Thesis

Title: Quantitative and qualitative differences in reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students

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Quantitative and Qualitative Differences in Reading Performance between Greek Language Teachers & 12th grade Pupils and between Adult Dyslexic & Non-Dyslexic Students

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Aims & Objectives of the Research

The aims of the current study were to find out *"whether significant quantitative and/or qualitative differences in reading Greek texts exist between:*

a) *teachers of Ancient Greek and pupils of the 12th grade,* and
b) *adult dyslexic university students and matched for age, sex and socio-educational level normal controls*

in terms of reading speed, accuracy, the amount and kind of reading errors, as well as the level of reading comprehension".

The common characteristic between these seemingly different aims is the reading process from pupils to students, disabled and non-disabled, to teachers. The results may prove important for both theoretical and practical reasons, as they will illuminate in a comprehensive way the reading process in the Greek language by investigating its components *(reading speed, accuracy, and comprehension)* at multiple educational levels, from high school pupils through university students, focusing particularly on dyslexics, to adult and professional life.

The current study may also contribute in a better understanding of learning difficulties related to reading, and dyslexia in particular, in the development of more appropriate teaching methods as well as in the establishment of more accurate diagnostic criteria for adult dyslexics and individualised treatment methods.

Thus, to be more precise, the results will prove significant and useful for both the participants and the society:

For the participant: The results will help the participants, especially dyslexics, to find out any difficulties they encounter related to the reading process and to choose the appropriate methods to deal with.

For the society: The results of the current study will prove important, as they may lead to new approaches and teaching methods for learning Ancient and Modern Greek, as there will be a comparison of the level of difficulty between the 2 languages. Such a comparison will determine whether the existing differences in language structure *(syntactic & grammatical features, intonation marks, etc.)* facilitate or hinder the efficiency in reading. New approaches and methods may be more effective and useful for teachers, who teach Ancient and Modern Greek, but also for pupils, who learn Ancient and Modern Greek. Furthermore, results will fill in our knowledge about dyslexics, especially adults, so that they will be treated in a more fair and effective way. It is unfortunately known that in our society any derivation from the ideal is often rejected or even excluded. Learning disabled pupils and students are usually treated unfairly. Because of the society's ignorance they do not have the support they need neither at home nor even school or later University. Thus, the accurate and on time diagnosis will contribute in the development of individualised treatment methods that will improve the social, psychological and educational level of adult dyslexics.

Concluding, hopefully the present study may become the basis for further research in the Greek language, so that the reading process will be fully investigated.

Abstract

The significance of reading is undoubted today, while learning to read efficiently is a main aim of every educational system. Reading is one of the greatest challenges that pupils, students and adults have to encounter daily at school, university and professional life, especially dyslexics, for whom it is a really hard and demanding process. Given the importance of reading and the various factors can positively or negatively influence the reading ability, the current study aims to investigate to what extent the reading process is affected a) by familiarity with text, and b) by biological-constitutional factors. In this respect, the reading performance a) of Greek language teachers was compared to that of 12th grade pupils, and b) of adult dyslexic students to that of age-matched normal controls in terms of reading speed, accuracy and comprehension.

The reading performance of teachers and pupils was evaluated in an Ancient Greek text and its corresponding translation in Modern Greek. The reading performance of adult dyslexics and controls was evaluated in 2 texts of varying difficulty and a list of words of raising difficulty. Participants read both aloud and silently, while being timed and tape-recorded for further analysis. After reading each text, they answered to reading comprehension questions.

Pupils made significantly more reading errors compared to teachers in both Ancient ($p < .001$) and Modern Greek ($p <.05$). However, they were significantly faster than teachers in all reading procedures ($p < .001$), while they did not lack in comprehension ($p > .05$). Both groups made similar reading errors in both Ancient and Modern Greek. Finally, comparing the two languages, both teachers and pupils were significantly faster ($p < .001$), comprehended better ($p < .001$) and were more accurate ($p < .05$) in Modern Greek.

Adult dyslexic students were significantly slower ($p < .001$), attained lower level of comprehension ($p < .05$) and made significantly more reading errors ($p < .001$) than the control group in all reading procedures. In contrast to non-dyslexics who read significantly faster silently ($p < .05$), dyslexics read at almost the same rate in both aloud and silent condition ($p > .05$). Additionally, the former attained higher level of comprehension in the silent condition, as opposed to the latter, who showed a trend to comprehend better aloud. Comparing reading in context and out of context, dyslexics made significantly more reading errors in the word list ($p < .001$), whereas non-dyslexics made comparable reading errors in the word list and the two passages ($p > .05$). Both groups made similar reading errors. Finally, logistic regression analysis revealed that the 2 groups could be almost perfectly differentiated based on only one variable, namely reading speed (classification accuracy 98.1%).

