same-age normal readers. The finding that Greek children/participants with dyslexia achieve rather high accuracy scores on word reading is in line with Wimmer's study (1993) that showed that German children/participants with dyslexia were quite accurate readers. Similarly the study by

Ziegler, Perry, Ma-Wyatt, Lander and Schutte-Korne (2003) found that German children/participants with dyslexia were less accurate in word reading than same-age normal readers, but performed more accurately than reading-level-matched readers. The present finding also supports the study by Nikolopoulos, Goulandris and Snowling (2003). According to their findings children's/participants' with dyslexia word reading accuracy scores were high. However in their study children/participants with dyslexia read words and nonwords with the same accuracy as chronological-age control children.

The present study revealed that children/participants with dyslexia performed quite accurately on the task of phoneme deletion; this evidence is consistent with the aforementioned study in Greek (Nikolopoulos et al., 2003), which found that the tasks of phoneme and syllable counting and deletion were “easy” for children/participants with dyslexia to complete. However in contrast to our study, in which children/participants with dyslexia scored high on the task of phoneme deletion, but significantly lower than same-age normal readers, in the study by Nikolopoulos and colleagues performance on phoneme deletion did not discriminate children/participants with dyslexia from average readers.

The spoonerisms task was the phonological awareness measure that created difficulties for the children/participants with dyslexia of the present study. Although their scores were low, they did not differ from the scores obtained by the reading-level-matched readers. It could be argued that the complex metalinguistic task of spoonerisms was too difficult for younger normal readers, whose mean age was 7 years six months and they had only received one and a half year of reading instruction. This finding supports previous evidence in Greek and German (Landerl et al., 2000; Nikolopoulos et al., 2003),

according to which children/participants with dyslexia performed less well than same-age normal readers on spoonerisms, yet similarly to younger normal readers.

There is extensive evidence that English-speaking individuals with dyslexia show rapid naming impairments in relation to normal readers (Wolf, 1986; Felton and Wood, 1989). In addition evidence from studies in transparent orthographies consistently showed that children/participants with dyslexia have a rapid naming deficit (Wimmer, 1993; Van den Bos, 1998). The study by Wimmer, Mayringer and Landerl (1998) investigated the phonological deficit hypothesis versus the general automatization hypothesis. It was found that rapid naming was one of the tasks that differentiated children/participants with dyslexia from same-age normal readers. Likewise the present study showed that children/participants with dyslexia were impaired in rapid digit naming in comparison to same-age normal readers. In support to previous findings in Greek concerning children's/participants' with dyslexia performance on rapid naming tasks (Nikolopoulos et al., 2003) the present results showed that children/participants with dyslexia were slower than younger normal readers in rapid digit naming, but the difference did not reach conventional levels of significance.

A consistent finding among studies in transparent orthographies is that children/participants with dyslexia show a low error rate for words and nonwords, but suffer a reading speed deficit (Wimmer, 1993; Zoccolotti et al., 1999). Indeed the present findings add new evidence in favor of the prevalence of reading speed difficulties. Children/participants with dyslexia read words and especially nonwords significantly slower than same-age normal readers. They were also slower than reading-level-matched readers – mainly when they read nonwords- but the difference failed to reach conventional significance. This finding agrees with the study by Nikolopoulos and his

colleagues (2003), but does not fully agree with the evidence provided by Ziegler and his colleagues (2003) that German children/participants with dyslexia exhibited a robust nonword reading speed deficit even in comparison to younger normal readers.

The analyses of the children's/participants' with dyslexia performance on the tasks of orthographic proof spelling, spelling of suffixes, morphological proof spelling of words and morphological proof spelling of nonwords revealed that the clinical group performed significantly poorer than same-age normal readers. In comparison to younger normal readers, children/participants with dyslexia did not differ significantly; however, children/participants with dyslexia were slightly more accurate in the two morphological proof spelling tasks. The latter tasks required children to choose the word or nonword whose prefix was spelled correctly. Reading-level-matched readers attended the second grade at the time of testing. At this level there is no explicit instruction on the morphology of prefixes and teachers do not draw children's attention on the spelling of prefixes. On the other hand it could be argued that the prefixes included in the tests were of low frequency of occurrence and therefore were unfamiliar to younger readers. Our findings provide support to past evidence in Greek (Nikolopoulos et al., 2003), according to which children/participants with dyslexia produced significantly more orthographic spelling errors than chronological-age control children, and they spelled multi-letter inflectional morphemes significantly poorer than same-age controls. The present results also support studies in English (Nelson, 1980; Olson, 1985; Pennington, McCabe, Smith, Lefly, Bookman, Kimberling and Lubs, 1986), which showed that children's/participants' with dyslexia orthographic skills do not differ from those of younger normally developing children. However since we used a reading-level-match and not a spelling-level-match design, the lack of differences between the clinical and the reading-age control group could be due to differences in spelling skills.

At the second assessment one and a half year after first assessment the children of our sample were assessed on all the time 1 measures, as well as on four additional tasks. In addition the time each participant needed to complete the tasks of phoneme deletion and spoonerisms was measured at the second test time. The performance of the group of children/participants with dyslexia and the two control groups on the majority of the time 1 measures improved. The performance of the chronological-age control children was similar across the two test times on the tasks of phoneme deletion (words and nonwords/accuracy score), word and nonword reading (accuracy score) and morphological proof spelling (words). The performance of the children/participants with dyslexia on the task of phoneme deletion (nonwords/accuracy score) did not change across times.

In line with the results of the time 1 comparison between children/participants with dyslexia and normal readers, the time 2 comparison between children/participants with dyslexia and same-age normal readers revealed significant differences on all the measures. Same-age normal readers significantly outperformed their counterparts with dyslexia. Unlike the results of the comparison between dyslexic and younger normal readers at test time 1, which produced no significant differences between the two groups, the comparison between the groups on the same and additional tests produced some significant differences with children/participants with dyslexia performing significantly poorer than younger normal readers. At the second test time children/participants with dyslexia were significantly less accurate than younger normal readers on the task of phoneme deletion that contained nonwords; they were also significantly less accurate in nonword reading, they were significantly slower when they read nonwords and they were significantly poorer in conventional spelling (graded spelling dictation task/orthographic accuracy score). These findings suggest that Greek children/participants with dyslexia do

not catch up with their normally developing peers by the age of twelve years approximately (mean age of group of children/participants with dyslexia) on any of the measures that tap their cognitive and literacy skills. Children's/participants' with dyslexia phonological, nonword reading and orthographic spelling difficulties not only do they persist over time, but they also differentiate them from younger normal readers. Therefore children's/participants' with dyslexia impairments cannot be attributed to poorer reading and spelling exposure, but they reflect a deviant developmental pattern.

Studies in transparent languages have reported evidence of a phonological deficit among children/participants with dyslexia. Wimmer, Mayringer and Landerl (1998) found that children/participants with dyslexia were significantly less accurate than younger normal readers on phonological memory tasks. Wimmer (1999) found evidence of phonological awareness and phonological memory difficulties among children/participants with dyslexia. Our findings support evidence in transparent orthographies and they are also consistent with studies on dyslexia in English, which have extensively shown that children/participants with dyslexia have phonological deficits (Bruck, 1990; Manis et al., 1993). In line with the present findings Bruck (1992) found that phoneme awareness difficulties (assessed on tasks of phoneme counting and deletion containing nonwords) do not improve as a function of word recognition skills, but persist over time.

The most consistent finding among studies in both regular and irregular orthographies is that children/participants with dyslexia have impairments in nonword reading (Ziegler et al., 2003; Snowling, 1980). The children/participants with dyslexia of our study read nonwords with the same accuracy and speed as younger normal readers at first assessment, but approximately two years on they were found impaired in nonword reading (both accuracy and speed) in relation to reading-age control readers. This finding

supports the evidence provided by Snowling (1981) and Snowling, Goulandris and Defty (1996) that children's/participants' with dyslexia decoding abilities did not develop as their reading age increased. The existence of significant differences in nonword reading between children/participants with dyslexia and younger normal readers and the absence of significant differences between the two groups in word recognition skills agrees with the majority of the studies reviewed by Rack, Snowling and Olson (1992) and by Izjendoorn and Bus (1994), which revealed significant differences in nonword reading between children/participants with dyslexia and younger normal readers in the absence of differences in word recognition abilities. These findings provide strong evidence in support of the phonological deficit hypothesis.

The assessment of Greek children's/participants' with dyslexia spelling skills revealed that their performance in all the spelling tasks was significantly poorer than that of same-age normal readers and similar to that of younger normal readers, with the exception of the orthographic accuracy on the graded spelling dictation task on which children/participants with dyslexia were significantly less accurate than reading-age control children. Based on this finding it is suggested that Greek children/participants with dyslexia show a deviant developmental pattern in learning to spell rather than a developmental delay (Lennox and Siegel, 1994). It is of particular interest to concentrate on the graded spelling dictation task, as it was a spelling measure that was administered at the second time of testing, it was suitable for assessing the spelling skills of the study's age groups, as well as it measured both the phonological and orthographic accuracy of children's spellings. The analyses revealed that children/participants with dyslexia were impaired in phonological spelling accuracy in comparison to same-age normal readers; this finding does not agree with Nikolopoulos' and his colleagues' study (2003) in which children/participants with dyslexia did not make spelling errors of a phonological nature.

However the dyslexic sample of that study was younger than the sample of the present study. On the other hand and in contradiction to Bourassa's and Treiman's (2003) finding that children/participants with dyslexia were indistinguishable from younger typically developing children in the orthographic accuracy of their spellings, the children/participants with dyslexia of the present study were significantly impaired in the orthographic accuracy of their spellings in relation to younger normal readers. It could be argued that the transparency of the Greek orthographic system and the phonics-based literacy instruction facilitates children's/participants' with dyslexia phonological processing and therefore it enables them to represent the phonological structure of words similarly well to younger normal readers. Children's/participants' with dyslexia poorly specified phonological representations, which became evident in their performance on phoneme deletion and nonword reading, could have affected the development of orthographic representations, which are a fundamental prerequisite for the learning of complex orthographic patterns. The importance of orthographic knowledge in the development of conventional spelling and the difficulties that children/participants with dyslexia experience with orthographic spelling had been stressed by Schwartz and Doehring early on (Schwartz, 1983; Schwartz and Doehring, 1977).

Children's/participants' with dyslexia performance on the spelling dictation task of consonant clusters was found to be significantly poorer to same-age normal readers, but similar to younger normal readers. Children's/participants' with dyslexia errors were mainly omissions of consonants and substitutions with consonants that sound the same or similar to the target consonants. It seems that children's/participants' with dyslexia poor phonological skills cause difficulties with the representation of the phonological structure of consonants; nonetheless the regularity of the Greek orthography moderates the degree of difficulty that children/participants with dyslexia experience when they represent

consonant clusters to such an extent that they do not appear to have a deficit in relation to younger normal readers.

An important aim of the study was to investigate the predictors of Greek children's with dyslexia and normally developing children's reading and spelling ability. Concurrent and longitudinal correlations were conducted in order to meet this goal. The concurrent partial correlations, that were performed at both test times and controlled for the effect of verbal IQ and chronological age, showed that phonological awareness measures significantly correlated with reading tasks across children/participants with dyslexia and reading-level-matched readers. However when the longitudinal predictors of reading ability were examined (the autoregressive effect of reading at time 1 on reading at time 2 was controlled for), it was found that phonological awareness skills predicted later reading ability only in the case of younger normal readers. These children attended the second grade when they were assessed the first time, and they attended the fourth grade when they were assessed the second time. According to our findings the longitudinal predictive role of phonological awareness skills does not exceed fourth grade reading skills, but at the same time it is not limited to early reading skills. The predictive relationship between phonological skills and reading ability that emerged in our study is in line with the findings of the study by Parrila, Kirby and McQuarrie (2004), according to which grade 1 phonological awareness was a strong longitudinal predictor of reading over the first three years of formal schooling. Although the predictive power of phonological awareness on third grade reading decreased when the effect of grade 1 reading was partialled out, phonological awareness skills accounted for significant unique variance. The effect of phonological awareness on subsequent development in reading revealed in the present study also supports the evidence provided by Wagner and his colleagues (1997).

The importance of phonological awareness in the prediction of concurrent and subsequent spelling skills was pointed out in the present study. In line with the study by Cardoso-Martins and Pennington (2004), which showed that among children with high risk of dyslexia phoneme awareness significantly predicted spelling skills at the end of first and second grade, the results of the present study revealed that among the group of children/participants with dyslexia, phoneme awareness significantly predicted phonological and conventional spelling skills. Among the younger and same-age normal readers phoneme awareness was also a longitudinal predictor of phonological spelling skills (phoneme awareness significantly correlated with conventional spelling only among same-age normal readers). Once again this evidence supports Cardoso-Martins' and Pennington's (2004) findings according to which among the low familial risk for dyslexia group phoneme awareness was a significant predictor of spelling ability at both developmental periods. Similarly Caravolas, Hulme and Snowling (2001) reported that phoneme isolation skills were one of the strongest predictors among others of spelling skills over the first three years of schooling. Further path analyses showed that performance on phoneme isolation was one of the predictors of early phonological spelling ability and conventional spelling ability at the second year at school. The present findings clearly suggest that phonological awareness in Greek is a critical ability for the development of phonological and orthographic spelling skills.

The present study also aimed at investigating the predictive role of rapid naming skills in reading and spelling ability. The partial correlations that were conducted for looking at the concurrent prediction of rapid naming revealed that rapid digit naming skills were concurrent predictors of children's/participants' with dyslexia nonword reading skills at the first time of assessment. Rapid naming significantly correlated with nonword reading among younger normal readers at test time 2 and among same-age normal readers at both

test times. The association between rapid naming and reading difficulties that emerged in our study is consistent with robust previous evidence. Wolf and colleagues (2000a) reviewed approximately 28 studies that showed the association between rapid naming skills and specific reading difficulties.

An important result of the present study was the quite strong correlation ($r=0.5$) between rapid digit naming and phoneme deletion of nonwords among the younger normal readers at test time 1. This finding is in agreement with modest to strong correlations ($r=0.3$ to $r=0.6$) that are evident between RAN and phonological awareness among normal readers (Cronin and Carver, 1998; Frederickson, Frith and Reason, 1997), suggesting that rapid naming, like phonological awareness, taps underlying phonological representations (Hulme and Snowling, 1992; Wagner et al., 1994).

When the correlational analyses were concerned with the longitudinal prediction of rapid naming skills in reading ability, a significant moderate correlation between naming speed and nonword reading speed emerged among younger normal readers. This correlation along with the concurrent correlations between these variables strongly supports previous evidence of an association between RAN and later reading (Catts, Fey, Zhang and Tomblin, 2001; Meyer Wood, Hart and Felton, 1998; Wolf, Bally and Morris, 1986). In line with the present findings, Parrila, Kirby and McQuarrie (2004) found that first grade naming speed made a unique prediction of third grade reading ability. Similarly Cronin and Carver (1998) showed that rapid naming ability contributed unique variance in the prediction of reading. However the present findings are not consistent with the results of the study by Cardoso-Martins and Pennington (2004), according to which rapid naming added significant variation to reading only among high-risk readers. In our study the longitudinal prediction of naming speed in reading was evident only among younger

normal readers. It should be noted however, that the reading tasks that were included in the study by Cardoso-Martins and Pennington assessed single word reading accuracy, nonword reading accuracy, reading comprehension and accuracy and speed of text reading, whereas in the present study rapid naming longitudinally correlated with nonword reading speed. Our study failed to find a longitudinal association between naming speed and reading difficulties. Differences in findings among studies have been interpreted in terms of differences in severity of reading difficulties between samples of children/participants with dyslexia (Wolf et al., 2000a). Another argument about the explanation of differences in findings concerns the autoregressive effect of earlier reading on later reading. Wolf and colleagues (2000a) argued that the interpretation of a longitudinal association between RAN and reading might be problematic, as rapid naming skills may influence early reading ability to the same extent as it does later reading ability. Savage (2004) argued that the best evidence of a longitudinal prediction would come from studies that assess children's rapid naming skills before they receive any reading instruction.

It is noteworthy that in the present study rapid naming skills were concurrent, as well as longitudinal predictors of nonword reading speed, which contradicts studies that relate naming speed to low performance on exception word reading accuracy and word reading speed, rather than nonword reading (Wolf and Bowers, 1999). Our finding could be taken to suggest that naming speed taps phonological access and retrieval of phonological labels (Wolf and Bowers, 1999).

Moreover rapid naming ability was a longitudinal predictor of conventional spelling skills among same-age normal readers. On the contrary in the study by Cardoso-Martins and Pennington (2004) the same longitudinal prediction was evident among children with

high risk for dyslexia. Nevertheless the influence of rapid naming on spelling may suggest that processes other than phonological could participate in the development of orthographic spelling skills.

The concurrent and longitudinal correlations performed on the reading measures showed that reading skills significantly correlated with each other across groups. It was clearly demonstrated that earlier reading skills and mainly reading speed affect the development of subsequent reading skills (mostly word and nonword reading speed).