Findings confirmed that the reading process in the phonologically consistent Greek language is influenced by factors, such as language structure and familiarity with print as well as by biological-constitutional factors. Results emphasise on the importance of daily extensive reading practice for a better reading speed, at least, which is essential not only for normal-achieving population but dyslexic readers as well, since reading speed was found to be the latter's main deficit and the main differentiating factor between dyslexics and controls.

The results may be useful for effectively addressing the difficulties encountered not only by pupils who are taught but also by teachers who teach Ancient and Modern Greek, as they may lead to new teaching methods and learning strategies. Also, results might be helpful for the accurate diagnosis of adult dyslexics based on reading speed, as well as for the effective treatment of the difficulties dyslexic university students still encounter, due to their constitutional reading deficit.

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CHAPTER 1

INTRODUCTION

1.1. Reading: Historical Review

Reading and spelling's significance is undoubted nowadays. In every modern society, learning to read and spell is each educational system's main aim and constitutes the focal point of the social interest. Literacy skills are of the most essential someone should be equipped with, as they increase educational and professional opportunities, promote social and financial adaption and offer entertainment chances.

Reading and spelling have long been a main point of concern for most societies throughout all periods of human activity. In ancient times, a great part of the citizens in Athens of the 5th century B.C. were literate, being able to read laws that were posted around the city (Stubbs, 1980), except for many Athenian women and citizens of other districts of Attica who were *"illiterate or semi-literate"* (Harris, 1991, p.8). Similarly, throughout the Roman Empire a great deal of the population was learning reading and writing. Besides, written documents were used for governmental and administrative purposes, and there were, also, many authors at that time. In addition, a number of graffiti and inscriptions, for example signs on the gates saying "CAVE CANEM" *(= beware of the dog)*, indicated Romans' literacy skills, though not actually spread to women, artisans or farmers in imperial Italy.

Later, in the so-called Middle Ages *(from the 5th to the 15th century A.C.)*, literacy was still not a universal skill across Europe. Mainly surviving in monastic communities, with the invention of the library or *"scriptorium"* in the 13thcentury, as a large reading and writing room with large benches and shelves of chained books in monasteries (Petrucci, 1995), it was also proved that literacy was still a privilege of the clergy. During that period, the aristocracy gradually began to discover the joy of written word. In the aristocratic "yards", reading was a social activity. In the late medieval period, literacy skills spread further down the social strata, as reading and writing were necessary for several merchants and townsmen to carry out their occupations, while judges, lawyers, and scriveners were drawn from the laity (Tillotson, 2005).

In the beginning of the 16th century, the Reformation, the market economy, schooling, industrialisation and many other factors contributed to the wide expansion of literacy (Venezky, 1991). Human desire to know and monitor what was happening in distant political centres, the need to communicate, and the mental expansion were directly related to the spread of literacy. Also, printing press (Venezky, 1991) and technology (Harris, 1991) contributed to the wide spread of literacy since then.

Towards the end of the 17th century and the beginning of the 18th, being literate was considered to be really important. In Sweden and Finland, parents were obliged by the government to teach their children to read, and they had to pay fines if they failed to do so (Harris, 1991), whereas adults could be prevented from being married if they could not prove some literacy (Venezky, 1991; McCormick & Zutell 2010). Also, literacy, in western countries, was promoted so that citizens would be educated for political and military duties. A better education would mean an improvement of the nation's economic condition (McCormick & Zutell, 2010). Furthermore, the numerous schools, the large amounts spent for educational foundations, favouring compulsory schooling (Harris, 1991) consisted a proof that literacy gradually was becoming a main aim of the educational system.

Currently, since the beginning of the 19th century, the percentage of literates was gradually increasing and literacy was expanding, since basic education came to the forefront of the national and educational interest of almost all industrialised countries. The right of every child in education, learning and knowledge is now fundamental and consolidated by the law in all developed countries. Modern societies attempt to educate all members to the same extent and to successfully deal with learning difficulties. Besides, the progress of the scientific research in reading and writing has a positive influence in their scientific analysis not only at learning and teaching level, but also regarding the treatment of reading and spelling difficulties.

Summing up, from the times when literacy was promoted for political or religious purposes, for economic benefits or even personal enjoyment, and learning to read and write was a privilege of a minority, the situation is totally different today. Literacy skills have become a teaching aim of the educational systems and no one is excluded from becoming literate.

1.2. The importance of Reading

Even though reading, since it became a main teaching aim, was always attracting the educational and social interest, the care for learning to read has rapidly risen only since the beginning of the 20th century. It was during that century that reading also became the subject of the scientific research of several sciences *(e.g. Psychology, Pedagogy, Psycholinguistics, etc.)*. According to Porpodas (2002), in the end of the 20th century, a special cognitive branch in the field of Psychology was developed, namely the Psychology of Reading, which is now taught in many universities worldwide, including Greek ones.

In every modern society, every single person is expected to manage with reading. It is a social demand and a basic condition for his educational, social and professional inclusion, as, nowadays, written language has deluged our lives with plenty of printed material and unlimited possibilities to access information. In addition, reading is the main mean to acquire knowledge through the Internet, which invaded our lives (Porpodas, 2002). The social, economical, cultural and educational benefits of the reading skill have resulted in the increase of the interest for systematically studying the function of the reading process.

Furthermore, the determinant role of the reading ability in the quality but also in the efficiency of the educational system is undoubted. Keppel (1964) mentions that *"every examination of the problems of our schools of poverty, every question raised by troubled* *parents about our schools, every learning disorder seems to show some association with reading difficulty"* (p.8).

However, the reading skill is not totally understood yet in spite of its positive influences. Thus, it is necessary to analyse and investigate the reading process, in order to better understand its nature and function. Therefore, it may be possible to develop new methods for both teaching and learning reading, but also for the identification and treatment of any learning difficulties related to the reading process, because any difficulty in learning to read not early identified and successfully treated may possibly lead to educational, social as well as professional marginalisation. Besides, research has shown that learning disabilities exist across cultures, languages and writing systems (Pavlidis & Giannouli, 2003), with a percentage of almost 3-10% of the population, internationally, dealing with learning disabilities (Pavlidis, 1990).

1.3. What is Reading?

As stated in Vellutino and colleagues (2004), *"reading may be defined as the process of extracting and constructing meaning from written text for some purpose"* (p.5). The ability to learn to read requires the acquisition of a variety of knowledge *(e.g. world knowledge)* and skills *(e.g. memory)*, which, in turn, require normal development of reading-related linguistic *(e.g. linguistic processes)* and non-linguistic *(e.g. visual perception)* cognitive abilities. In general, reading is a complex process depending on adequate development of two component processes: decoding and comprehension (Shaywitz, 1998).

Decoding is a cognitive function involving the identification of written symbols and their translation into pronunciation *(phonological representation)*. Complete decoding enables access to the semantic memory, so as the meaning of a word to be perceived. Understanding the alphabetic principle seems important for acquiring proficiency in phonological decoding *(letter-to-sound transformation)* as well as awareness that written words represent spoken words and that they are comprised of letters which represent sounds is required (Vellutino et al., 2004). The role of decoding in learning to read is vital. Research in the field of specific learning disabilities indicated that reading disabilities are primarily manifested in inadequate ability in decoding print and word identification, and, hence, dyslexia could be defined as a decoding deficit (Vellutino et al., 2004; Snowling, 2000; Vellutino et al. 1994).

Reading comprehension involves not only integration of the meanings of written words in ways that facilitate understanding, but also integration of sentences in text, in order to perceive the broader concepts and ideas represented (Vellutino et al., 2004). Comprehension is the purpose of reading. According to Kendeou, Muis, and Fulton (2011), a common component of most definitions of reading comprehension is that *"it involves the construction of a coherent mental representation of the text in reader's memory*" (p.365), and, therefore, the reader, in order to understand a word, must access his semantic memory and recall its meaning. Finally, in order to comprehend written word, the reader *"must be able to identify the words contained in running text with enough accuracy and fluency to allow computation of the meanings embodied in the text within the limits of working memory"* (Vellutino et al., 2004, p.5-6).

There is much research supporting the view that decoding and comprehension are two distinctive components of the reading ability (Hoover & Gough, 1990). There are cases of individuals with superior comprehension abilities in the absence of decoding skill, such as the case of dyslexia (Gough & Tummer, 1986; Vellutino et al, 1996), or, conversely, there are individuals with superior decoding skills but inferior comprehension, such as the syndrome of hyperlexia (Healy, 1982). The differentiation between decoding and comprehension is also supported by the results of neuropsychological research studying the reading process. Functional magnetic resonance imaging studies suggested that different parts of the brain are responsible for the different cognitive functions of reading, such as phonological processing and comprehension (Shaywitz, 1996).

However, even though decoding and comprehension are two different cognitive functions, reading is the result of the reciprocal functioning of both decoding and comprehension. If decoding of a written word is inadequate, then reading is not accomplished. Similarly, there is no successful reading, if the meaning of the word decoded is not adequately perceived. Besides, Vellutino and colleagues (2004) suggest that adequate facility in word identification is a necessary although not sufficient condition for reading for meaning. Thus, decoding and comprehension may be different on the one hand, but inextricably related functions on the other.

1.4. How beginners develop the ability to read?

According to Ehri (1991), until relatively recently, researchers suggested two ways of how beginners read: *decoding* and *sight-reading*. Decoding means that the reader applies grapheme to phoneme relations, in order to transform printed words into pronunciation. According to this approach, reading is a process of transforming written symbols into phonological units, which enable access to the semantic memory, in order to understand the word. On the other hand, sight-reading indicates that the reader memorises the connections between the visual form of a word and its meaning without the interference of a phonological translation. As a result, written words can be identified and read independently of their phonological identity and, as far as the reader recognises the written symbols, he can directly access the meaning of the word.