Reading skills were also longitudinal predictors of conventional spelling skills among the three groups and longitudinal predictors of phonological spelling skills among children/participants with dyslexia and younger normal readers. Finally it was found that prior spelling ability predicted subsequent phonological and orthographic spelling ability. These findings taken together suggest that reading and spelling experience and formal instruction in reading and spelling promote further development of reading and spelling abilities (Caravolas et al., 2001).

The evidence reported in this chapter has both theoretical and practical implications, as well as significant limitations. It is evident that phonological skills play an important role in the development of reading, but mainly in the development of Greek dyslexic and normal readers' phonological and conventional spelling skills. Phonological abilities and less rapid naming skills are important precursors of reading and spelling in Greek. In regard to the study's practical implications it follows that explicit instruction on metalinguistic awareness, reading and spelling could increase children's/participants' with dyslexia and normally developing children's reading and spelling skills and facilitate the learning of complex orthographic patterns.

The present study has important limitations. A critical disadvantage is that the findings were based on correlational analyses and therefore they cannot indicate causal connections. The limited number of participants did not allow us to perform regression or path analyses that would be more informative and could reveal unique longitudinal predictions of cognitive and literacy skills in reading and spelling abilities. A unique causal relationship between phonological skills and reading and spelling, as well as between rapid naming speed and reading and spelling could be established if children's phonological and rapid naming skills are assessed before they receive any form of reading instruction and the influence of other factors, such as IQ, are controlled for (Savage, 2004).

Chapter 9. The Study on the Spelling of Derivational and Inflectional Suffixes

9.1. Introduction

Evidence from studies in English and other languages has shown that learning to spell is a complex process that involves the integration of different linguistic information, such as phonological, orthographic and morphological information. Phonological processing is a basic component involved in the acquisition of recoding and orthographic skills that are necessary for the successful development of spelling ability (Wagner & Torgesen, 1987; Wagner, 1988; Wagner, Torgesen & Laughton, Simmons & Rashotte, 1993). However learning to spell does not only require the representation of sounds by letters; another fundamental resource for the acquisition of orthographic competency is the language submodule of morphology. In many alphabetic languages learning to spell must take morphology into account, as the spelling patterns that represent inflectional morphemes cannot be reduced to phonology. For example in English the ‘-ed’ suffix in regular past tense verbs cannot be spelled on the basis of letter-sound correspondence rules, because it is pronounced differently in writing (according to the phonological context); we write ‘called’, ‘missed’ and ‘sounded’ but we pronounce the endings differently (/d/, /t/ and /id/ respectively).

The morphology of Greek nouns, adjectives and verbs is an essential component of the grammar and is taught in the primary school and the first years of secondary school during the literacy hour. When children spell the derivational and inflectional endings of this type of words, they are faced with the task of deciding between alternative spellings

for representing the same phonemes. A grasp of morphology and gradual learning of the morphological spelling rules is the key to mastering the spelling of word suffixes.

The existence of alternative spelling patterns for the representation of vowels in words and the importance of morphology in choosing the correct spelling representation of a given phoneme has been the focus of many studies in English and other languages. Barry and Seymour (1988) sought to examine the sound-to-spelling contingency and priming effects on the selection of spelling patterns for nonword spelling. Based on Campbell's study (1983), which demonstrated that the spelling patterns of previously heard, rhyming words ("lexical priming") can influence nonword spelling, the authors compared adult participants' nonword spelling in a priming task (experimental) and a free-spelling (control) task in which nonwords were presented orally on their own. Within the priming task four conditions were compared: a. nonwords preceded by words with the most common high-contingency (i.e., common spelling patterns representing vowel phonemes in words) spelling pattern of their vowel (e.g., "corn"), b. words with the second most common high-contingency spelling pattern (e.g., "dawn"), c. words with low-contingency (i.e., rare) spelling patterns that were phonologically regular for reading (e.g., "type") and d. words with low-contingency spelling patterns which were phonologically irregular (e.g., "eyes"). For the control task the exact same words in the four conditions were presented. It was found that the frequency of production of the "primed" spelling patterns was greater in the experimental task than in the free-spelling task and to an equal extent in each of the four conditions. However a substantial effect of sound-to-spelling contingency was evident in both tasks. Further analyses revealed significant main effects of both lexical priming and sound-to-spelling contingency on nonword spelling. According to the authors this outcome is indicative of a joint influence of these two factors on the selection

of spelling patterns for nonword spelling and supports the existence of an interactive model in which nonword spellings are produced through a system of correspondences that are subject to modification by interference of the lexical level.

Researchers' interest in the alternative spelling patterns that represent a phoneme has led them to investigate whether children adopt mostly one specific spelling at the beginning of learning to spell, and whether there is a differentiation at later stages of spelling development with respect to morphology. Evidence from Portuguese studies (Nunes Karraher, 1985; Nunes, 1992) showed that at first there is a remarkable preference for one of the spelling choices, but through children's exposure to reading and writing the use of more alternative spellings increases. For instance the nasal diphthong /au/, which can either be spelled as 'ao' or 'am', is spelled by the majority of children at the first two years of schooling with the grapheme 'ao'. However from about the second or third year at school they begin to use the grapheme 'am' in their spellings.

Data from Greek (Bryant et al., 1999) has revealed a similar pattern. Beginning spellers tend to prefer one spelling of a sound even when there are clear alternatives. The use of alternative spellings emerges, as children grow older. This group of researchers categorized cross-sectional data on over 200 Greek children ranging from seven to ten years on the basis of the spelling of the final sound (/o/, /e/, & /i/) of sixty-four words into stages that reflect children's progressive understanding of the use of alternative spellings. The stimuli that represented the final phoneme /o/ with the grapheme 'o' were neuter nouns in the singular nominative, and the stimuli that represented the same sound with the grapheme 'ω' were verbs in the first person singular, active voice. The stimuli that represented the final phoneme /e/ with the grapheme 'ε' were verbs in the first person

plural, active voice, whereas the stimuli that represented the same sound with the grapheme ‘αι’ were verbs in the third person singular, passive voice. The words that included the phoneme /i/ in their endings were the following: (a) feminine nouns and adjectives in the singular nominative form [grapheme ‘η’], (b) neuter nouns in the singular nominative form [grapheme ‘ι’], (c) masculine nouns and adjectives in the plural nominative form [diagraph ‘οι’], and (d) verbs in the third person singular, active voice [diagraph ‘ει’].

The stages were defined on these criteria: the number of alternative spellings that children used to represent each ending sound, and whether the final phonemes were represented with the appropriate grapheme. At stage 1, children used only one spelling for each word category 80 per cent of the time or more. At the second stage children were expected not to use a single spelling pattern more than eighty per cent of the time. Even though they were aware of the existence of alternative spellings, they were still unable to make the correct choice between them. They showed a marked preference for one spelling (or two in some cases), but systematically produced correct spellings for one word type. In stage 3, children successfully used at least three spelling patterns and produced systematically correct responses for two types of words. Stage 4 performance was characterized by the use of three alternative spellings and the correct spelling of three word categories. At stage 5 children produced correct responses for all types of words. This study also examined the relations between Greek children’s morphological awareness and their use of different morphological spelling patterns. Word and sentence analogy tasks were used to assess children’s morphological skills. Discriminant function analysis revealed significant results. Word and sentence analogy scores predicted the stages that children achieved with both the /o/ and /i/ suffixes. The word analogy and not the sentence

analogy task was a strong predictor of the spelling stages. It is evident that Greek children's grasp of morphological rules necessary for spelling word suffixes develops in a progressive manner.

The work of Bryant and his colleagues, as well as that of other researchers, has also focused on the way that knowledge of morphological rules facilitates the spelling of regular and irregular verb suffixes in the past tense in English. It has been found (Read, 1986; Treiman, 1993; Nunes et al., 1997) that beginning spellers write the suffixes of regular past tense verbs phonetically, but as they grow older they increasingly add the 'ed' spelling to their repertoire.

In a longitudinal study by Nunes et al. (1997) over 300 children who attended the second, third and fourth grade at school were assessed on spelling three categories of past tense verbs ending in /d/ and /t/: regular past-tense verbs, irregular past-tense verbs, and non-verbs. In addition they were administered three morphological awareness tasks (sentence and word analogy, and productive morphology), as well as an IQ test. A five-stage model was used to describe the developmental progress that occurred in children's spellings of past-tense verb suffixes. At the first stage children did not produce phonetically acceptable spellings of the verb endings. At the following stage children's spelling of the 'ed' remained unsystematic but was phonetically acceptable. Stage 3 children used the 'ed' spellings frequently but overgeneralised them to irregular verbs and non-verbs. Stage 4 children started to realize the syntactic significance of the 'ed' ending; they did not use them in non-verbs, but they still generalized to irregular verbs. At the final stage children were able to confine these endings to regular verbs only.

Discriminant function analysis and multiple regressions were conducted to test the association between morpho-syntactic awareness and stage membership. The sentence and word analogy scores were predictive of all the spelling stages even after partialling out the effects of age and IQ. The productive morphology task had no predictive power. This finding supports the hypothesis that mastery of conventional spellings for morphemes depends on morpho-syntactic awareness and occurs at the later spelling stages.

The acquisition and use of morpho-syntactical information relative to the verb, as well as the developmental aspect of morphological resources has been the aim of a study in the Spanish language (Titos et al., 2003). Following on studies in French (Alegria & Mousty, 1996; Totereau, Thevenin & Fayol, 1997), which have emphasized the use of morpho-syntactic knowledge for writing the orthographic markers 's' and 'nt' at the end of nouns, adjectives and verbs, this group of researchers set out to explore whether 255 children, ranging from 6 to 8 years of age and attending the first, second, and third year at school, would make use of morphological knowledge in spelling the 's' ending of the second person singular of Spanish verbs which is not pronounced in speech. A reading test and a spelling dictation task were administered to children. The dictation task included incomplete phrases; the missing word was either a singular noun ending in 's' or a present indicative verb in the second person singular. Word items were of different syllable length and word frequency. Mixed analysis of variance showed that in the case of high frequency words the correct responses were higher in the lexical nouns than in verbs. On the contrary for low frequency words children were more accurate when spelling the final 's' of verbs than nouns. It is suggested that it is in the case of verbs that children exercise their morpho-syntactic knowledge. Additionally it was found that the percentage of

correct spellings increases progressively as the child's schooling advances. Children begin to internalize and generalize the morphological rule of verb spelling from the third year at school onwards.

So far evidence from studies in inconsistent and consistent orthographies has shown that knowledge of morphological rules is essential for learning to spell word inflections. Based on this the present study aims to examine: (i) whether the children of our sample use this information when they spell inflections, (ii) whether children use morphological information for spelling derivational suffixes (iii) whether children/participants with dyslexia experience greater difficulties in comparison to normally developing children in spelling both derivational and inflectional suffixes, and (iv) which type of word (adjective, noun, verb) creates greater spelling difficulties.

9.2. Method

9.2.a. Participants

The sample included twenty-three children/participants with dyslexia, twenty-seven younger reading-level matched readers, and twenty-three same-age normal readers. The participants of the present study were the ones that formed the Time 2 sample of the longitudinal study described in chapter 8. Participants were administered the tests of the present study at the same time with the spelling measures administered at second test time (longitudinal study). At this time of testing all participants have explicitly been taught inflectional spelling rules. Teaching about the spelling of inflections begins from first grade, but the grammatical function of verbs, nouns and adjectives, as well as their inflectional properties in combination to the spelling of their inflection are taught in an explicit and systematic way from third grade through sixth grade of primary school and

early grades of secondary school. However, the teaching emphasis on inflectional spelling rules may sometimes depend on the individual initiative of the teacher. On the other hand, the teaching instruction on derivational morphology and the spelling of derivational suffixes is less often and not as explicit.

9.2.b. Tests

Two spelling dictation tests were devised; the first included twenty-eight adjective-noun pairs (e.g., τελευταίος αυτοκράτορας = last emperor). Equal numbers of each pair were in singular and plural nominative, genitive, accusative and vocative cases with each word including a different derivational suffix. Adjectives represented twenty different derivational suffixes and nouns sixteen different derivational suffixes (see appendix VIa for test items; frequencies for each word are reported instead of frequencies for each unit (stem, derivational suffix, inflectional suffix), since there is no frequency count for word units). Twenty-five adjective stems were inconsistent for spelling and only three were consistent, whereas twenty-six adjective suffixes were inconsistent for spelling and only two were consistent. As far as nouns were concerned, twenty-one noun stems were inconsistent for spelling and seven were consistent, whereas twenty-six noun suffixes were inconsistent for spelling and two were consistent. The child was asked to write the word pairs dictated by the experimenter. One point was awarded for the correct spelling of each part of each word in the pair (stem, derivational suffix, inflection). Some words contained only an inflectional suffix and not a derivational one. This was taken into account when scoring the data. The test had a Cronbach's Alpha Coefficient of 0.93.

The second task comprised eighteen sentences each including a subject and a verb or a verb and object (the subject and the object were always a noun). Each verb (fifteen

irregular and three regular) had a specific characteristic in the way it formed its active and/or passive stem. The majority of the verbs were in active voice with the exception of three, which were in passive voice. Equal number of items were distributed into singular and plural present and past tense (see appendix VIb for test items; frequencies for each word are reported instead of frequencies for each unit). Six verbs were in the first person, five in the second and seven in the third. Each noun was presented either in the nominative or the accusative singular form (two items were plural). All eighteen verb stems were inconsistent for spelling, whereas fifteen verb suffixes were inconsistent for spelling and three were consistent. As far as nouns were concerned, seventeen noun stems were inconsistent for spelling and only one was consistent, whereas nine noun suffixes were inconsistent for spelling and 10 were consistent. Each word in each word pair was scored for correct stem and correct inflection (maximum score 4 for each word pair). The test had a Cronbach's Alpha Coefficient of 0.88.

The derivational suffixes of the nouns and adjectives included in the spelling dictation tasks are displayed in tables 9.1, 9.2 and 9.3 below. The suffixes included in the tables are in singular nominative case, even though in the tests some of the words were also in singular as well as in plural genitive and accusative cases. Suffixes that were used in the tests more than once are included in the table once.

Table 9.1
Derivational & inflectional suffixes of nouns and their phonetic realization included in the spelling dictation task of verbs & nouns

Derivational & Inflectional Suffixes of Masculine Nouns	Derivational & Inflectional Suffixes of Feminine Nouns	Derivational & Inflectional Suffixes of Neuter Nouns
-υτής /itis/ eg., ιδρυτής /iðritis/ (founder)	-εια /ia/ eg., βοήθεια /voithia/ (help)	-ειο /io/ eg., ωδείο /oðio/ (conservatory)
-τήρας /tiras/ eg., ανεμιστήρας /anemistiras/ (fan)	-τητα /tita/ eg., ταχύτητα /taçitita/ (acceleration)	-ιο /io/ eg., μαρτύριο /martirio/ (suffering)
-ωνας /onas/ eg., καύσωνας	-σύνη /sini/ eg., δικαιοσύνη	-υ /i/ eg., δάκρυ /ðakri/ (tear)

/kafsonas/ (hot weather) -μος /mos/ eg., λυτρωμός /litromos/ (relief)	/ðikeosini/ (justice) -ισα /isa/ eg., Λάρισα /Larisa/ (Larisa) -ια /ia/ eg., συμπόνια /simboɲa/ (compassion) -ίδα /ida/ eg., επικεφαλίδα /epikefaliða/ (headline) -αία /ea/ eg., κεραία /kerea/ (antenna)	-ι /i/ eg., αντικλείδι /andikliði/ (spare key)
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Table 9.2

Derivational & inflectional suffixes and their phonetic realization of adjectives included in the spelling dictation task of adjectives & nouns

Derivational/Inflectional Suffixes of Masculine Adjectives	Derivational/Inflectional Suffixes of Feminine Adjectives	Derivational/Inflectional Suffixes of Neuter Adjectives
- αίος /eos/ eg., τελευταίος /telefteos/ (last) - ος /os/ eg., νέος /neu/ (new) - ηρός /iros/ eg., τολμηρός /tolmiros/ (daring) - ερός /eros/ eg., μαυριδερός /mavriberos/ (dark) - ινός /inos/ eg., παντοτινός /pantotinos/perpetual - ιος /ios/ eg., τίμιος /timios/ honest - σιμος /simos/ eg., συζητήσιμος /sizitisimi/ (debatable) - λέος /leos/ eg., ρωμαλέος /romaleos/ (robust) - ειμός /inos/ eg., ταπεινός /tapinos/ (humble)	- εία /ia/ eg., αστεία /astia/ (funny) - ική /iki/ eg., ευγενική /evjeniki/ (kind) - υκή /iki/ eg., θηλυκή /θiliki/ (feminine) - ινη /ini/ eg., πέτρινη /petrines/ (made of stone) - τέα /tea/ eg., διαμετέα /ðieretea/ (divisible) - ωτή /oti/ eg., μεταξωτή /metaksoti/ (made of silk) - ωπή /opi/ eg., αγριωπή /agriopi/ (fierce)	- οίο /io/ eg., γελοίο /jelio/ (ridiculous) - εικό /iko/ eg., δανεικό /ðaniko/ (borrowed) - μο /mo/ eg., έτοιμο /etimo/ (prepared) - σιμο /simo/ eg., νησισίμο /nistisimo/ (lenten) - ο /o/ eg., κρύο /krio/ (cold) - σιο /sio/ eg., ετήσιο /etisio/ (yearly) - ίσιο /isio/ eg., βουνίσιο /vunisjo/ (mountainous)

Table 9.3

Derivational & inflectional suffixes and their phonetic realization of nouns included in the spelling dictation task of adjectives & nouns

Derivational/Inflectional Suffixes of Masculine Nouns	Derivational/Inflectional Suffixes of Feminine Nouns	Derivational/Inflectional Suffixes of Neuter Nouns
- ώτης /otis/ eg., πατριώτης /patriotis/ (patriot) - ώνας /onas/ eg., αγώνας /agonas/ (match) - όνας /onas/ eg., ηγεμόνας /ijemonas/ (ruler) - μός /mos/ eg., ερχομός /erxomos/ (arrival) - ότης /otis/ eg., αγρότης /agrotis/ (farmer) - τής /tis/ eg., κριτής	- ιά /ia/ eg., γειτονιά /gitonía/ (neighbourhood) - τητα /tita/ eg., ποσότητα /posotita/ (quantity) - ίτσα /itsa/ eg., ποδίτσα /poditsa/ (apron) - ισσα /issa/ eg., αρχόντισσα /arxondisa/ (lady) - εία /ia/ eg., πλατεία /platia/ (square) - αινά /ena/ eg., λύκαινα	- τό /io/ eg., νοικοκυριό /nikokirjo/ (household) - ιο /io/ eg., τετράδιο /tetradío/ (notebook) - ημα /ima/ eg., τηλεγράφημα /tilegrafima/ (telegram) - ητό /ito/ eg., φαγητό /fayito/ (food)

/krits/ (judge)	/likena/ (she-wolf)
-τορας /toras/ eg.,	-οια /ia/ eg., έννοια
αυτοκράτορας /aftokratoras/	/enia/ (concept/meaning)
(emperor)	
-ητής /itis/ eg., αθλητής	
/aθlitis/ (athlete)	

9.3. Results

Table 9.4 shows the performance of the clinical and the two comparison groups on the spelling measure of adjectives and nouns.