These two ways were thought to emerge from different methods of instruction. Precisely, *"decoding emerged from phonic-oriented programmes"*, while *"sight word reading emerged from whole-word, look-and-say, meaning-emphasis programmes"* (Ehri, 1991, p.383). Research findings indicate that as readers develop their reading skill, they all become able to sight-reading whatever the method of instruction was. Furthermore, according to Ehri (1991), reading by sight is not necessarily a memorisation process that ignores grapheme-to-phoneme correspondence, as there are several ways to sight-reading, while, also, there are other ways to read besides the aforementioned, such as by analogising to already known words, by orthographic structure, or by contextual guessing. These ways may depend on the different instructional methods, but also other factors, such as the kind of words, the kind of reading and writing activities, or even the cognitive maturation, may influence which way is used by the reader.

1.5. Models and Theories of the Reading Process

What happens in a reader's mind when reading has for long been discussed by researchers, attempting to interpret the cognitive processes taking place. Thus, the need for understanding the nature and function of the reading process, which is *"a silent and internal process"* (Zaidah, 2003, p.104), has resulted in the development of different theories and models around it. Trying to explain how readers approach written language, in order to retrieve information, three types of reading models have been developed: the bottom-up models, the top-down models, and the interactive models.

The bottom-up and top-down models suggest that reading occurs in separate, sequential stages that, actually, do not interact with each other (Bakirtzis, 2005), whereas, in the interactive reading models, the different stages co-operate and help each other (Samuels & Kamil, 1984), and readers can move from higher to lower stages of the reading process and vice versa, in order to interpret written information.

The role the reader plays in text processing and comprehension has also been emphasised in these reading models. On the one hand, bottom-up models regard the reader as just decoding words and sentences, in order for the information contained in the text to be conveyed. On the other hand, in top-down and interactive models, the reader has an active role in deriving meaning from the text, either guessing words meaning before identifying them (top-down) or moving back and forth between processing stages to construct the right meaning (interactive), along with the reader's background knowledge that contributes to the construction of text meaning (Eskey, 1988). However, as the aim of the current research was not the investigation of the different reading theories that exist, it was impossible for all reading models to be presented here. Besides, it was not a purpose of the thesis to confirm or reject any of the existing reading theories. For this reason, some of the most representative reading models of each category *(bottom-up, top-down and interactive)* were selected to be described further down in the current section. Furthermore, these are the ones that are the most cited in the relevant literature.

1.5.1. LaBerge and Samuels' model (1974)

LaBerge and Samuels (1974) developed a bottom-up reading model including three processing stages: the *visual memory system*, the *phonological memory system* and the *semantic memory system*, suggesting that the reading process occurs following these stages in a linear order.

The first stage is the *visual memory* processing stage, responsible for taking the print information from the page, and deciding which size unit of print to use *(letters, letter clusters, entire words),* in order for the printed material to be recognised. Whether a small or large unit is used in word recognition is dependable upon several factors, such as the reader's skill and familiarity with the word, word difficulty, or even the contextual information surrounding it (Samuels, 1987).

Then, the *phonological memory* system takes action by recoding the visual units received in the previous stage, in order to find a sound unit to be mapped on (Samuels & Kamil, 1984). The size of sound units varies from phonemes to graphemes, and this print to sound mapping should occur with accuracy and automaticity by the reader (Samuels, 1987).

After words have been recognised, the *semantic memory system* processes them to attribute meaning to the print material. Incoming information and lexical information stored in the reader's memory collaborate to perceive and comprehend the written text. However, the knowledge stored in memory, along with the reader's attitude towards the print material, vary and affect what a reader can understand, thus explaining why a text can be interpreted differently by people (Samuels & Kamil, 1984).

This reading model emphasized on the *attention* given by the readers to each of the three memory systems described above. Samuels (2002, p.169) talked about attention as *"the cognitive energy used in mental processing tasks"*, which tasks in the case of reading are decoding and comprehension. Both these tasks require the reader's attention, which is of a certain amount in each person. How much attention is allocated to decoding and comprehension varies across different readers. Skilled readers need to spend more attention to comprehension, essential in every case written information is processed, as decoding occurs rather automatically for them. Readers' familiarity with the words in a text also affects the amount of attention needed (Samuels & Kamil, 1984). In less skilled readers, though, attention changes direction from decoding to comprehension quite frequently, so attention goes beyond its given amount and prevents the two tasks from being performed at the same time. Too much time and attention is wasted on decoding that these readers lack automaticity, the ability to correspond to demanding tasks with the least possible attention and effort (Samuels & Flor, 1997).

1.5.2. Gough model (1972)

Another bottom-up model was developed by Gough (1972), who described that reading proceeds serially from letter to sound, to words, to meaning (Liu, 2010). It begins with the eye fixation upon the printed words on the page and then moves forward *(sometimes switching back and forth)* to fixate on other letters, in order for the written information to be formed as an "image" and enter the *iconic memory*. Then, the reader's *decoder* turns the letters (graphemes) into sounds (phonemes) and passes the phonemic representations to the *librarian*, where they are recognised as words and it is attempted to attribute a meaning to them with the help of the reader's mental lexicon. The lexical entries of each word are stored in the reader's *primary memory*, until the whole sentence is processed, which in turn is processed by *Merlin* applying syntactic and semantic cues to give sentence a meaning and move in the "Place Where Sentences Go When They Are Understood" (PWSGWTAU) (Gough, 1972; Zaidah, 2003). Just then, it is the *editor*'s turn to apply phonological rules, and the sentence is placed at the *script* and finally at the *vocal system* (Zaidah, 2003), where the reader produces an oral representation of the sentence (Bown, 2004).

According to this model, higher-level processing of information has no influence on any lower-level processing (Liu, 2010), and the reader's knowledge of the language is not accounted as an important contributor to the text meaning (Bown, 2004).

1.5.3. Goodman model (1967)

Considering reading a psycholinguistic guessing game, Goodman developed a top-down processing model where readers bring their knowledge and expectations to the text, in order to construct meaning, by constantly predicting the meaning of the incoming information. Based on their prior knowledge and the content of the material, readers first guess the meaning of words and then identify them. They can utilize not only *graphic* information, to form a perceptual image of what they see, but also *syntactic* (grammatical and sentence sense) and *semantic* information (meaning) to make a guess, which will be either confirmed or rejected and a new guess will have to be made (Goodman, 1967).

In his model, reading is achieved through five processes. In the *recognition-initiation* process, the reader recognises the printed material. Then, he/she predicts the meaning and makes a hypothesis *(prediction stage)*. Subsequently, in *confirmation*, these predictions are checked, in order to be confirmed or not, depending on the incoming information. If the prediction is found incorrect and unable to be confirmed, written input is reprocessed and the reader corrects it *(correction process)*. Finally, the *termination* stage is where the reading task is completed.

For this theorist, efficiency in reading does not come as a result of identifying accurately all the elements in a word, but of the reader's skill to choose *"the fewest, most* *productive cues"* (Goodman, 1967, p.127) for more accurate first guesses. Hence, higher-level processes are embedded in the whole process, and the fact that the reader brings knowledge of the language to the text makes his/her role really active (Liu, 2010).

1.5.4. Rumelhart model (1976)

Rumelhart proposed an interactive processing model, which allows lower-level processes (word-identification) and higher-level processes (meaning) to interact (Samuels & Kamil, 1984).

Using four sources of knowledge, namely *syntactical knowledge, semantic knowledge, orthographic knowledge,* and *lexical knowledge*, the reader's *pattern synthesizer* is activated and allows an interaction of all these different types of knowledge, in order to derive meaning of what has been registered by the reader's *visual information store* (Zaidah, 2003). The *message centre* of the brain holds all the information, where the different hypotheses about the written input are assessed by the appropriate type of knowledge, so as to be confirmed or not, and new hypotheses to be entered (Samuels & Kamil, 1984).

The active role of the reader is once again emphasised, as he/she constantly forms hypotheses about the text meaning.

1.5.5. Stanovich model (1980)

Also known as *interactive compensatory model*, Stanovich tried to evolve Rumelhart's model. He developed it under the concept that lower-level processes while reading can compensate for higher-level processes and vice versa (Samuels & Kamil, 1984; Zaidah, 2003). With this, he wished to incorporate skilled and poor reading. Suggesting a direct interaction between the Rumelhart's sources of knowledge, if there is a deficiency in any of these sources, the reader, either skilled or unskilled, can compensate by relying on another knowledge source that is better developed, regardless of their hierarchy in the whole reading process.

For example, a poor reader, who shows a weakness at automatic word recognition (lexical knowledge), may rely on his syntactic and semantic knowledge, in order to identify the word and read the text more sufficiently. On the other hand, skilled readers do not use context cues to derive meaning from a text, because of their good sight word recognition and phonological decoding skills.

Consequently, the interactive feature of Stanovich's model lies at the possibility of any stage of the reading process to communicate with any other stage, and its compensatory one is in the sense that any reader may use his better developed knowledge sources when necessary (Samuels & Kamil, 1984; Stanovich & West, 1979).