Table 9.4
Mean percentage scores for children/participants with dyslexia and comparison groups on the spelling dictation measure of adjectives & nouns

	Chronological- Age Controls (N=23)	Reading- Age Controls (N=27)	Children/Participants with Dyslexia (N=23)
Spelling of adjectival stems (% correct)	84.5 (11.6)	73 (11.6)	70.5 (11.1)
Min-max	54-100	43-93	50-92
Items	28	28	28
Spelling of noun stems (% correct)	93 (8.2)	83.6 (10.7)	79.2 (12.2)
Min-max	71-100	57-100	46-100
Items	28	28	28
Spelling of adjectival derivational suffixes (% correct)	77.5 (12.1)	64.7 (13)	55.6 (11.2)
Min-max	52-100	35-91	39-86
Items	23	23	23
Spelling of noun derivational suffixes (% correct)	88.1(11.7)	80.1 (11.9)	70.9 (14.2)
Min-max	59-100	54-100	50-100
Items	22	22	22
Spelling of adjectival inflectional suffixes (% correct)	97.2 (4.8)	92.2 (7.8)	90.4 (9.1)
Min-max	78-100	75-100	71-100
Items	28	28	28
Spelling of noun inflectional suffixes (% correct)	95 (2.8)	92 (4.7)	91.7 (6.3)
Min-max	86-96	82-96	71-100
Items	28	28	28

Note. N, Number of participants; standard deviations are in parentheses.

Three-way mixed analysis of variance was conducted to investigate children's performance on the grammatical spelling test of nouns and adjectives. The effect of three factors was investigated: group as the between-subjects factor, word type as the first within-subjects factor with two levels (noun and adjective), and word part as the second within-subjects factor with three levels (stem, derivational suffix and inflectional endings)¹. The analysis revealed a significant main effect of group ($F(2, 70) = 15.032, p \leq 0.001$). The CA control children were more accurate spellers than both the children/participants with dyslexia and the RA control children; the children/participants with dyslexia performed less accurately than the RA controls at both levels of word type and at all three levels of word part.

In addition the analysis revealed a significant effect of word type ($F(1, 70) = 151.202, p < 0.001$), whereby children performed better when they spelled the nouns rather than the adjectives. The interaction group by word type missed significance ($F(2, 70) = 2.381, NS$) indicating that the performance of each group did not differ across the two conditions.

A significant effect of word part was also found ($F(1, 70) = 154.248, p < 0.001$), whereby children performed better when they spelled the inflectional suffixes and the stem of the test items. The interaction group by word part was significant ($F(2, 70) = 6.626, p < 0.005$), indicating that the performance of the three groups changed between the three levels of word part. It seems that all participants and especially children/participants with dyslexia had greater difficulty with the spelling of derivational suffixes and word stems than the spelling of inflectional suffixes. Post hoc comparisons (LSD) further revealed that children/participants with dyslexia and younger reading-age controls performed

¹ Percentages were used in the analysis instead of raw scores, since the derivational suffixes were fewer than the stems and the inflectional suffixes of both adjectives and nouns.

significantly worse than the CA controls in spelling all three parts of both nouns and adjectives. The children/participants with dyslexia were significantly less accurate spellers than the RA controls in the spelling of derivational suffixes of nouns and adjectives ($p < 0.05$ and $p < 0.01$ respectively).

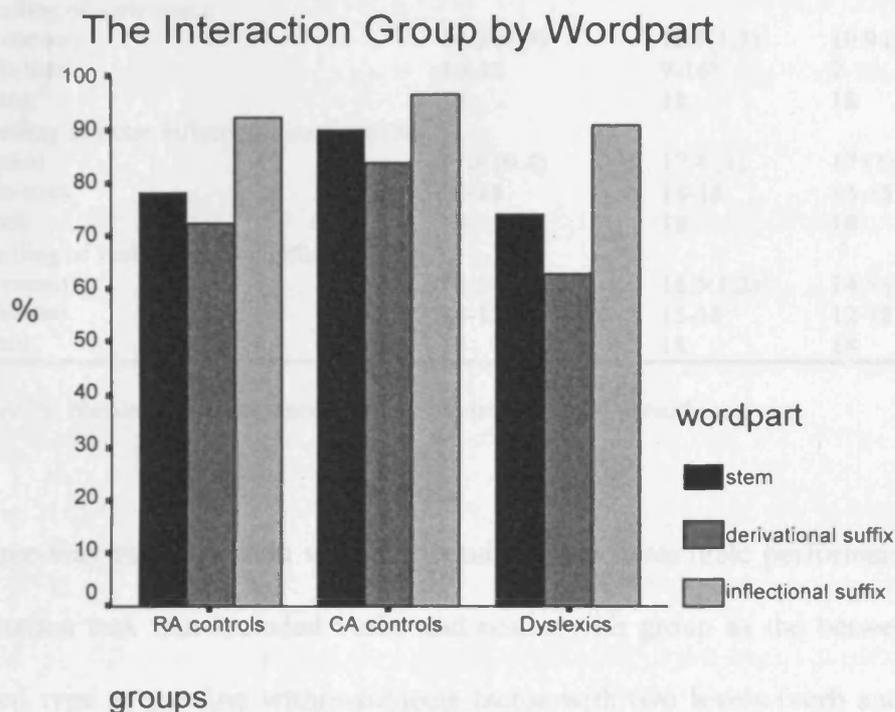


FIG. 9.1. Means for the interaction of group by wordpart (spelling of nouns & adjectives).

Table 9.5 shows the performance of the clinical and the two comparison groups on the spelling measure of nouns and verbs.

Table 9.5

Mean scores for children/participants with dyslexia and comparison groups on the spelling dictation measure of nouns & verbs

	Chronological- Age Controls (N=23)	Reading- Age Controls (N=27)	Children/Participants with Dyslexia (N=23)
Spelling of noun stems (N correct)	13.9 (3.6)	11 (2.9)	8.7(3.2)
Min-max	5-18	5-18	5-16
Items	18	18	18
Spelling of verb stems (N correct)	14.2 (1.9)	12.1(1.5)	10.9 (3.2)
Min-max	10-17	9-16	7-15
Items	18	18	18
Spelling of noun inflectional suffixes (N correct)	17.8 (0.4)	17.4 (1)	17 (1)
Min-max	16-18	14-18	15-18
Items	18	18	18
Spelling of verb inflectional suffixes (N correct)	16.5 (1.3)	16.5(1.2)	14.5 (1.8)
Min-max	14-18	15-18	12-18
Items	18	18	18

Note. N, Number of participants; standard deviations are in parentheses.

Three-way mixed Anova was also conducted to investigate performance on the spelling dictation task that included verbs and nouns with group as the between-subjects factor, word type as the first within-subjects factor with two levels (verb and noun), and word part as the second within-subjects factor with two levels (stem and inflection). The analysis indicated that there was a significant main effect of group ($F(2, 70)=19.412$, $p<0.001$). Children/participants with dyslexia achieved the lowest spelling score in comparison to both control groups; CA control children were the most accurate spellers.

The main effect of word type did not reach significance ($F(1, 70)=1.4$, NS); nouns were spelled at the same level as verbs across groups. The interaction group by word type was also not significant ($F(2, 70)=1.87$, NS). The performance of each group did not differ across the two conditions.

A significant main effect of word part was found ($F(1, 70) = 464.714, p < 0.001$), whereby participants were more accurate in spelling the word inflections than the word stems. The interaction group by word part was also significant ($F(2, 70) = 14.620, p < 0.001$), as there was a greater difference in the spelling performance of the clinical group and the two control groups when they spelled the stems than the inflectional suffixes of words. Post hoc tests (LSD) revealed that children/participants with dyslexia were significantly worse than the chronological-age control group in spelling both the stem and the inflection of both verbs and nouns (participants with dyslexia < CA controls, $p < 0.001$). Similarly the children/participants with dyslexia were significantly less accurate spellers than the RA controls when they spelled the stem of both verbs and nouns ($p < 0.05$), as well as the inflection of verbs ($p < 0.001$); however when they spelled the inflection of nouns, children/participants with dyslexia and RA controls did not differ (NS). The scores attained by the chronological-age controls when they spelled the stem of verbs and nouns ($p < 0.001, p < 0.005$) were significantly higher than those of the reading-age control children. When they spelled the inflection of both word types the two control groups' performance did not differ (NS).

The Interaction Group by Wordpart

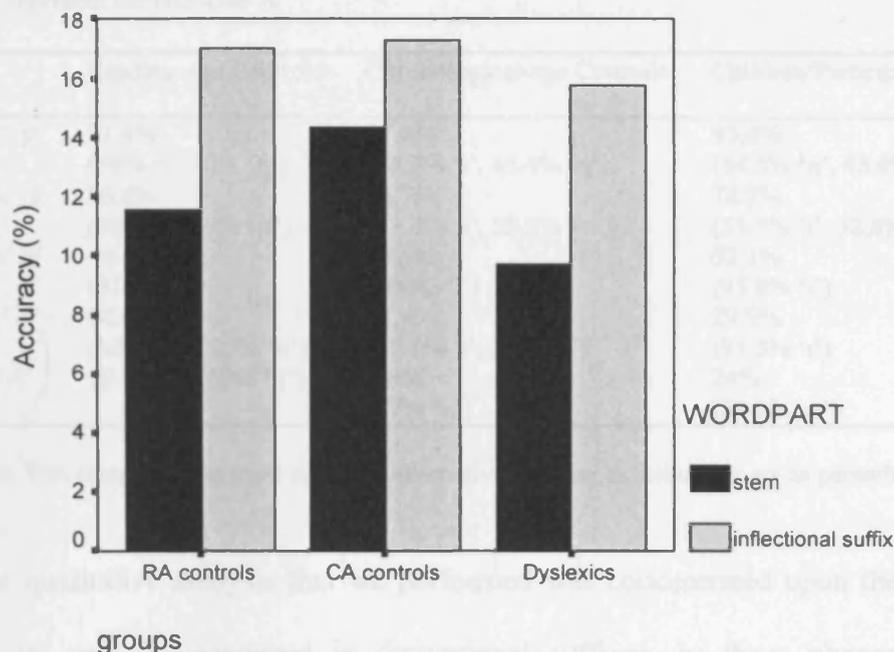


FIG. 9.2. Means for the interaction of group by wordpart (spelling of nouns and verbs).

A qualitative analysis of the spelling errors made by the children of the clinical group and the two control groups was undertaken in order to investigate which were the most common alternative vowel spellings. Tables 9.6 and 9.7 demonstrate the percentages of spelling errors in the vowels of adjectival and noun derivational suffixes, as well as the percentages of the most common alternative spellings.

Table 9.6
Percentages of children's spelling errors on the graphemes of adjectival & noun derivational suffixes that represent the phonemes /e/ & /o/

	Reading-age Controls	Chronological-age Controls	Children/Participants with Dyslexia
'ω' /o/	48.1 % (100% 'o')	41.2% (100% 'o')	76% (93% 'o')
'αι' /e/	29.6 % (95.4% 'ε')	15.1% (100% 'ε')	63% (93.7% 'ε')
'ε' /e/	30.4% (100% 'αι')	30.4% (96% 'αι')	34.7% (92% 'αι')
'o' /o/	10.1% (81.8% 'ω')	5.4% (100% 'ω')	10.8% (100% 'ω')

Note. Percentages of the most common alternative spelling substitutions are in parentheses.

Table 9.7

Percentages of children's spelling errors on the five graphemes of adjectival & noun derivational suffixes that represent the phoneme /i/

	Reading-age Controls	Chronological-age Controls	Children/Participants with Dyslexia
'υ' /i/	81.4% (50% 'ι', 50% 'η')	47.8% (54.5% 'ι', 45.4% 'η')	95.6% (54.5% 'η', 45.4% 'ι')
'οι' /i/	66.6% (50% 'ι', 50% 'ει')	34.7% (33.3% 'ι', 55.5% 'ει')	78.2% (55.5% 'ι', 38.8% 'ει', 5.5% 'η')
'ει' /i/	44.4% (91.6% 'ι')	19.5% (100% 'ι')	52.1% (95.8% 'ι')
'η' /i/	14.4% (82.2% 'ι', 25% 'υ')	13.4% (87.5% 'ι', 25% 'υ')	29.9% (91.3% 'ι')
'ι' /i/	19.4% (69% 'η')	8.6% (77% 'η')	24% (59.1% 'η')

Note. Percentages of the most common alternative spelling substitutions are in parentheses.

The qualitative analysis that we performed was concentrated upon the vowel phonemes /i/, /e/, and /o/ contained in derivational suffixes, as these phonemes are the most inconsistently spelled due to the existence of two or more spelling patterns for representing them. It can be seen that children/participants with dyslexia have made the most errors than both control groups. The majority of errors occurred in the case of spelling the vowels 'υ' /i/, 'οι' /i/, 'ω' /o/, 'αι' /e/, and 'ει' /i/ across groups and word type. The minority of spelling mistakes occurred in the spelling of the vowels 'η', 'ι' (both produce the sound /i/) and 'ο' /o/ across groups and word type.

It was found that the children of the experimental and the two control groups made the most spelling errors when the vowel phonemes in question were represented by less common spelling patterns; in particular the mistaken written representation of the phonemes included the most common spelling pattern. For instance in the case of the phoneme /o/ children made more errors when the suffixes were spelled with 'ω' and used the most common alternative spelling 'ο'. On the contrary children were accurate approximately 90% of the time when they spelled the 'ο'. Similarly in the case of the

phoneme /i/ children were less accurate when the phoneme was represented by less common vowel spellings, such as ‘v’ and the diphthong ‘ei’; again children used the most common alternative spelling patterns to represent this phoneme (i.e., ‘i’ and ‘η’).

A close inspection of table 9.7 reveals an interesting pattern. When the children spell the derivational suffixes that include the vowel ‘η’ /i/, the children of the two control groups seem to be more able to use more than one alternative spellings in comparison to the group of children/participants with dyslexia; they use the most common spelling ‘i’ (about 85% of the time), but they also use the less common spelling ‘v’ (25% of the time).

Another striking pattern was revealed; children of both control groups were less accurate in representing the common spelling ‘ε’ than the less common spelling ‘αι’ as would have been expected. This finding indicates that these children have adopted the diphthong ‘αι’ in their repertoire, in contrast to children/participants with dyslexia who seem to have difficulties with this spelling pattern; as a result the probability of writing the ‘ε’ spelling correctly was decreased (Bryant et al., 1999).

9.4. Discussion

The comparison between children/participants with dyslexia and chronological and reading-age control children’s performance on the grammatical spelling measures revealed interesting results. The analysis of variance performed on the spelling dictation task of adjective-noun pairs showed that the children of all three groups made the most spelling errors on the vowels included in derivational suffixes. The spelling of inflectional suffixes, as well as stems (but to a lesser degree), proved to be an easier task for the

children of the present sample. Even the children of the chronological-age control group (Mean CA: 11.9) were less accurate in spelling the derivational suffixes than the other two word parts. This finding agrees with the study by Sterling (1983) who showed that twelve-year-olds do not appear to analyze the morphological components of derived words, such as 'closely'. Fischer and his colleagues (1985) found that even some adult spellers are not able to incorporate complex derivational relations (for example, the relation between 'courage' and 'courageous'). Similarly, reading-age control children made most spelling errors in the vowels of derivational suffixes rather than in the vowels of the other two parts and were significantly worse than the chronological-age control children. It seems that children's sensitivity to derivational morphology and the ability to incorporate this kind of knowledge into spelling is a growing process. Henderson's (1985) study showed that the use of derivational morphology in children's spelling does not take off until they are in the third grade of primary school.

Children's/participants' with dyslexia spelling performance on the three parts of both adjectives and nouns was significantly lower than the performance of same-age typically developing children. Moreover, when the spelling performance of children/participants with dyslexia was compared to that of reading-level-matched control children, it was shown that the former group was significantly worse in the spelling of derivational suffixes of both word types (adjective, noun). This finding could be understood in terms of the linguistic properties of derivational suffixes. According to Peters (1997) grammatical morphemes within words tend to be acquired from outside in, with inner slots being left empty at first, and maybe being filled with protomorphemes at a later stage; as a result morphemes that are situated in the inner recesses of a word are difficult to be perceived. Evidence from studies in West Greenlandic Eskimo indicated that the

first combinations to appear are of stems, which are word-initial and inflections which are word-final. Derivational markers, which are word-internal appear later (Fortescue et al., 1992). Early stage Turkish learners were found in some cases to employ “meaningless syllables” to approximate the passive and causative articles that occur in the middle of multi-morphemic verb forms (Asku-Koç et al., 1985). Unlike derivational suffixes that are located in the inner part of words, inflectional suffixes have a final word position that seems to facilitate their acquisition by young learners.

The acquisition of grammatical morphemes is relatively easy when the morphemes occur frequently, have an easily recognizable form, keep a fixed position relative to an open-class stem, have a specific function, and are easy to segment (Peters, 1997). Inflectional morphemes hold more than one of these properties. Slobin (1973) suggested that morphemes of final position play a characteristically significant role, as they can be easily segmented and occupy a salient position. Studies in Japanese and Mandarin showed that sentence-final particles are produced early (Erbaugh, 1992; Tardif, 1994). In Hebrew even children with specific language impairments seem to have very few difficulties with inflections, which are clause-final and stressed or lengthened (Dromi et al., 1993).

Research on the influence of linguistic characteristics of shallow orthographies on readers' word recognition skills has pointed out the importance of the inflectional suffix in word reading. Chitiri and Willows (1994) assessed seventy-two English- and sixty-five Greek-speaking students (age range 15-17 years) on a letter cancellation task among others, whereby children had to cross out every instance of a certain target letter that they noticed while they were reading a short text. It was assumed that readers tend to detect the letters that are processed consciously and miss the ones that are not. In addition

omissions were thought to reflect word processing factors. The results indicated that Greek readers were consistently paying more attention to the last syllable, which carried the inflection, in contrast to their English counterparts who appeared to attend more to the initial parts of the word. Omission patterns revealed that Greek readers missed target letters in the inflections less often than the letters in the first or second syllable. Similarly studies in Italian – a highly transparent language- have shown that inflections can differentiate children’s reaction time to verbs (Jarvella, Job, Sandstrom, & Schreuder, 1987).

The focus of the present study was the spelling of derivational and inflectional suffixes by children/participants with dyslexia and typically developing children and not the acquisition of these morphemes by young learners, or their effect on word recognition. However, the studies mentioned thus far provide an indication of the difficulty that derivational suffixes may cause in their acquisition by children. On the other hand it has been shown that inflections are acquired more easily and earlier than derivational suffixes, and also they facilitate readers’ lexical access. The “difficult” linguistic characteristics of derivational morphemes as opposed to the “easy” linguistic properties of inflections may account for the spelling problems that the children of the present sample – and especially those in the group of children/participants with dyslexia – experienced.

Another argument concerning the finding that children were less accurate in spelling the vowels of derivational suffixes rather than those of inflectional suffixes could be made on the basis of the teaching instruction on Greek morphology. Greek children are taught in an explicit and systematic way about inflectional morphology during the literacy hour

through most grades of primary school and early secondary school. The grammatical function of verbs, nouns and adjectives, as well as their inflectional properties in combination to the spelling of their inflection, forms an important objective of the Greek educational curriculum. Nevertheless, the teaching instruction of Greek derivational morphology and how this information could facilitate children's spelling skills is rather less often and not as explicit and systematic. In some cases the teaching emphasis on derivational morphology may be dependent on the individual initiative of the teacher.

The statistical analysis on the spelling dictation task of adjective-noun pairs also revealed an advantage of nouns over adjectives; the suffixes of nouns were spelled more accurately than those of adjectives. This difference could be attributed again to the nature of teaching instruction. Simply more teaching emphasis may be placed on the morphology of nouns and less of adjectives. On the other hand, this difference in performance between these two grammatical categories of words could be the artefact of a word frequency effect that was not controlled for in the present study.

The comparison between children's/participants' with dyslexia and control children's performance on the spelling dictation task of noun-verb sentences confirmed the results of the adjective-noun spelling measure, whereby inflectional suffixes posed fewer spelling difficulties to children. It should be noted that in the present task verbs and nouns were compared in relation to their stem and inflection. Derivational suffixes were not included in the analysis, since Greek verbs can only be divided into two parts, stem and inflection. Overall children were more accurate spellers of inflectional suffixes included in both verbs and nouns, and were less accurate spellers of the stem of these two word types. Moreover children were more accurate when they spelled the stem of verbs than the stem

of nouns; on the contrary they were more accurate when they spelled the inflection of nouns than verbs. The fact that children found the spelling of noun stems more difficult than the verb stems might be due to the scoring system that was employed for this test. As already mentioned Greek verbs are only divided into stem and inflection; due to this limitation we were forced to divide the nouns into two parts as well. This meant that the derivational suffix of any noun was counted as part of the stem. Children's possible spelling errors in the derivational suffix of nouns would therefore have been regarded as spelling mistakes in the stem.

According to the present findings the majority of children's spelling errors occurred in the inflection of verbs than that of nouns. This result reflects the complexity of the Greek verb morphology. As mentioned in the introduction of this chapter, Greek verbs are inflected for person, number, tense and mood, whereby Greek nouns are inflected only for gender, case and number. It could be argued that this finding contradicts in a way Titos and his colleagues' argument (2003) that children use their morpho-syntactic knowledge for spelling the suffixes of verbs than nouns. In the present study the opposite pattern was found. In addition these authors' observation that the percentage of correct spellings of verb and noun inflections grows progressively as children advance in school grades, was also not supported by our study, according to which chronological-age and reading-age control children spelled the inflection of both verbs and nouns at the same level.

The statistical analysis conducted on the spelling task of noun-verb sentences also shed light on the difficulties that children/participants with dyslexia face when they have to spell the stem and inflection of both grammatical categories of words. They were found to perform significantly worse than their typically developing counterparts and the younger

reading-level matched controls; in the case of spelling the noun inflections, the latter and the experimental groups did not differ. It is apparent that children/participants with dyslexia have not altogether grasped the morphological spelling rules of the Greek orthography, and in consequence lack the ability to apply this knowledge to the spelling of the morphologically complex verb suffixes.

The qualitative analysis performed on children's spelling errors when they write the derivational suffix of adjectives and nouns allowed us to examine in some detail the kind of alternative spellings they use and the frequency with which these occur. Children of all three groups (children/participants with dyslexia made the most errors) were found to misspell the vowel phonemes that were represented by the less common Greek spelling pattern, and in turn they used the most common one. The present results are in line with Barry and Seymour's study (1988) which revealed a substantial sound-to-spelling-contingency effect; this meant that children produced more high-contingency (common) spelling patterns of vowels than low-contingency (rare) spellings. Within high-contingency spellings the most common spelling correspondence of vowels was produced more frequently than the second most common, whereas within low-contingency spelling patterns phonologically plausible spellings were produced more frequently than irregular ones.

Evidence from studies in Portuguese (Nunes Carraher, 1985; Nunes, 1992) and Greek (Bryant et al., 1999) have demonstrated that there is a developmental sequence in the use of alternative spelling patterns for representing vowel phonemes in words. At first children show a distinct preference for one spelling choice, but as they advance in years and reading experience there is an increase in the use of alternative spellings. Our data

provides support to previous findings. The children/participants with dyslexia showed a preference for one or two alternative spellings for representing the vowel phonemes of derivational suffixes. On the other hand the control group children and especially those in the chronological-age control group were aware of more spelling patterns, and even the rare ones. A characteristic example is the case of the less common diphthong 'αι' which was used by chronological-age controls more accurately than the more common spelling 'ε' to represent the phoneme /e/. The study by Bryant, Nunes and Aidinis (1999) revealed a similar pattern. Children who had started to adopt the 'ω' spelling, as well as the 'ο' spelling (both represent the phoneme /o/) were correct in only ninety-three per cent of the words ending in the common 'ο' spelling. The authors argued that the probability of writing the words ending in 'ω' correctly increased, but at the same time the probability of spelling the 'ο' correctly decreased.

Overall the data presented in this study has emphasised the importance of morphological information in the spelling of word suffixes by both normally developing young individuals and children/participants with dyslexia. Knowledge of inflectional morphology is a necessary requirement for spelling correctly word endings. It has been shown that children of ten to twelve years approximately have internalised and generalised the morpho-grammatical information necessary for spelling the ending of nouns, adjectives and verbs. Children/participants with dyslexia still have weaknesses in applying morphological information in the spelling of word endings when compared to their typically developing peers. However they appear to perform at the same level with the younger reading-level matched control children with the exception of the spelling of verb inflections.

Moreover the present study has established the substantial role of derivational morphology in word spelling. It has been clearly stated that the derivational suffix is the part of a word that both children/participants with dyslexia and control children have most spelling difficulties with. It is therefore suggested that teaching of derivational morphology at Greek schools is imperative. A systematic and explicit teaching approach to derivational morphology and the spelling of derivational suffixes will be particularly effective for young spellers and especially those who suffer from developmental dyslexia. The causal role and the effectiveness of derivational morphology in spelling could be further tested in intervention studies.

Chapter 10. General Discussion

The goal of the present thesis was to gain an insight in the nature of dyslexia and dysgraphia in the transparent orthography of Greek in relation to normal development. In order to meet our aim three studies were conducted: a longitudinal study of Greek children/participants with dyslexia and normally developing children's literacy abilities, a cross-linguistic comparison between Greek and English children/participants with dyslexia, and a cross-sectional study on Greek children's ability to spell derivational and inflectional suffixes.

Overall our findings suggest that the manifestation of dyslexia is dependent on the complexity of the orthography in which children learn to read and spell. Similarly to English children/participants with dyslexia, Greek children/participants with dyslexia had phonological processing and decoding difficulties; however their difficulties appeared

less severe due to the effect of the orthographic transparency of Greek. This assumption was based on the finding that Greek children/participants with dyslexia were more accurate than English children/participants with dyslexia on word and nonword reading accuracy, as well as on phoneme deletion, but impaired relative to their same-age normally developing peers. On the other hand English children/participants with dyslexia were impaired in relation to both control groups.

The effect of orthographic transparency on children/participants with dyslexia's word and nonword reading speed did not appear as strong. The cross-linguistic comparison clearly showed that, although Greek children/participants with dyslexia were significantly faster than English children/participants with dyslexia in both word and nonword reading, both language groups were impaired relative to same-age normal readers and not relative to younger normal readers (English children/participants with dyslexia were significantly slower than same-age normal readers only in the case of regular word reading; they did not differ significantly from same-age normal readers in nonword reading speed).

An important aim of the present thesis was to explore the phonological and orthographic spelling skills of Greek children/participants with dyslexia. Our results from Time 2 data showed that children/participants with dyslexia have an orthographic spelling deficit, as they were significantly poorer spellers than same-age and younger normal spellers, and persistent phonological spelling difficulties. It was found that children/participants with dyslexia's phonological recoding problems had not resolved by the first grades of secondary school; they were less accurate in representing the phonological structure of words than their normally developing peers. These findings are strong evidence in favour of the phonological deficit hypothesis, which postulates that children's poor spelling

derives from poor phonological processing skills; these skills are necessary for the acquisition of phonological recoding skills, which in turn form the foundation for developing orthographic spelling skills.

In line with the phonological deficit hypothesis the present longitudinal study found evidence of a phonological deficit among Greek children/participants with dyslexia, who performed significantly poorer than same-age and younger normal readers on phoneme deletion of nonwords, and on nonword reading (accuracy and speed) at the second test time. These findings contradict the hypothesis that children/participants with dyslexia who read in more transparent orthographies than English, resolve their phonological processing difficulties by the end of second grade approximately, and that children/participants with dyslexia's impaired spelling skills can be explained in terms of a malfunctioning timing mechanism responsible for the formation of grapheme-phoneme associations (Landerl and Wimmer, 2000; Wimmer, 1993).

The present studies revealed significant differences between Greek children/participants with dyslexia and younger normally developing children only at the second time of assessment. The lack of differences between the two groups at the first test time could be attributed to the age of the reading-level-matched children. These children were second graders and their phonological processing and decoding skills were still inadequate, resulting in low performance on the difficult tasks of phoneme awareness and nonword reading.

Our findings stressed the importance of phoneme awareness skills on the development of reading ability, as well as on the acquisition of phonological and conventional spelling

skills. Children's/participants' with dyslexia assessment at the second test time revealed that they suffered a phonological processing and decoding deficit. In addition the investigation of the longitudinal predictors of reading and spelling among children/participants with dyslexia and typically developing children emphasised the importance of phoneme awareness in the development of reading skills among younger normal readers and phonological and orthographic spelling skills for both normal and children/participants with dyslexia. Our results could be accommodated by current connectionist models of reading development (Harm and Seidenberg, 1999; Plaut, McClelland, Seidenberg and Patterson, 1996). In contrast to the original parallel-distributed-processing model (Seidenberg and McClelland, 1989), which used coarse-coded distributed representations, the new model used local representations of graphemes and phonemes at input and output levels. The operation of mappings between phonology and orthography at this fine-grained level enabled the system to effectively generalize to new words and nonwords. Phoneme awareness skills show whether children have well-specified phonological representations, which in turn are necessary for creating efficient mappings between graphemes and phonemes. Within the connectionist model it is not surprising that phoneme awareness skills were significant predictors of later development of reading and spelling skills.

The findings reported in the present thesis have significant practical implications. It has been clearly shown that phoneme awareness skills, as well as reading and spelling skills, can promote the development of later reading and spelling abilities of both children/participants with dyslexia and normally developing children. Therefore phoneme awareness instruction should be part of the school curriculum along with reading and spelling instruction.

The present thesis highlighted the significance of derivational and inflectional morphology in learning to spell. Based on this evidence it is suggested that explicit and systematic instruction on the spelling of derivational and inflectional suffixes would be extremely effective for the development of children's spelling skills.

An additional practical implication concerns the methods for identifying children/participants with dyslexia. Our findings suggest that phonological awareness measures are informative and useful in the diagnosis of dyslexia in Greek despite the effect of orthographic transparency on children's phonological skills. Moreover our data has established the diagnostic value of spelling measures.

The present thesis has important limitations that are summarised in the following: Some of the characteristics of the English children/participants with dyslexia might have influenced the results of the cross-linguistic comparison. In particular most of the children/participants with dyslexia had received specialized reading instruction. Similarly the characteristics of the reading level control group could have affected the results of the cross-linguistic study. Most of the children of this group were recruited from a school in a deprived area of London and possibly they had poor reading opportunities outside the school settings.

Another limitation regards the investigation of children/participants with dyslexia's spelling skills. The spelling measures administered at first assessment, as well as for the purposes of the cross-linguistic study did not assess children's phonological spelling skills. The assessment of Greek children/participants with dyslexia' phonological recoding skills in comparison to those of English children/participants with dyslexia, as

well as the investigation of phonological spelling as a long-term predictor of later reading and conventional spelling would shed more light on the role of phonology on reading and spelling among children/participants with dyslexia and normal readers of a transparent orthography.

In conclusion it is suggested that large-scale longitudinal studies and detailed cross-linguistic studies will better explain the nature of cognitive and literacy difficulties experienced by children/participants with dyslexia of shallow orthographies.