1.5.6. Frith model (1985)

Adapting Marsh's developmental theory of reading and modifying his four stages in the reading process (*linguistic guessing*, *discrimination* based on visual letter cues, *sequential decoding*, *hierarchical decoding*), Frith divided her theory into three stages and processing strategies: *logographic*, *alphabetic* and *orthographic* strategies, which *"follow each other in strict sequential order"* in a three-phase model and each new strategy *"capitalise on the earlier ones"*, as she has hypothesised (Frith, 1985, p.307).

The logographic strategy seems to be applied in the first phase of this model. With a "look-and-say" method, where the child brings and applies his memory skills to the written word, and then directs to its meaning, a sight vocabulary can be developed.

In the next phase, the child adopts the alphabetic strategy. He or she is able to identify and transform graphemes to phonemes, based on correspondence rules, starting from simple rules and going on to the so-called context-sensitive rules (Marsh et al. 1981, as cited in Frith, 1985, p.307).

The last strategy to be adopted by children is the orthographic strategy. It includes the analysis of words as *"abstract letter-by-letter strings"* which can create an unlimited number of words when they are recombined (Frith, 1985, p.306).

1.5.7. Seymour Dual Foundation model

After extensive and elaborate studies, Seymour developed the “dual foundation model” (Seymour, 1997, 1999), proposing four phases that do not follow a strict order but they can overlap (Porpodas, 2006).

The phase 0, the *preliteracy*, refers to the pre-reading period, where the child cannot identify and process words or syllables or other language units.

In phase 1, the *foundation literacy*, children acquire the knowledge of letters of the alphabet and their corresponding sounds. Here, two processes are established: a) *logographic reading*, where children read a word by relying on some of the letters of the word (sight word recognition), and b) *alphabetic reading,* which includes decoding of every single letter to their sounds, later formed to pronounce the word (Porpodas, 2006; Seymour, 2007).

In Phase 2, the *orthographic literacy*, the children identify larger structural units that compose syllables, onset-peak-coda or onset-rime elements.

In Phase 3, the *morphographic literacy*, the linguistic units that are identified are whole syllables, or free and bound morphemes that can be combined and give the word a meaning (Seymour, 2007).

1.5.8. Ehri’s model

Examining the development of word reading and how it changes until it becomes *“fluent and automatic”* (Ehri, 2007, p.140), Ehri labelled four phases of development on the basis of the connections formed between the types of knowledge used.

During the *pre-alphabetic phase*, children read words by connecting visual features of the word, called cues, with their pronunciation or semantic representation stored in memory. Letter-sound connections do not occur. If any word reading takes place, it is performed by using non-alphabetic cues of words and contextual cues, as well (Ehri, 2005).

In *partial alphabetic phase*, children can use some of the letters of a word, often the first and final letters, to connect their sound to spelling and pronunciation, in order to remember how to read the word when encountered again. Unable to identify every single phoneme of the word, children only form partial connections, which are not helpful with reading new, unfamiliar words that may be mistaken for *"known sight words sharing similar letters"* (Ehri, 2007, p.144).

In *full alphabetic phase*, children are able to make alphabetic connections, namely connections between graphemes and phonemes. Being aware of the grapheme-phonemes correspondences, they can decode unfamiliar words (Ehri, 2005) and can secure and store sight words that have been entirely analysed (Ehri, 1999).

The *consolidated alphabetic phase* comes last in Ehri's phase model. Here, the connections between graphemes and phonemes are consolidated into larger units (rimes, syllables, morphemes, and whole words). Readers are facilitated with the knowledge of letter chunks, as the latter help them to remember how to read multisyllabic words and reduce the "burden" of their memory (Beech, 2005). For instance, the word "interesting", instead of being read as 10 grapheme-phonemes connections, is read as four syllabic chunks (Ehri, 2005).

1.6. Phonological Awareness

Phonological awareness and how it relates to the reading process has received the attention of research in the last decades. Vellutino and colleagues (2004) argue that *"phonological awareness refers to conceptual understanding and explicit awareness that spoken words consist of individual speech sounds (phonemes) and combinations of speech sounds (syllables, onset-rime units)"*. Furthermore, such awareness *"is believed to be important for learning that letters carry sound values and for learning to map alphabetic symbols to sounds"* (p.4-5). Similarly, according to Porpodas (1999), phonological awareness refers to the *"ability to isolate and manipulate the constituent sounds of spoken words by* *gaining access to, and performing, mental operations on the word's phonological information"* (p.407).

Many researchers, in several alphabetic languages, have extensively studied the relationship between phonological awareness and reading success. The main finding of such kind of research was that insufficient awareness of the phonological structure of words is associated with poor reading ability, while, in contrast, superior phonological awareness is related to reading success (Porpodas, 1999). Currently, there is abundant evidence that phonological awareness is a major discriminator between good and poor readers (Vellutino et al., 2000; Elbro, Borstrom & Petersen, 1998; Juel, 1988; Juel, Griffith & Gough, 1986; Tunmer & Rohl, 1991; Liberman & Shankweiler, 1985; Liberman et al., 1989). Even research conducted in the Greek language suggested that phonological awareness could distinguish between disabled and non-disabled beginning readers (Aidinis & Nunes, 2001; Porpodas, 1999; Nikolopoulos et al., 2006).

Even though the vast majority of researchers agree that there is an actual relation between phonological awareness and reading achievement, their main disagreement concerns the causal or non-causal character of this relationship. This disagreement has led to the formation of three different viewpoints.

Many researchers argued that phonological awareness is a precursor and a strong predictor of reading achievement across languages, and suggested a causal relation between a child's phonological awareness and reading development, namely supporting that phonological awareness skills are prerequisite for learning to read (Bradley & Bryant, 1983; Hoien, Lunberg, Stanovich & Bjaalid, 1995; Lundberg, Frost, & Petersen, 1988; Bryant, MacLean, Bradley & Crossland, 1990; Goswami, 2008; Snowling, 2000; Scanlon & Vellutino, 1996; Liberman & Shankweiler, 1985; Snowling, 1981; Goswami & Bryant, 1990). Bradley and Bryant (1983) found a strong relationship between children's sensitivity to certain phonological tasks when they begin school and their reading development over the next 3 years. Goswami (1986) has shown that even 5 year-old children, who had not begun to read yet, were able to use rime analogies to read new words. Goswami and Bryant (1990) proposed a reading development model suggesting that children who are more experienced in rhyme develop such awareness before they begin to read. Finally, a strong relation between limited knowledge of the phonological structure of oral language and reading disability was found, indicating that awareness of the phonological structure of language in beginning readers is predictive of reading ability (Scarborough, 1991; Mann & Ditunno, 1990; Mann & Liberman, 1984; Shankweiler & Liberman, 1972; Liberman, 1973; Shankweiler et al., 1979). Snowling, Goulandris and Stackhouse (1994), based on case studies, suggested that the width and intensity of phonological difficulty in children might be a predictor of reading disability.

Conversely, other researchers claimed that phonological awareness comes as a direct consequence of learning to read, and, as a result, it is affected and facilitated by the reading process. Morais and colleagues (1979), for instance, in their research on Portuguese found that illiterates were worse on phonological tasks compared to ex-illiterates, who had learned to read in adulthood and, thus, they concluded that learning to read has led to greater phonological awareness rather than vice versa. Similar findings were drawn from studies comparing readers of alphabetic and logographic orthographies. Read and colleagues (1986) found that logographic readers *(Chinese logographic orthography)* were significantly worse at phonological skills than alphabetic script readers *(alphabetic version of Chinese)* concluding that learning to read, particularly in an alphabetic system, leads to the development of phonological awareness skills. The same conclusion was reached by Mann (1986) who compared Japanese *(logographic)* to American *(alphabetic)* six-year old learners.

Finally, according to the third point of view, phonological awareness and reading are thought as mutually and reciprocally related, with phonological awareness being both a prerequisite and a result of learning to read (Perfetti et al., 1987). This latter view is mainly supported by research aiming to investigate the effectiveness of various teaching approaches for learning to read. Results revealed better reading development, when both training in phonological awareness and reading by learning grapheme-to-phoneme correspondence are integrated in the teaching method. Hatcher and her colleagues (1994) investigated the reading progress of groups of beginning readers and found that the group taught and practiced in both reading and phonological skills made the most progress in reading compared to groups trained either in reading or in phonology alone. Similarly, Hatcher and colleagues (2004) concluded that training in phonological awareness combined with phonic reading instruction *(linking phonemes with letters)* would be beneficial for children at risk of reading failure.

It is noteworthy that the theories of phonological deficit are contested theories. The phonological theory, which is considered the most influential among the theories of dyslexia, is presented later in the third chapter of the current thesis that focuses on dyslexia (p. 163-164). The phonological theory has been critisised lately as not been able to adequately explain the cause of dyslexia (see p. 168-169). This becomes most evident in the results of this thesis, where it was found that reading speed was the parameter that could extremely accurately differentiate dyslexic from non-dyslexic students, a fact that runs contrary to the premises of the phonological theory.

Some researchers claimed that the concept of phonological awareness should be divorced from the notion of consciousness, which is inherently involved in a term such as *"awareness"*. Stanovich (2000) proposed the term *"phonological sensitivity"* instead of awareness. He argued that phonological sensitivity could be best described along a continuum from shallow sensitivity of larger phonological units to deep sensitivity of smaller phonological units.

Two levels of phonological awareness have been identified: *implicit phonological awareness*, which refers to the ability to analyse words into their constituent sounds at syllabic or sub-syllabic level, and *explicit phonological awareness* or *phonemic awareness*, which refers to the ability to detect and manipulate phonemes within words (Harris &

Giannouli, 1999). Implicit phonological awareness develops before schooling and does not require reading acquisition, while phonemic awareness develops as children learn to read.