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APPENDIX I

Towre Word Efficiency Test: Greek Version

σιγά	άγαλμα	εγχείριση
γιαγιά	αυλή	διανυκτερεύω
ψηλά	κάποια	αρχαιολόγος
βροχή	μηχανή	διευθύνω
κοντά	άνθρωπος	εκκωφαντικό
χρόνια	εκείνοι	θέλγητρο
δρόμος	άνοιξη	ευγνωμονώ
χωριό	αυτοκίνητο	αυτάρκης
φύλλα	γυναίκα	εγκαθιδρύω
νερό	δημοσιογράφος	απόφθεγμα
κόσμος	δουλεύει	παρρησία
νύχτα	κυνηγός	ακτοπλοϊκός
φωτιά	εφημερίδες	αναντίρρητος
ύστερα	τηλεόραση	υιοθεσία
δάσκαλος	εμπιστοσύνη	ευνοϊκός
θάλασσα	ιδιοκτησία	συγχαρητήρια
ανάμεσα	χειροκρότημα	δυλιστήριο
στιγμή	εκμετάλλευση	φερέγγυος
πρόσωπο	οικογένεια	εξωραϊσμός
καράβι	ελεύθερος	παλιγγενεσία
πράγματα	συνέντευξη	ελλόγιμος
μπορεί	ενημέρωση	παυσίλυπος
δέντρο	ναυάγιο	εχέγγυο
νησί	επιχειρηματίας	παλιννόστηση
τραγούδι	υπερωκεάνιο	επευφημώ
ειρήνη	αλληγορικό	
γρήγορα	συσσώρευση	

APPENDIX II

The Greek and English Tasks of Phoneme Deletion, Spoonerisms and Rapid Digit Naming

APPENDIX IIa

The Greek Phoneme Deletion Task of Words

Instructions: “Listen very carefully, I will say a word. The word is *τρένο*. Can you repeat it?” “Good. Now I will ask you to take a sound away. Can you say *τρένο* without the /t/?”

Trial items: *τρένο* /treno/, *παντρεία* /padria/, *κότα* /kota/, *κοπάδι* /kopaði/, *άντρας* /adras/.

Experimental items

A. Consonant cluster structure

στα /sta/ (Initial position)
προς /pros/ (Medial position)

φρένο /freno/ (Initial position)
κάστρο /kastro/ (Medial position)

μπριζόλα /brizola/ (Initial position)
πάμπλουτος /pamblutos/ (Medial position)

B. Open CV syllable structure

των /ton/ (Initial position)
λες /les/ (Final position)

πίτα /pita/ (Initial position)
βάζο /vazo/ (Medial position)
μάγος /magos/ (Final position)

φιδάκι /fiðaki/ (Initial position)
ψαλίδι /psalidi/ (Medial position)
γερανός /jeranos/ (Final position)

APPENDIX IIb

The Greek Phoneme Deletion Task of Nonwords

Instructions: “Listen very carefully, I will say a funny made up word. The funny word is *τρείδι*. Can you repeat it?” “Good. Now I will ask you to take a sound away. Can you say *τρείδι* without the /t/?”

Trial items: *τρείδι* /triði/, *λεστό* /lestó/, *μέζος* /mezós/, *χάτι* /xati/, *σάντρικα* /sadrika/.

Experimental items

A. Consonant cluster structure

σπο /spo/ (Initial position)
φρεις /fris/ (Medial position)
φλέκω /fleko/ (Initial position)
λάστρο /lastro/ (Medial position)
κρυφώνω /krifono/ (Initial position)
καμπρέλα /kabrela/ (Medial position)

B. Open CV syllable structure

φους /fus/ (Initial position)
μωγ /mon/ (Final position)
σέκο /seko/ (Initial position)
λήτα /lita/ (Medial position)
πύφος /pifos/ (Final position)
πέτωμο /petomo/ (Initial position)
χαρεπός /xarepos/ (Medial position)
νέρανος /neranos/ (Final position)

APPENDIX IIc

The English Phoneme Deletion Task of Words

Instructions: “Listen very carefully, I will say a word. The word is *train*. Can you repeat it?” “Good. Now I will ask you to take a sound away. Can you say *train* without the /t/?”

Trial Items: *train*, *country*, *cat*, *cup*, *body*

Experimental Items

A. Consonant Clusters

- | | |
|-------------|---|
| 1 Syllable | <u>s</u> top (Initial position)
p <u>r</u> ice (Medial position)
mon <u>k</u> (Final position) |
| 2 Syllables | <u>f</u> riday (Initial position)
pa <u>s</u> try (Medial position)
fore <u>s</u> t (Final position) |
| 3 Syllables | <u>b</u> rocoli (Initial position)
pub <u>l</u> icer (Medial position)
eleph <u>a</u> nt (Final position) |

B. Open CV Syllable

- | | |
|-------------|---|
| 1 Syllable | <u>t</u> ea (Initial position)
bu <u>s</u> (Final position) |
| 2 Syllables | <u>p</u> ony (Initial position)
la <u>z</u> y (Medial position)
ros <u>e</u> s (Final position) |
| 3 Syllables | <u>f</u> amily (Initial position)
me <u>l</u> ody (Medial position)
garag <u>e</u> s (Final position) |

APPENDIX II*d*

The English Phoneme Deletion Task of Nonwords

Instructions: “Listen very carefully, I will say a funny made up word. The funny word is *treppy*. Can you repeat it?” “Good. Now I will ask you to take a sound away. Can you say without the /t/?”

Trial items: *treppy*, *lambric*, *boonies*, *nosty*, *foral*.

Experimental Items

A. Consonant Clusters

- 1 Syllable spo (Initial position)
 frot (Medial position)
 nistl (Final position)
- 2 Syllables floty (Initial position)
 lostrel (Medial position)
 prodentl (Final position)
- 3 Syllables crotipal (Initial position)
 sambrella (Medial position)
 mitaronk (Final position)

B. Open CV Syllable

- 1 Syllable fet (Initial position)
 ponn (Final position)
- 2 Syllables sacant (Initial position)
 retal (Medial position)
 foses (Final position)
- 3 Syllables kelody (Initial position)
 derital (Medial position)
 malages (Final position)

APPENDIX IIe

Greek Spoonerisms

1. Καλή νύχτα /kali nichta/
2. μικρό χέρι /mikro heri/
3. παιδική χαρά /pediki hara/
4. πάνω-κάτω /pano kato/
5. τυρί φέτα /tiri feta/
6. κακός λύκος /kakos likos/

1. φρέσκο κέικ /fresko kaik/
2. πρόγραμμα τηλεόρασης /programa tileorasis/
3. κρέμα παγωτό /krema pagoto/
4. πλαστικό κουτί /plastiko kouti/
5. τρελή πορεία /trelī poria/
6. κόκκινη φλόγα /kokini floga/

APPENDIX II

English Spoonerisms

Experimental Items

A. Open CV Syllables

7. naughty cat
8. minute hand
9. happy people
10. pencil case
11. tuna fish
12. candle light

B. Consonant Clusters

7. fresh cake
8. television programme
9. Christmas pudding
10. plastic can
11. trusting person
12. corn flakes

APPENDIX IIg
Rapid Digit Naming (Form A)

Form A

7 2 6 7 3 6 3 2 8

2 6 5 8 3 2 5 8 7

6 8 3 6 5 7 2 8 5

5 6 5 2 7 3 7 3 8

APPENDIX IIh
Rapid Digit Naming (Form B)

Form B

6 2 5 6 3 5 3 2 8

7 3 8 5 7 3 6 2 5

2 5 8 6 3 7 6 8 7

8 2 3 7 6 2 5 7 8

APPENDIX III

The Greek and English Tasks of Regular Word and Nonword Reading

APPENDIX IIIa

Regular Words of English and Greek Reading Task

the	το
end	ένα
trip	τρία
opera	όνομα
spider	σπίτι
potato	πατέρας
memory	μητέρα
pajamas	παλάτι
papyrus	πάπυρος
magical	μαγικό
embassy	έμφαση
mastery	μυστήριο
symmetrical	συμμετρικό
monastery	μοναστήρι
photographer	φωτογράφος
strategic	στρατηγικός
estimation	εκτίμηση
morality	μεταφορά
ideology	απολογία
arithmetical	αριθμητικό
animosity	ανωνυμία
chronological	χρονολογικός
anatomical	ανατομικό
disability	δοσοληψία
characteristical	χαρακτηριστικά

APPENDIX IIIb

Nonwords of Greek Nonword Reading Task

φο
έπα
πρία
ότημα
σπότι
κατέρας
σητέρα
λαπάτι
πάρυτος
γαρικό
ήμφεση
μυρήστιο
συμματρικό
ναμηστόρι
θαμωγράφος
στηγατικός
εκτόσημη
ταμεφορά
αλοπογία
αρεθμοτικό
αμωνυτία
χρονογολικός
ανοταμικό
σολοδηψία
χιρηκταριστικά

APPENDIX IIIc

Nonwords of English Nonword Reading Task

po
mep
prit
migot
skoter
karetos
silera
lapaty
paritus
yarito
impesy
myrister
trisymecal
namistery
thamostraper
strangtition
eloctenic
amephora
apelogy
athomatical
amonity
nogachrolikos
amonatic
solothipser
chirictaristic

APPENDIX IV

The Greek and English Tasks of Orthographic Proof Spelling,
Spelling of Suffixes and Morphological Proof Spelling of Words
and Nonwords

APPENDIX Iva

The Greek and English Orthographic Proof Spelling Tasks

1.	θάλασα begining	θάλλασα begginning	θάλλασσα beggining	<u>θάλασσα</u> <u>beginning</u>
2.	φήλλα <u>leaves</u>	<u>φύλλα</u> leeves	φίλλα leives	φοίλλα lieves
3.	δάχτιλα moonies	δάχτηλα <u>movies</u>	<u>δάχτυλα</u> mounies	δάχτειλα moonys
4.	σίμερα <u>today</u>	<u>σήμερα</u> todey	σύμερα todai	σοίμερα toda
5.	παραμήθι <u>fairy tale</u>	παραμίθι fery tale	παραμοίθι fairee tale	<u>παραμύθι</u> ferea tale
6.	<u>σύννεφα</u> <u>seasons</u>	σύνναιφα seesons	σύνεφα seisons	σύναιφα sysons

7.	γλώσσα <u>glue</u>	γλόσα gloo	<u>γλώσσα</u> glu	γλόσσα glou
8.	δήναμη powir	δίναμη powur	δείναμη pouer	<u>δύναμη</u> <u>power</u>
9.	είδειση odience	<u>είδηση</u> <u>audience</u>	ήδειση odyence	ήδηση awdience
10.	χρηάζεται cryticize	χριάζεται critycise	χροιάζεται criteecize	<u>χρειάζεται</u> <u>criticize</u>
11.	<u>χειμώνας</u> <u>winter</u>	χημώνας wintir	χιμώνας wintur	χυμώνας wintar
12.	ησιχία <u>health</u>	<u>ησυχία</u> helth	υσηχία haelth	ησειχία halth
13.	ελλάτωμα eficiency	ελάτωμα efishency	<u>ελάττωμα</u> <u>efficiency</u>	ελάττομα effishency

14.	<u>συνοικία</u> <u>salmon</u>	συνικία solmon	συνηκία somon	συνεικία samon
15.	έλληψη ilusion	έλειψη ilousion	έλλιψη illousion	<u>έλλειψη</u> <u>illusion</u>
16.	εγχίριση encaragement enkeragement	<u>εγχείριση</u> <u>encouragement</u>	εγχύριση enkaragement	εγχοίριση
17.	επιδιώρθωση identifycaytion	επιδιόρθωση identificaytion	επιδειόρθωση identificaition	<u>επιδιόρθωση</u> <u>identification</u>
18.	μειαιυτήρας <u>exhaustion</u>	<u>μαιευτήρας</u> exhawstion	μαιεφτήρας exhoastion	μειαιφτήρας exhostion
19.	δίικηση <u>decrease</u>	διύκηση decreese	διείκηση decreise	<u>διοίκηση</u> decriese
20.	εγκύηση parashute	εγγείηση parashoot	<u>εγγύηση</u> <u>parachute</u>	εγγίηση parachout

APPENDIX IVb

The Greek Spelling Task of Suffixes

1. Ο Νίκος και ο Γιώργος είναι συμμηρητές. Τα σπίτια των δυο συμμηρητ(ώ)ν είναι κοντά.
2. Η πρώτη εφάληση ήταν εύκολη. Οι υπόλοιπες εφαλήσ(ει)ς ήταν δύσκολες.
3. Τα περισσότερα γαρήτια είναι καθαρά. Ένα μόνο γαρήτ(ι) είναι βρώμικο.
4. Τα χρατεία έχουν μεγάλα συρτάρια. Τα συρτάρια των χρατεί(ω)ν είναι άσπρα.
5. Σήμερα η Άννα γουτιάζει από το πρωί. Χτες δεν γούτιασ(ε) καθόλου.
6. Μου αρέσει να τροβίζω. Εσάς σας αρέσει να τροβίζετ(ε);
7. Τα ήτρια ζώα ζουν ελεύθερα. Η ζωή τ(ω)ν ήτρι(ω)ν ζώ(ω)ν διαφέρει από τη ζωή των κατοικίδι(ω)ν ζώ(ω)ν.

8. Ο Ανδρέας είναι ένας ταρεφής μαθητής. Οι εργασίες τ(ω)ν ταρεφ(ώ)ν μαθητ(ώ)ν δίνονται στην ώρα τους.
9. Η σούπα που έφαγα το μεσημέρι ήταν λαρή. Οι λαρ(έ)ς σούπ(ε)ς δεν μου αρέσουν.
10. Το καινούργιο παντελόνι του αδερφού μου είναι κορπύ. Τα κορπ(ιά) παντελόν(ια) φαίνονται αστεία πάνω του.
11. Ο σκύλος του γείτονα μας είναι βεχικός. Οι βεχικ(οί) σκύλ(οι) σε αφήνουν να παίζεις μαζί τους.
12. Ο διευθυντής του εργοστασίου κάθε χρόνο στερύει κάποιον εργάτη. Πέρσι οτέρ(υ)σ(ε) δυο εργάτες.
13. Κρελαίνομαι όταν έρχεται η άνοιξη. Φέτος την άνοιξη δεν μας έκανε καλό καιρό, γι' αυτό δεν κρελάθ(η)κ(α) καθόλου.
14. Το χειμώνα ράχυνα αρκετά από το πολύ φαγητό. Συνήθως δεν ραχ(αί)ν(ω) τόσο.
15. Όλοι οι λαοί ετώθηκαν για να σταματήσει ο πόλεμος. Όταν οι λαοί ετών(ο)ντ(αι) επικρατεί η ειρήνη.

16. Μου αρέσει να πείχνω τη συλλογή μου από γραμματόσημα. Χτες το πρωί την έπ(ει)ξ(α) σε μια φίλη μου.

17. Χτες ο πατέρας με αντάλ(ει)β(ει)ς τον άλλον για τις καλές του πράξεις. Είναι ωραίο να ανταλ(ει)β(ει)ς τον άλλον για τις καλές του πράξεις.

18. Κάθε χρονιά πρατεύομαι για τις καλές μου επιδόσεις στον αθλητισμό. Δυστυχώς πέρσι δεν πρατεύτ(η)κ(α).

APPENDIX IVc

The English Spelling Task of Suffixes

1. Nick and George are ronds and their houses are next to each other.

The two rond__ houses are next to each other.

2. The first blurch was easy to solve. The rest of the blurch__ were difficult.

3. I norry the cat in the morning. My sister norr__ the cat in the evening.

4. I have one delf with big drawers in every room of the house. All the del__ big drawers are white.

5. Today Anna gaires all day. Yesterday she also gair__ all day long.

6. Moxes live for two hundred years. Moxe__ lives are longer than the lives of humans.

7. Most of the prushes are clean. Only one pru__ is dirty.

8. Andrew is a fouse in his class. All fous__ essays are given to the teacher on time.

9. I will have a riss for lunch. Yesterday I had two riss__ for lunch.

10. My brother's new cotty is baggy. All his baggy cott__ look funny on him.

11. This vock is very friendly. All the friendly vock__ enjoy playing with children.

12. Every year the factory manager lerates a worker. Last year he lerat__ two workers.

13. The dog often nolds me. Yesterday I was n__ all day by the dog.

14. Last winter I kaid because I ate a lot of food. Usually I eat less food and don't ka__ that much.

15. The nations have to dool to make the war stop. When the nations get dool__, there is peace.

16. I like to kove my stamp collection. Yesterday morning I kov___
my collection to a friend of mine.

17. Yesterday my father lissed me for my good behaviour. I like it
when my father liss___ me for my good behaviour.

18. Every year people mart me because of my excellent performance
in sports. Unfortunately last year I wasn't mart___.

APPENDIX IVd

The Greek Morphological Proof Spelling Task/Words

- σινομιλώ σοινομιλώ συνομιλώ σηνομιλώ

- διάστημα δυάστημα δειάστημα δηάστημα

- ηπολογίζω υπολογίζω ειπολογίζω ιπολογίζω

- επιτρέπω επτυτρέπω επητρέπω επειτρέπω

- σινεργείο σηνεργείο συνεργείο σεινεργείο

- σιμφοιτητής σημφοιτητής σοιμφοιτητής συμφοιτητής

- επτυυχία επειτυχία επιτυχία επητυχία

- δυάλειμμα διάλειμμα δηάλειμμα δειάλειμμα

▪ επήδειξη επύδειξη επείδειξη επίδειξη

▪ διανυκτερεύω δυανυκτερεύω δηανυκτερεύω
δειανυκτερεύω

▪ σινάδελφος συνάδελφος σηνάδελφος σεινάδελφος

▪ επιγραφή επειγραφή επηγραφή επιγραφή

▪ σειμπάθεια σιμπάθεια σημπάθεια συμπάθεια

▪ δυαφημίσεις διαφημίσεις δειαφημίσεις δηαφημίσεις

▪ ηπόθεση ιπόθεση υπόθεση ειπόθεση

APPENDIX IVe

The English Morphological Proof Spelling Task/Words

- photoagraph photoeagraph photograph photowgraph

- removal reemoval reamoval riemoval

- microscope microscope microascope microwscope

- autograph otograph awtograph oughtograph

- photoecopy photowcopy photocopy photoacopy

- photowstat photoastat photoestat photostat

- awtomatic otomatic automatic oughtomatic

- reevision revision reavision rievision

- oughtonomy otonomy awtonomy autonomy

- reconsider reeconsider reaconsider rieconsider

- photoefinish photofinish photowfinish photoafinish

- automobile otomobile awtomobile oughtomobile

- photoaplay photoeplay photowplay photoplay

- recall recall reecall riecall

- microwphone microaphone microphone microeophone

▪ awtorapic autorapic otorapic oughtorapic

▪ riesoll reesoll resoll reasoll

▪ microerone microrone microarone microwrone

▪ photoebray photobray photoabray photowbray

▪ microwmave microamave micromave microemave

▪ otoboly autoboly oughtoboly awtoboly

APPENDIX V

Additional Time 2 Greek Spelling Tasks

APPENDIX Va

The Greek Graded Spelling Dictation Task

1. Και. Η Μαρία και ο Νίκος είναι αδέρφια. Και.
2. Πού; Πού θα πάμε; Πού;
3. Έλα . Έλα μέσα. Έλα.
4. Είναι. Η Μαρία και ο Νίκος είναι αδέρφια. Είναι.
5. Είπε. Τι είπε ο δάσκαλος στα παιδιά; Είπε.
6. Δουλειά. Τι δουλειά κάνεις; Δουλειά.
7. Άλλη. Πάρε με τηλέφωνο άλλη φορά. Άλλη.
8. Σχολείο. Το σχολείο είναι κοντά στο σπίτι μου. Σχολείο.
9. Παιχνίδι. Τι παιχνίδι θα παίζουμε; Παιχνίδι.
10. Απόγευμα. Το απόγευμα θα πάω στο πάρκο. Απόγευμα.
11. Άνθρωποι. Οι άνθρωποι δεν ζουν χωρίς ύπνο. Άνθρωποι.
12. Ερώτηση. Η ερώτηση του δασκάλου ήταν εύκολη. Ερώτηση.
13. Κατεβαίνει. Η θερμοκρασία κατεβαίνει το χειμώνα. Κατεβαίνει.
14. Σημαίνει. Τι σημαίνει αυτή η λέξη; Σημαίνει.
15. Ποδόσφαιρο. Μ'αρέσει πολύ το ποδόσφαιρο. Ποδόσφαιρο.
16. Πρόσωπο. Το πρόσωπο της Μαρίας είναι χλωμό. Πρόσωπο.
17. Ανήσυχα. Το βράδυ κοιμάμαι ανήσυχα. Ανήσυχα.
18. Ευτυχισμένος. Είμαι πολύ ευτυχισμένος που θα αποκτήσω αδερφάκι.
Ευτυχισμένος.
19. Θόρυβος. Μ'ενοχλεί αυτός ο θόρυβος. Θόρυβος.
20. Πείνα. Έχω μεγάλη πείνα. Πείνα.
21. Μουσεία. Η πόλη μας έχει αρκετά μουσεία. Μουσεία.
22. Συνέχεια. Το μωρό κλαίει συνέχεια. Συνέχεια.

23. Τελευταία. Είναι η τελευταία μέρα των διακοπών. Τελευταία.
24. Δάκρυα. Τα δάκρυά της ήταν ψεύτικα. Δάκρυα.
25. Μήνυμα. Έχω μήνυμα στον τηλεφωνητή. Μήνυμα.
26. Κύματα. Τα κύματα είναι πελώρια. Κύματα.
27. Λύπη. Νιώθω μεγάλη λύπη. Λύπη.
28. Συγκέντρωση. Η συγκέντρωση των γονέων θα γίνει σύντομα.
Συγκέντρωση.
29. Πολυτεχνείο. Είμαι φοιτητής στο Πολυτεχνείο. Πολυτεχνείο.
30. Υπομονή. Κάνε υπομονή, μη βιάζεσαι. Υπομονή.
31. Πρόκειται. Πρόκειται να μετακομίσω. Πρόκειται.
32. Στοιχεία. Ο αστυνομικός ζήτησε τα στοιχεία της ταυτότητάς μου. Στοιχεία.
33. Σύστημα. Το αυτοκίνητό του έχει σύστημα συναγερμού. Σύστημα.
34. Πρωθυπουργός. Ο πρωθυπουργός της Ελλάδας εκλέγεται κάθε τέσσερα
χρόνια. Πρωθυπουργός.
35. Ευρωπαϊκή. Η Ελλάδα ανήκει στην Ευρωπαϊκή Ένωση. Ευρωπαϊκή.
36. Οικονομικών. Το πανεπιστήμιο έχει τμήμα οικονομικών σπουδών.
Οικονομικών.
37. Εταιρείες. Στις εταιρείες εργάζονται πολλοί άνθρωποι. Εταιρείες.
38. Λειτουργία. Η λειτουργία στην εκκλησία άρχισε. Λειτουργία.
39. Δημοκρατίας. Ο πρόεδρος της δημοκρατίας έδωσε συγχαρητήρια στον
πρωταθλητή. Δημοκρατίας.
40. Υπηρεσίες. Οι υπηρεσίες του κράτους εξυπηρετούν τους πολίτες.
Υπηρεσίες.
41. Ταυτόχρονα. Τα αυτοκίνητα στο ράλι ξεκίνησαν ταυτόχρονα. Ταυτόχρονα.

42. Ανακοίνωση. Η ανακοίνωση του γάμου μας δημοσιεύτηκε στην εφημερίδα. Ανακοίνωση.
43. Συνέντευξη. Ο υπουργός έδωσε συνέντευξη τύπου. Συνέντευξη.
44. Συνεδρίαση. Η συνεδρίαση των γονέων έγινε στο σχολείο. Συνεδρίαση.
45. Πλειοψηφία. Η πλειοψηφία κερδίζει. Πλειοψηφία.
46. Κατεύθυνση. Προς ποια κατεύθυνση έτρεξε ο κλέφτης; Κατεύθυνση.
47. Οποιαδήποτε. Τηλεφώνησέ μου οποιαδήποτε ώρα. Οποιαδήποτε.
48. Διευθυντής. Ο διευθυντής της εταιρείας υπέγραψε τα συμβόλαια. Διευθυντής.
49. Δικαιωμάτων. Έγινε πορεία για την προάσπιση των ανθρωπίνων δικαιωμάτων. Δικαιωμάτων.
50. Αλληλεγγύη. Μεταξύ συνανθρώπων υπάρχει αλληλεγγύη. Αλληλεγγύη.
51. Προϋποθέσεις. Υπάρχουν κάποιες προϋποθέσεις για την συμμετοχή στην ομάδα. Προϋποθέσεις.
52. Εφεύρεση. Η εφεύρεση του τηλεφώνου έγινε στις αρχές του προηγούμενου αιώνα. Εφεύρεση.
53. Διείσδυση. Η διείσδυση στο θέμα είναι δύσκολη. Διείσδυση.
54. Επευφημίες. Οι επευφημίες για τη νίκη του δρομέα ήταν θερμές. Επευφημίες.
55. Υιοθεσία.. Η υιοθεσία του βρέφους ήταν νόμιμη. Υιοθεσία.
56. Μυϊκή. Η μυϊκή μάζα των ανδρών είναι περισσότερη από των γυναικών. Μυϊκή.
57. Προσγείωση. Η προσγείωση του αεροπλάνου ήταν ομαλή. Προσγείωση.

APPENDIX Vb

The Greek Graded Spelling Dictation Task of Consonant Clusters

2 syllable words

1. Βγάζω. Βγάζω το σκύλο βόλτα.
2. Σκνίπα. Η σκνίπα είναι έντομο.
3. Γκλίτσα. Η γκλίτσα του βοσκού είναι ξύλινη.
4. Ντύνω. Ντύνω το μωρό.
5. Τούβλο. Το τούβλο χρησιμοποιείται για το χτίσιμο.
6. Άσπρο. Το κουταβάκι είναι άσπρο.
7. Γαμπρός. Θα γίνει γαμπρός στην εκκλησία.
8. Σόμπα. Η σόμπα καίει.

3 syllable words

1. Γραβάτα. Ο γαμπρός φορούσε μπλε γραβάτα.
2. Σφραγίζω. Σφραγίζω το μπουκάλι.
3. Ντροπαλός. Είναι ντροπαλός.
4. Τσεκούρι. Κόβω ξύλα με το τσεκούρι.
5. Τυφλώνω. Σε τυφλώνω με το φως από τη λάμπα.

6. Άσπλαχνος. Είσαι άσπλαχνος που με διώχνεις.
7. Έγκλημα. Το έγκλημα ήταν άγριο.
8. Αγγίζω. Αγγίζω το σίδερο προσεχτικά.

4 syllable words

1. Σχηματίζω. Μου αρέσει να σχηματίζω εικόνες.
2. Σκληρότητα. Ο αστυνομικός έδειξε μεγάλη
σκληρότητα στον ληστή.
3. Μπλεξίματα. Είχανε μπλεξίματα με την αστυνομία.
4. Τζαμαρία. Η τζαμαρία είναι εύθραυστη.
5. Μητρότητα. Χαίρομαι τη μητρότητα.
6. Επιστροφή. Ζαλίστηκα στην επιστροφή.
7. Συγκρότημα. Το συγκρότημα έπαιζε μουσική.
8. Μελιτζάνα. Η μελιτζάνα είναι λαχανικό.

5 syllable words

1. Χρησιμότητα. Ο ηλεκτρονικός υπολογιστής έχει μεγάλη χρησιμότητα.
2. Στρατολογίας. Ο Γιώργος πληροφορήθηκε για το στρατό από το γραφείο στρατολογίας.
3. Γκρινιάρογας. Είσαι γκρινιάρογας.
4. Μποτιλιάρισμα. Τα αυτοκίνητα δεν κινούνται από το μποτιλιάρισμα.
5. Περιληπτικά. Πες το μάθημα περιληπτικά.
6. Επισφράγιση. Η επισφράγιση της συμφωνίας.
7. Ανεξάντλητη. Η υπομονή του είναι ανεξάντλητη.
8. Συγκινητικός. Ο λόγος που έβγαλες ήταν συγκινητικός.

APPENDIX VI

Spelling Tasks used in the Study of Derivational and Inflectional Suffixes

APPENDIX VIa

The Greek Grammatical Spelling Dictation Task (Nouns & Adjectives)

1. Ο τελευταίος αυτοκράτορας /o telefteos aftokratoras/ (the last emperor)
[Frequency according to National Hellenic Corpus: 1417 (0.0415‰) & 95 (0.0028‰) respectively]
2. Του νέου αγώνα /tu neu agona/ (new match)
[Frequency: 5284 (0.1547‰) & 10,362 (0.3033‰) respectively]
3. Την αστεία παρέα /tin astia parea/ (the funny group)
[Frequency: 377 (0.0110‰) & 1460 (0.0427‰) respectively]
4. Γελοίο τραγούδι /jelio trayudi/ (ridiculous song)
[Frequency: 103 (0.0030‰) & 1775 (0.0520‰) respectively]
5. Ο τολμηρός πατριώτης /o tolmiros patriotis/ (the daring patriot)
[Frequency: 54 (0.0016‰) & 69 (0.0020‰) respectively]
6. Του μαυριδερού ληστή /tu mavrikeru listi/ (dark robber)
[Frequency: 1 (0.0000‰) & 61 (0.00189‰) respectively]
7. Τον ισχυρό ηγεμόνα /ton isjiro ijemona/ (the mighty ruler)
[Frequency: 996 (0.0292‰) & 100 (0.0029‰) respectively]
8. Ευγενική αρχόντισσα /evjeniki arxondisa/ (kind lady)
[Frequency: 129 (0.0038‰) & 25 (0.0007‰) respectively]
9. Το δανεικό τετράδιο /to ðaniko tetraðio/ (the borrowed notebook)
[Frequency: 65 (0.0019‰) & 41 (0.0012‰) respectively]
10. Της θηλυκής έννοιας /tis ðilikis enias/ (feminine concept/meaning)
[Frequency: 5 (0.0001‰) & 303 (0.0089‰) respectively]

11. Τον πρόθυμο πολίτη /ton prothimo politi/ (the willing citizen)
[Frequency: 48 (0.0014%) & 1951 (0.0571%) respectively]
12. Διάσημη επιστήμονα /diasime epistimona/ (famous scientist)
[Frequency: 359 (0.0105%) & 196 (0.0057%) respectively]
13. Το έτοιμο νοικοκυριό /to etimo nikokirjo/ (the prepared household)
[Frequency: 838 (0.0245%) & 0 respectively]
14. Του παντοτινού ερχομού /tu pandotinu erchomu/ (the perpetual arrival)
[Frequency: 1 (0.0000%) & 12 (0.0004%) respectively]
15. Τις πέτρινες πλατείες /tis petrines platies/ (the squares of stone)
[Frequency: 24 (0.0007%) & 230 (0.0067%) respectively]
16. Ταπεινοί κριτές /tapini krites/ (humble judges)
[Frequency: 33 (0.0010%) & 87 (0.0025%) respectively]
17. Οι τίμιοι αγρότες /i timii ayrotes/ (the honest farmers)
[Frequency: 24 (0.0005%) & 1809 (0.0530%) respectively]
18. Των άδειων γειτονιών /ton adjon yiton/ (the empty neighbourhoods)
[frequency: 17 (0.0005%) & 11 (0.0003%) respectively]
19. Τις όμοιες εικόνες /tis omies ikones/ (the similar images)
[Frequency: 105 (0.0031%) & 1610 (0.0471%) respectively]
20. Νησίσιμα φαγητά /nistisima fayita/ (foods for lent)
[Frequency: 9 (0.0003%) & 114 (0.0033%) respectively]
21. Οι συζητήσιμοι κυβερνήτες /i sizitisimi kivernites/ (the debatable leaders)
[frequency: 0 & 76 (0.0022%) respectively]

22. Των βουνίσσιων τοπίων /ton vunisjion topion/ (the mountainous terrain)
[frequency: 12 (0.0004‰) & 31 (0.0009‰) respectively]
23. Τα ετήσια ταξίδια /ta etisia taksiðja/ (the yearly trips)
[Frequency: 1067(0.0312‰) & 546 (0.0160‰) respectively]
24. Ρωμαλέοι αθλητές /romalei aθlites/ (robust athletes)
[Frequency: 1 (0.0000‰) & 828 (0.0242‰) respectively]
25. Οι διαιρετές ποσότητες /i ðieretees posotites/ (the divisible quantities)
[frequency: 0 & 796 (0.0233‰) respectively]
26. Των αγριωπών λύκαινων /ton αγριοπον likenon/ (the fierce she-wolves)
[frequency: 0 & 0 respectively]
27. Τις μεταξωτές ποδίτσες /tis metaksotes poðitses/ (the silk aprons)
[Frequency: 23 (0.0007‰) & 1 (0.0000‰) respectively]
28. Κρύα τηλεγραφήματα /kria tilegrafimata/ (cold telegrams)
[Frequency: 144 (0.0042‰) & 124 (0.0036‰) respectively]

APPENDIX VIb

The Greek Grammatical Spelling Dictation Task (Nouns & Verbs)

1. Αφήνω τα μαλλιά μου μακριά. /afino ta malja mu makria/ (I am growing my hair long). [Frequency: 156 (0.0046%) & 920 (0.02699%) respectively]
2. Έπνιξες το δάκρυ σου. /epnikses to dakri su/ (You held back your tear). [frequency: 55 (0.0016%) & 85 (0.0025%) respectively]
3. Το γυμναστήριο έκλεισε. /to gimnastirio eklise/ (The gymnasium closed). [frequency: 120 (0.0035%) & 1783 (0.0522%) respectively]
4. Νιώσαμε συμπόνια. /Niosame simbonia/ (We felt compassion). [Frequency: 45 (0.0013%) & 52 (0.0015%) respectively]
5. Η κεραία δέσποσε στην κορυφή /i kerea despose stin korifi/ (The antenna dominates the peak). [Frequency: 57 (0.0017%) & 9 (0.0003%) respectively]
6. Απένειμαν δικαιοσύνη. /apeniman dikeosini/ (They served justice). [Frequency: 24 (0.0007%) & 1790 (0.0524%) respectively]
7. Εσείς αυξήσατε ταχύτητα /esis afksisate tacitita/ (You accelerated). [Frequency: 1 (0.0000%) & 2493 (0.0730%) respectively]
8. Ήρθες για βοήθεια. /irthes ja voiθia/ (You came for help). [Frequency: 71 (0.0021%) & 4134 (0.1210%) respectively]
9. Έβγαλα αντικλείδι. /evgala andikliði/ (I made a spare key). [Frequency: 113 (0.0033%) & 6 (0.0002%) respectively]
10. Στέκομαι δίπλα στον ανεμιστήρα. /stekome ðipla ston anemistira/ (I am standing next to the fan). [Frequency: 57 (0.0017%) & 44 (0.0013%) respectively]
11. Ο καύσωνας με αρρωσταίνει. /o kafsonas me arosteni/ (The hot (scorching) weather makes me ill). [Frequency: 62 (0.0018%) & 12 (0.0004%) respectively]

12. Αναγγέλλουν τον ιδρυτή του μουσείου./*anagfelun ton idriti tu musiu/* (They are announcing the museum's founder).
[Frequency: 19 (0.0006%) & 449 (0.0131%) respectively]
13. Σπέρνουμε κρεμμύδια. /*spernume kremiðja/* (We are sowing onions).
[Frequency: 0 & 27 (0.0008%) respectively]
14. Εσείς πηγαίνετε στη Λάρισα. /*esis pijenete sti larisa/* (You are going to Larisa).
[Frequency: 85 (0.0025%) & 1184 (0.0347%) respectively]
15. Εύχονται τον λυτρωμό του λαού. /*efxonde ton litromo tu lau/* (They pray for the relief of the people).
[Frequency: 70 (0.0020%) & 0 respectively]
16. Εσείς αφαιρείτε την επικεφαλίδα. /*esis aferite tin epikefaliða/* (You are removing the headline).
[Frequency: 19 (0.0006%) & 26 (0.0008%) respectively]
17. Τον μηνούμε για το μαρτύριο που προκάλεσε. /*ton minume ja to martirio pu prokalese/* (We are suing him for the suffering he caused).
[Frequency: 0 & 175 (0.0051%) respectively]
18. Διδάχτηκε στο ωδείο. /*ðidaxtike sto oðio/* (She was taught at the conservatory).
[Frequency: 13 (0.0004%) & 160 (0.0047%) respectively]

APPENDIX VII

Tables of Partial Correlations: Longitudinal Study

Table 1. Partial Correlations (controlling for chronological age and verbal IQ) between all the measures at time 1 for the reading-age control children

	Read	DigSp	SpnSc	Phdelse/w	Phdelse/n	Rdgnm	WordrdSc	NwRdSc	WRdSp	NwRdSp	MphPrW	MphPr/N	OrtPr	Spelsuf
Read	----													
DigSp	.14	----												
SpnSc	.32	.34	-----											
Phdelse/w	.51*	.36	.62*	-----										
Phdelse/n	.36	.21	.33	.45	-----									
Rdgnm	-.29	-.18	-.42	-.35	-.50*	-----								
WordrdSc	.73*	.03	.25	.39	.43	-.29	-----							
NwRdSc	.09	-.08	.27	.26	.36	-.23	.28	-----						
WRdSp	-.62*	-.00	-.21	-.38	-.31	.20	-.46	-.11	-----					
NwRdSp	-.38	.05	-.19	-.33	-.29	.26	-.17	.08	.82*	-----				
MphP/W	.54*	.30	.21	.26	.08	-.12	.52*	-.34	-.08	.02	-----			
MphP/N	.44	.44	.27	.29	.00	-.11	.32	-.33	-.12	-.11	.64*	-----		
OrthPr	.64*	-.11	-.03	.18	.15	.05	.46	.00	-.02	.11	.50*	.28	-----	
SpelSuf	.52*	.38	.41	.48	.09	-.05	.31	.09	-.01	.13	.40	.44	.52*	-----

* $p < 0.01$

Table 2. Partial Correlations (controlling for chronological age and verbal IQ) between all the measures at time 1 for the chronological-age control children

	Read	DigSp	SpnSc	Phdelse/w	Phdelse/n	Rdgnm	WordrdSc	NwRdSc	WRdSp	NwRdSp	MphP/W	MphP/N	OrtPr	Spelsuf
Read	----													
DigSp	.10	----												
SpnSc	-.15	-.04	-----											
Phdelse/w	.29	-.17	-.02	-----										
Phdelse/n	.01	.34	.31	.26	-----									
Rdgnm	-.44	-.01	-.14	-.39	-.26	-----								
WordrdSc	-.03	.06	-.20	-.03	-.30	.18	-----							
NwRdSc	.04	-.22	.22	.09	.04	.10	-.00	-----						
WRdSp	-.72*	-.07	-.07	-.14	.14	.42	-.12	-.02	-----					
NwRdSp	-.55*	-.04	.10	-.46	-.11	.71*	-.05	-.13	.61*	-----				
MphP/W	.19	-.04	.13	.29	.42	-.19	-.12	.36	-.09	-.42	-----			
MphP/N	-.01	.00	-.25	.46	.30	-.14	.10	.10	.24	-.32	.64*	-----		
OrthPr	.15	.06	.04	.32	.34	-.05	.02	.35	-.30	-.45	.61*	.33	-----	
SpelSuf	.31	.37	.08	.36	.52*	-.06	.03	.38	-.14	-.26	.48	.28	.51*	-----

* $p < 0.01$

Table 3. Partial Correlations (controlling for chronological age and verbal IQ) between all the measures at time 1 for the dyslexic children

	Read	DigSp	SpnSc	Phdelse/w	Phdelse/n	Rdgnm	WordrdSc	NwRdSc	WRdSp	NwRdSp	MphP/W	MphP/N	OrtPr	Spelsuf
Read	----													
DigSp	.40	----												
SpnSc	.16	.33	-----											
Phdelse/w	.26	.26	.68*	-----										
Phdelse/n	.39	.46	.54*	.64*	-----									
Rdgnm	-.42	-.36	-.13	.03	-.33	-----								
WordrdSc	.26	.50	.23	.31	.28	-.32	-----							
NwRdSc	.36	.39	.60*	.67*	.54	-.06	.32	-----						
WRdSp	-.64*	-.65*	-.42	-.47	-.70*	.43	-.49	-.52	-----					
NwRdSp	-.19	-.48	-.20	.07	-.43	.63*	-.19	-.14	.53	-----				
MphP/W	.13	.19	.27	.52	.43	-.11	.15	.18	-.38	-.18	-----			
MphP/N	.13	-.05	.15	.44	.38	.28	.02	.06	-.04	.29	.50	-----		
OrthPr	.28	.56*	.38	.54*	.32	-.05	.48	.40	-.47	-.09	.66*	.36	-----	
SpelSuf	-.00	.37	.15	.43	.28	.46	.17	.15	-.25	.14	.38	.38	.54	-----

* $p < 0.01$

Table 4. Partial correlations (controlling for chronological age) between all measures at time 2 for the reading-age control children.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Read	----																					
2. DigSp	.13	----																				
3. NWRRep	.05	.32	-----																			
4. SpnSc	.03	.54*	.21	-----																		
5. SpnTm	-.21	-.52*	-.02	-.60*	-----																	
6. Phdelse/w	.12	.52*	.40	.49	-.32	-----																
7. Phdltm/w	-.17	-.56*	-.12	-.39	.58*	-.40	-----															
8. Phdelse/n	.09	.58*	.34	.64*	-.62*	.71*	-.44	-----														
9. Phdltm/n	-.20	-.67*	-.04	-.58*	.64*	-.52*	.66*	-.67*	-----													
10. Rdgnm	-.43	-.04	.00	-.08	.02	-.40	.08	-.01	.24	-----												
11. Rltm	-.05	-.13	.07	-.05	.19	-.01	-.17	-.03	.21	.33	-----											
12. WordrdSc	.19	.07	.22	.20	-.43	.15	-.53*	.45	-.34	-.15	.27	-----										
13. NwRdSc	.09	.21	.06	.33	-.40	.17	-.47	.41	-.38	-.03	.22	-.60*	-----									
14. WRdSp	-.51*	-.20	.07	-.23	.12	-.32	.11	-.14	.31	.15	-.02	-.21	-.01	-----								
15. NwRdSp	-.44	-.24	-.05	-.21	-.01	-.10	.03	-.08	.35	.63*	.20	-.10	.09	.53*	-----							
16. MphP/W	.06	.06	.12	.48	-.20	.33	-.06	.40	-.21	.10	.32	.30	.24	-.37	-.20	-----						
17. MphP/N	.08	-.03	.12	.16	-.06	.11	.21	.13	-.09	.12	-.01	.01	-.15	-.28	-.17	.66*	-----					
18. GrSpl/Or	-.04	.10	.06	.38	-.26	.06	-.17	.34	-.29	.12	.14	.51*	.45	-.23	-.06	.69*	.47	-----				
19. GrSpl/Ph	-.03	.38	.08	.48	-.54*	.12	-.64*	.37	-.41	.18	.18	.54*	.50*	.02	.10	.32	-.01	.58*	-----			
20. OrthPr	.15	.43	.29	.40	-.28	.31	.04	.50*	-.29	-.04	.07	.11	.17	-.24	-.24	.61*	.45	.53*	.13	-----		
21. SpelSuf	.04	.53*	.23	.45	-.63*	.37	-.42	.68*	-.54*	.14	-.07	.53*	.43	-.20	.05	.43	.34	.51*	.60*	.44	-----	

* $p < 0.01$

Table 5. Partial correlations (controlling for chronological age) between all measures at time 2 for the chronological-age control children.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Read	----																					
2. DigSp	.30	----																				
3. NWRep	-.37	.17	----																			
4. SpnSc	.04	.14	.30	----																		
5. SpnTm	-.15	-.26	.05	-.48	----																	
6. Phdelse/w	.12	-.14	.08	.26	-.30	----																
7. Phdltm/w	-.13	-.11	-.27	-.32	.65*	-.24	----															
8. Phdelse/n	.56*	.30	.16	-.09	-.14	.27	-.14	----														
9. Phdltm/n	-.47	-.35	.07	-.16	.64*	-.17	.52	-.59*	----													
10. Rdgnm	-.75*	-.29	.42	.23	.16	-.03	.21	-.38	.39	----												
11. Rltm	-.48	-.10	.35	-.06	.01	.17	.13	-.07	.21	.63*	----											
12. WordrdSc	.07	-.28	.18	-.04	-.18	.15	-.22	.26	-.06	-.14	.21	----										
13. NwRdSc	-.02	-.39	.21	.09	-.17	.11	-.21	.10	.03	-.06	-.11	.67*	----									
14. WRdSp	-.74*	-.20	.23	-.13	.26	-.33	.33	-.24	.36	.68*	.32	.00	-.06	----								
15. NwRdSp	-.65*	-.13	.24	.14	.24	.05	.47	-.45	.48	.71*	.51	-.32	-.28	.56*	----							
16. MphP/W	.04	-.15	.07	.11	-.24	.43	-.40	.01	-.03	.05	.09	.44	.28	-.10	-.10	----						
17. MphC/N	.08	-.03	.31	.07	-.18	.30	-.36	.08	-.01	-.04	.21	.60*	.50	-.34	-.28	.72*	----					
18. GrSpl/Or	.34	-.11	-.23	-.24	-.35	.17	-.54	.35	-.43	-.36	-.23	.46	.33	-.35	-.67*	.50	.39	----				
19. GrSpl/Ph	.10	.02	.23	.01	-.27	.04	-.40	.21	-.31	.07	.14	.65*	.41	-.18	-.26	.61*	.71*	.59*	----			
20. OrthPr	.05	.08	.13	.12	-.44	.24	-.55*	.12	-.44	.14	.16	.59*	.14	-.12	-.30	.46	.48	.53	.69*	----		
21. SpelSuf	.02	.39	.06	.06	-.38	-.22	-.15	.11	-.36	-.03	-.06	-.04	.43	-.08	-.10	.20	.19	.33	.42	.09	----	

* $p < 0.01$

Table 6. Partial correlations (controlling for chronological age) between all measures at time 2 for the dyslexic children.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Read	----																					
2. DigSp	.14	----																				
3. NWRRep	.21	.37	-----																			
4. SpnSc	.13	.46	-.03	-----																		
5. SpnTm	-.40	-.40	-.30	-.55*	-----																	
6. Phdelsc/w	.42	.49	.41	.47	-.65*	-----																
7. Phdltm/w	-.35	-.34	-.19	-.46	.76*	-.57*	-----															
8. Phdelsc/n	.45	.49	.42	.36	-.52	.69*	-.41	-----														
9. Phdltm/n	-.44	-.42	-.42	-.54*	.67*	-.70*	.71*	-.81*	-----													
10. Rdgnm	-.39	-.39	.10	-.05	-.01	-.14	.06	-.28	.15	-----												
11. Rltm	-.39	.00	.20	.17	-.04	.13	.00	.05	-.00	.62*	-----											
12. WordrdSc	-.09	.35	-.28	.24	-.22	.00	-.13	.20	-.13	-.24	.01	-----										
13. NwRdSc	.15	.55*	.02	.60*	-.32	.49	-.28	.32	-.41	-.30	.10	.37	-----									
14. WRdSp	-.70*	-.10	-.13	-.24	.11	-.31	.25	-.31	.41	.29	.26	.06	-.22	-----								
15. NwRdSp	-.43	-.11	.22	-.28	.24	-.00	.42	-.04	.25	.35	.40	-.13	.04	.51	-----							
16. MphP/W	.49	.48	.22	.48	-.59*	.59*	-.46	.60*	-.55*	-.26	.01	.11	.49	-.30	-.21	-----						
17. MphP/N	.27	.46	.41	.53*	-.50	.59*	-.42	.53*	-.59*	-.16	-.05	.04	.60	-.26	.02	.71*	-----					
18. GrSpl/Or	.50	.41	.44	.59*	-.63*	.62*	-.39	.58*	-.62*	.03	.24	.13	.39	-.45	-.16	.71*	.58*	-----				
19. GrSpl/Ph	.25	.58*	.53*	.62*	-.45	.59*	-.25	.69*	-.69*	-.07	.17	.20	.55*	-.28	.15	.45	.65*	.73*	-----			
20. OrthPr	.61*	.01	.20	.41	-.51	.34	-.31	.37	-.49	.08	.04	-.01	.22	-.51	-.31	.55*	.43	.79*	.44	-----		
21. SpelSuf	.34	.36	.41	.45	-.39	.44	-.32	.49	-.55*	-.13	.02	.08	.26	-.46	.01	.50	.47	.71*	.68*	.44	-----	

* $p < 0.01$

Read=Reading Ability
DigSp=WISC-III Digit Span
NWRep=Nonword Repetition
SpnSC=Spoonerisms (score)
S[nTm=Spoonerisms (time)
OrthPr=Orthographic Proof Spelling Task
SpelSuf=Spelling Task of Suffixes
Phdelsc/w=Phoneme Deletion/Words (score)
Phdltm/w=Phoneme Deletion/Words
(time)
Phdelsc/n=Phoneme Deletion/Nonwords (score)
Phdltm/n=Phoneme Deletion/Nonwords (time)
Rdgnm=Rapid Digit Naming
(time)
Rltnm=Rapid Letter Naming
(time)
WordrdSc=WordWord Reading Accuracy
NwRdSc=Nonword Reading Accuracy
WRDSp=Word Reading Speed
(time)
NwRdSp=Nonword Reading Speed
(time)
MphP/W=Morphological Proof Spelling Task/Words
MphP/N=Morphological Proof Spelling Task/Nonwords
GrSpl/Or=Graded Spelling Test
(Orthographic Accuracy)
GrSpl/Ph=Graded Spelling Test
(Phonemic Accuracy)

APPENDIX VIII

List of Greek Irregular Verbs

<i>Present</i>	<i>Meaning</i>	<i>Active simple Past</i>	<i>Passive simple Past</i>	<i>Passive perfect participle</i>
αγαναχτώ	Am indignant	αγανάκτησα	-	Αγαναχτισμένος
-αγγέλλω	(-)	-άγγειλα/ -ήγγειλα dep. -αγγείλω	-αγγέλθηκα	-αγγελμένος
-άγω	(-)	-ήγαγα dep. -αγάγω	-άχθηκα/ -ήχθην	-ηγμένος
Αίρω	Raise	ἤρα dep. ἄρω	ἄρθηκα	(ηρμένος)
-αιρώ	(-)	-αίρεσα/-ήρεσα dep. -αιρέσω	-αιρέθηκα	-ηρημένος
Ακουμπώ	Lean	Ακούμπησα	-	Ακουμπισμένος
Ανακλώ	Reflect	Ανέκλασα	Ανακλάστηκα	Ανακλασμένος
Αναμιγνύω	Mix	Ανέμιξα	Αναμίχθηκα	Ανα(με)μιγμένος
Ανασταίνω	Resurrect	Ανάστησα	Αναστήθηκα	Αναστημένος
Ανατέλλω	Rise	Ανάτειλα/ ανέτειλα	-	-
Ανεβαίνω	Go up	Ανέβηκα dep. Ανέβω/ανεβώ imp. Ανέβα, ανεβείτε	-	Ανεβασμένος
Ανέχομαι	Tolerate	Ανέχτηκα	-	-
Αντέχω	Endure	ἄντεξα	-	-
Απαλλάσσω	Exempt	Απάλλαξα	Απαλλάχτηκα Dep. Απαλλαχτώ -αγώ	Απαλλαγμένος
Απελαύνω	Deport	Απήλασα dep. Απελάσω	Απελάθηκα	-
Απέχω	Am far from	(imperf.) απείχα	-	-
Απολαμβάνω	Enjoy	Απήλαυσα dep. απολαύσω	-	-
Αποτυχαίνω	Fail	Απέτυχα dep. Αποτύχω	-	Αποτυχημένος
Αρέσω	Please	ἄρεσα	-	-
Αρκώ	Suffice	ἄρκεσα/ήρκεσα	Αρκέστηκα	-
Αρταίνω	Spice	ἄρτυσα	Αρτύθηκα	Αρτυ(σ)μένος
Αυξάνω/-αίνω	Increase	Αύξησα	Αυξήθηκα	Αυξημένος
Αφήνω	Leave	ἄφησα imp. Ἄφησε/άσε αφήστε/άστε	Αφέθηκα	Αφη(σ)μένος
Βάζω	Put	ἔβαλα	Βάλθηκα	Βαλμένος
-βαίνω	(-)	-έβην dep. -βώ	-	-
-βάλλω	(-)	-έβαλα	-βλήθηκα	-(βε)βλημένος
Βαριέμαι	Am bored	Βαρέθηκα	-	Βαριεστημένος
Βαρώ	Strike	Βάρεσα	-	Βαρεμένος
Βαστώ	Bear	Βάσταξα/βάστηξα	Βαστάχτηκα/ Βαστήχτηκα	Βαστα(γ)μένος Βαστη(γ)μένος
Βάφω	Paint	ἔβαψα	Βάφ(τ)ηκα	Βαμμένος
Βγάζω	Take out	ἔβγαλα	Βγάλθηκα	Βγαλμένος
Βγαίνω	Go out	Βγήκα dep. Βγω imp. Βγες/έβγα, βγείτε	-	Βγαλμένος
Βλέπω	See	Είδα dep. Δω	Ειδώθηκα	Ιδωμένος

		imp. Δες, δέστε/ δείτε	Dep. Ιδωθώ	
-βλέπω	(-)	-έβλεψα	-	-
Βογκώ	Groan	Βόγκηξα	-	-
Βοσκώ	Graze	Βόσκησα	(βοσκήθηκα)	Βοσκημένος
Βούλομαι	Wish	Βουλήθηκα	-	-
Βουτώ	Dive	Βούτηξα	Βουτήχτηκα	Βουτηγμένος
Βρέχω	Wet	Έβρεξα	Βράχηκα	Βρε(γ)μένος
Βρίσκω	Find	Βρήκα dep. Βρω imp. Βρες, βρείτε	Βρέθηκα	-
Βροντώ	Thunder	Βρόντηξα/ Βρόντησα	-	-
Βυζαίνω	Suckle	Βύζαξα	Βυζάχτηκα	Βυζαγμένος
Γδέρνω	Skin	Έγδαρα	Γδάρθηκα	Γδαρμένος
Γελώ	Laugh	Γέλασα	Γελάστηκα	Γελασμένος
Γέρνω	Lean	Έγειρα	-	Γερμένος
Γερνώ	Grow old	Γέρασα	-	Γερασμένος
Γίνομαι	Become	Έγινα/γινήκα dep. Γίνω/γενώ	-	Γινωμένος
Γράφω	Write	Έγραψα	Γράφ(τ)ηκα	Γραμμένος
-δεικνύω	(-)	-έδειξα	-δείχθηκα	-(δε)δειγμένος
Δέομαι	Pray	Δεήθηκα	-	-
Δέρνω	Beat	Έδειρα	Δάρθηκα	Δαρμένος
Διαβαίνω	Pass [by]	Διάβηκα dep. Διαβώ	-	-
Διαθλώ	Refract	Διέθλασα	Διαθλάστηκα	Διαθλασμένος
Διαμαρτύρομαι	Protest	Διαμαρτυρήθηκα	-	Διαμαρτυρημένο ς
-δίδω	(-)	-έδωσα	-(ε)δόθηκα	-δεδομένος
Δίνω	Give	Έδωσα	Δόθηκα	Δο(σ)μένος Δεδομένος
Διψώ	Am thirsty	Δίψασα	-	Διψασμένος
Δρω	Act	Έδρασα	-	-
Εγείρω	Erect	Έγειρα	Εγέρθηκα	Εγερμένος
Εκλέγω	Elect	Εξέλεξα dep. εκλεγώ	Εκλέχτηκα Dep. Εκλεγώ	Εκλεγμένος
Εκπλήσσω	Surprise	Εξέπληξα	Εξεπλάγην Dep.εκπλαγώ	-
Εκρήγνυμαι	Explode	Εξερράγην dep. Εκραγώ	-	-
Επαινώ	Praise	Επαινέσα	Επαινέθηκα	Επαινεμένος
Επεμβαίνω	Intervene	Επενέβηκα/ Επενέβην dep. επέμβω	-	-
Έρχομαι	Come	Έρθα/ήλθα dep. Έρθω/έλθω imp. Έλα/ελάτε	-	-
-έρχομαι	(-)	-ήλθα dep. -έλθω	-	-
Εύχομαι	Wish	Ευχήθηκα	-	-
Εφευρίσκω	Invent	Εφεύρα dep. Εφεύρω	Εφευρέθηκα	Εφευρεμένος/ Εφευρημένος

Επιστώ	Draw [attention to]	Επέστησα	Επιστήθηκα	-
Έχω	Have	(imperf.) είχα	-	-
Ζουλώ	Squeeze	Ζούληξα	Ζουλήχτηκα	Ζουληγμένος
Ζω	Live	Έζησα	-	-
Θαρρώ	Believe	Θάρρεψα	-	-
Θέλω	Want	Θέλησα imperf. Ήθελα	-	(η)θελημένος
Θέτω	Place	Έθεσα	Τέθηκα	-
-θέτω	(-)	-έθεσα	-τέθηκα	-τεθειμένος
Θίγω	Touch	Έθιξα	Θίχτηκα/εθίγην	Θιγμένος
Θρέφω	Nourish	Έθρεψα	Θρέφτηκα	Θρεμμένος
Κάθομαι	Sit	Κάθισα/έκατσα imp. Κάθισε/κάτσε, καθίστε	-	Καθισμένος
Καθιστώ Pass. καθίσταμαι	Render	κατέστησα	Κατέστην Dep.καταστώ	Κατεστημένος
-καθιστώ	(-)	-κατέστησα	-καταστάθηκα	-κατεστημένος
Καίω	Burn	Έκαψα	Κάηκα	Καμένος
Καλώ	Call	Κάλεσα	Καλέστηκα	Καλεσμένος
-καλώ	(-)	-κάλεσα	-κλήθηκα	-κεκλημένος
Κάνω	Make	Έκανα/έκαμα	-	Καμωμένος
Καρτερώ	Wait patiently	Καρτέρεσα	-	-
Καταναλίσκω	Consume	Κατανάλωσα	Καταναλώθηκα	Καταναλωμένος
Καταπίνω	Swallow	Κατάπινα	-	-
Κατάσχω	Confiscate	Κατάσχεσα	Κατασχέθηκα	(κατασχεμένος)
Καταφρονώ	Scorn	Καταφρόνεσα	Καταφρονέθηκα	Καταφρονημένος
κατεβαίνω	Go down	Κατέβηκα dep. Κατέβω/κατεβώ imp.Κατέβα, κατεβείτε	-	Κατεβασμένος
Κερδίζω	Earn	Κέρδισα	Κερδήθηκα	Κερδισμένος
Κερνώ	Treat	Κέρασα	Κεράστηκα	Κερασμένος
Κλαίω	Weep	Έκλαψα	Κλαύτηκα	Κλαμένος
Κλέβω	Steal	Έκλεψα	Κλάπηκα (steal)/ Κλέφτηκα (elope)	Κλεμμένος
Κλείνω (-κλείω)	Close	Έκλεισα	Κλείστηκα	Κλεισμένος
Κόβω (-κόπτω)	Cut	Έκοψα	Κόπηκα	(-κε)κομμένος
Κοιτάζω/κοιτώ	Look	Κοίταξα	Κοιτάχτηκα	Κοιταγμένος
Κρεμώ Pass. κρέμομαι	Hang	Κρέμασα	Κρεμάστηκα	Κρεμασμένος
Κυλώ	Roll	Κύλησα	Κυλίστηκα	Κυλισμένος
Λαμβάνω/λαβαίνω	Receive	Έλαβα	-λήφθηκα/ -ελήφθην	-ειλημμένος
-λέγω	(-)	-έλεξα	-λέχθηκα/ -λέχτηκ -ελέγην	-λεγμένος
Λέ(γ)ω	Say	Είπα dep. πω imp. πες, πείτε/ πείτε	Λέχθηκα/ Ειπώθηκα	Ειπωμένος
Μαθαίνω	Learn	Έμαθα	Μαθεύτηκα	Μαθημένος

Μεθώ	Get drunk	Μέθουσα	-	Μεθυσμένος
Μένω	Stay	Έμεινα	-	-
Μηνώ/μηνύω	Inform/summons	Μήνυσα	Μηνύθηκα	Μηνυμένος
Μπαίνω	Enter	Μπήκα dep. μπω imp. Μπες/έμπα, μπίτε	-	Μπασμένος
-νέμω	(-)	-ένεμα	-(ε)νεμήθηκα	-νεμημένος
Ντρέπομαι	Am ashamed	Ντράπηκα	-	Ντροπιασμένος
Ξαίνω	Comb [wool]	Έξανα	Ξάστηκα	Ξασμένος
Ξερνώ	Vomit	Ξέρασα	Ξεράστηκα	Ξερασμένος
Ξέρω	Know	(imperf.) ήξερα	-	-
Ξεχνώ	Forget	Ξέχασα	Ξεχάστηκα	Ξεχασμένος
Παθαίνω	Suffer	Έπαθα	-	Παθημένος
Παίρνω	Take	Πήρα dep. πάρω imp. Πάρε, πάρτε	Πάρθηκα	Παρμένος
Παρελαύνω	Parade	Παρέλασα	-	-
Παρέχω	Provide	(imperf.) παρείχα dep. Παράσχω	Παρασχέθηκα	-
Πάσχω	Suffer	Έπαθα	-	-
Πεινώ	Am hungry	Πείνασα	-	Πεινασμένος
Περνώ	Pass	Πέρασα	Περάστηκα	Περασμένος
Πετώ	Throw	Πέταξα	Πετάχτηκα	Πετα(γ)μένος
Πέφτω	Fall	Έπεσα	-	Πεσμένος
Πηγαίνω/πάω	Go	Πήγα dep. πάω imp. Πήγαινε, πηγαίνετε	-	-
Πηδώ	Jump	Πήδηξα/πήδησα	Πηδήχτηκα	Πηδηγμένος
Πίνω	Drink	Ήπια dep. πω imp. πιες, πιέστε/πιείτε	Πιώθηκα	Πιωμένος
Πλάττω/πλάσσω	Mould	Έπλασα	Πλάστηκα	Πλασμένος
Πλένω	Wash	Έπλυνα	Πλύθηκα	Πλυμένος
Πλήττω	Am bored	Έπληξα	-	-
Πνίγω	Strangle	Έπνιξα	Πνίγηκα	Πνιγμένος
Ποικίλλω	Adorn	(ε)ποίκιλα	-	Ποικιλμένος
Πονώ	Hurt	Πόνεσα	-πονέθηκα	Πονεμένος
Πρήζω	Swell	Έπρηξα	Πρήστηκα	Πρησμένος
Προβαίνω	Advance	Προέβην Dep. προβώ	-	-
	Appear	πρόβαλα	-	-
Προβάλλω	Appear	Πρόβαλα	-	-
Προβάλλω	Project	προέβαλα	Προβλήθηκα	Προ(βε)βλημένος
Ρεύομαι	Belch	Ρεύτηκα	-	-
Ρουφώ	Suck	Ρούφηξα	Ρουφήχτηκα	Ρουφηγμένος
Σέβομαι	Respect	Σεβάστηκα	-	-
Σέρνω (-σύρω)	Drag	Έσυρα	Σύρθηκα	Συρμένος
Σκουντώ	Prod	Σκούντησα/ σκούντηξα	Σκουντήχτηκα	Σκουντηγμένος
Σπέρνω (-σπείρω)	Sow	Έσπειρα	Σπάρθηκα	-(ε)σπαρμένος
Στέκομαι/στέκω	Stand	Στάθηκα	-	-
-στέλλω	(-)	-έστευλα	-(ε)στάλ(θ)ηκα	-(ε)σταλμένος
Στέλνω	Send	Έστευλα	Στάλθηκα	Σταλμένος

Στενοχωρώ	Distress	Στενοχώρησα/ στενοχώρεσα	Στενοχωρήθηκα/ στενοχωρήθηκα	Στενοχωρημένος
Στρέφω	Turn	Έστρεψα	Στράφηκα	Στραμμένος
Συγχαίρω	Congratulate	συγγάρηκα	-	-
Συμβαίνει	Happens	Συνέβη/συνέβηκε Der. συμβεί	-	-
Συμμετέχω	Participate	(imperf.) Συμμετείχα Der. συμμετάσχω	-	-
Συμπίπτω	Coincide	Συνέπεσα	-	-
Σφάλω	Am mistaken	Έσφαλα	-	Εσφαλμένος
Σχολώ	Stop work	Σχόλασα	-	Σχολασμένος
Σώζω	Save	Έσωσα	Σώθηκα	Σωσμένος
Σωπαίνω	Am silent	Σώπασα Impr. Σώπα/σώπασε, Σωπάτε/σωπάστε	-	-
Τείνω	Tend	Έτεινα	-τάθηκα	Τεταμένος
Τελώ	Perform	Τέλεσα	Τελέστηκα	(τε)τελεσμένος
Τραβώ	Pull	Τράβηξα	Τραβήχτηκα	Τραβηγμένος
Τρέπω	Turn	Έτρεψα	Τράπηκα	-(τε)τραμμένος
Τρέφω	Nourish	Έθρεψα	Τράφηκα	Θρεμμένος
Τρώω	Eat	έφαγα Der. φάω Impr. φά(γ)ε, φάτε	Φαγώθηκα	Φαγωμένος
-τυγχάνω	(-)	-έτυχα	-	-τυχημένος
Υπάρχω	Exist	Υπήρξα Der. υπάρξω	-	-
Υπόσχομαι	Promise	Υποσχέθηκα	-	(υποσχεμένος)
Υφίσταμαι	Exist, undergo	Υπέστην Der. υποστώ	-	-
Φαίνομαι	Appear	Φάνηκα	-	-
Φέρνω (-φέρ(ν)ω)	Bring	Έφερα	Φέρθηκα	Φερμένος
Φεύγω	Leave	Έφυγα	-φεύχθηκα	-
Φθείρω	Corrupt	Έφθειρα	Φθάρηκα/ εφθάρην	Φθαρμένος
Φορώ	Wear	Φόρεσα	Φορέθηκα	Φορεμένος
Φταίω	Am to blame	Έφταιξα	-	-
Φυλά(γ)ω	Guard	Φύλαξα	Φυλάχτηκα	Φυλαγμένος
Φυσώ	Blow	Φύσηξα	-	-
Χαίρομαι/χαίρω	Am glad	Χάρηκα	-	-
Χαλώ	Spoil	Χάλασα	-	Χαλασμένος
Χορταίνω	Am satiated	Χόρτασα	-	Χορτασμένος
Χυμώ	Swoop	Χύμηξα	-	-
Χωρώ	Fit in	Χώρεσα	-	-
Ψάλλω/ψέλνω	Chant	Έψαλα	ψάλθηκα	Ψαλμένος
ωχριώ	Turn pale	Ωχρίασα	-	-

APPENDIX IX

Greek Word Frequency List (Accompanying CD)

The Greek word frequency table presented in the accompanying CD was devised using primary school textbooks. The procedure was the following: at first we collected all the textbooks that are used during the literacy hour at grades 1, 2, 3, 4, 5 and 6. The same textbooks are used at all schools across Greece and the same phonics-based reading instruction is implemented. The books were gathered from one of the Primary schools in Thessaloniki where the data collection took place. Twenty-two reading books were collected, four from each grade with the exception of the first grade textbooks that were just two. The books contained short texts, mainly short stories or poems, and grammatical and orthographic exercises for pupils to complete. The next step was to use a computational programme for scanning the texts included in the books. The pages of Greek text were scanned using optical character recognition, which produced word documents of the texts. The words in the exercise sections of the books were not scanned. Following that, a computer programme was written, which at first identified every word included in the documents, and then the number of instances of each of these words. The computational programme produced frequency lists. The frequency table contains 8,335 words arranged by frequency of occurrence. The maximum frequency is 1470 and the minimum is 1. The words that have the highest frequencies are monosyllabic articles, prepositions or pronouns. The words with the lowest frequencies are mainly polysyllabic verbs, nouns and adjectives.