Much research has found that phonemic awareness plays a central role in learning to read irrespective of the orthographic regularity of the alphabetic script, as developing phonemic awareness goes with developing expertise in reading. Segmentation and manipulation of phonemes is essential for the development of good grapheme-to-phoneme correspondence, necessary skills when reading using an alphabetic strategy and converting letters to sounds (Harris & Giannouli, 1999). On the other hand, there is plenty of research indicating that implicit phonological awareness predicts early reading success for orthographically irregular languages, such as English (Bradley & Bryant, 1983), and Danish (Lundberg, Frost & Petersen, 1988).

Research has revealed the general developmental sequence of phonological awareness, in its various forms. The pattern of development refers to sensitivity to smaller and smaller parts of words over time. Children generally can detect and manipulate words before syllables, syllables before onsets and rimes, and onsets and rimes before phonemes (Goswami, 2008; Ziegler & Goswami, 2005; Anthony & Francis, 2005; Anthony & Lonigam, 2004; Anthony et al., 2003, 2002). This means that the development of phonological awareness proceeds from syllabic through onset-rime to phonemic level (Goswami & Bryant, 1990; Bryant & Bradley, 1983; Treiman & Zukowski, 1991). According to Goswami and Bryant (1990), the awareness of syllables, onsets and rimes appears to develop long before children go to school and begin learning to read, while the awareness of phonemes appears to develop as reading is taught. The same authors argued that children adopt different strategies in early reading stages. They initially rely on a global-visual approach to recognise words, but through reading experience they gradually become aware of the phonemic nature of the language and they develop skill in using the knowledge of sounds. Similar findings were reached by Bryant and Bradley (1983) who found that beginning readers seem to adopt a visual strategy recognising words as logograms. And, as they become more proficient, they begin to use phonological coding rather more.

But, here lies the question: Does this developmental sequence of phonological awareness remain the same in individuals who are growing in different linguistic environments? In fact, this does not seem to be the case for regular languages. For instance, Wimmer, Landerl and Schneider (1994) found that, in German, phonological awareness is not predictive of early reading success but only of later reading achievement, as far as children develop an alphabetic reading strategy very rapidly, relying on indirect word recognition via grapheme-phoneme translation. They argue that this is in contrast to irregular orthographies like English, where reading makes greater use of units larger than phonemes in the initial stages of reading. Cossu and colleagues (1988) compared English-speaking children to Italian in terms of phonological segmentation abilities. They found that, although in preschool age syllable segmentation was stronger than phoneme segmentation for both groups, by entering school, this pattern was reversed for Italian children, while remained unchanged for Americans.

However, more recently, Goswami (2008) argued that the developmental sequence of phonological awareness is language-universal; she concluded that children across languages develop good syllable and onset-rime awareness prior to receive reading instruction. Nevertheless, she suggested that, as languages vary in syllable structure and orthographic transparency, there is divergence in the rate at which phoneme awareness is achieved and decoding skill develops as well as in the reading strategies used, as it will be discussed further down the current chapter.

As far as it concerns phoneme awareness, studies reported high levels of success in identifying phonemes within words for children learning to read in transparent orthographies: 100% correct for Greek (Harris & Giannouli, 1999), 97% correct for Italian (Cossu et al., 1988), 94% correct for Turkish (Durgunoglu & Oney, 1999), and 92% correct for German 1st graders (Wimmer et al., 1991). In contrast, studies of English-speaking 1st grade (Tunmer & Nesdale, 1985) and 2nd grade (Perfetti et al., 1987) children reported 71% and 65% success, respectively. Similarly, Demont & Gombert (1996) reported only 61% success for French children at the end of grade 1.

It is obvious, therefore, that there is no perfect scientific consensus yet. Hence, it is important to emphasise that research findings should be treated with caution before dragging any conclusions. Particularly when it comes for cross-language comparisons, the following problem should not be ignored: it is quite difficult to control for socio-cultural differences across languages, such as different school systems, curricula, teaching methods, or demographic distributions.

1.7. Reading in different languages

The way a child begins to read depends on two factors: the *writing system* (Perfetti & Marron, 1998) and the *method of instruction* used, as stated earlier (Ehri, 1991). It may also depend to a significant extent on other factors, such as motivation for reading and reading experience at home before schooling (Cunningham & Stanovich, 2001; Baker & Scher, 2002). Reading and writing are inextricably connected and although the present study focuses on the reading process, it would be wiser to briefly go through writing as well, because written language is in fact the written representation of the oral one *(written encodes oral language)* and the way that language is represented in written depends on its oral form *(oral decodes written language)*.

Compared to oral language, which is characterised by universality and has biological foundations (Lenneberg, 1967; Petitto, 2000), writing may be considered as a tool invented by humans to transmit thoughts and feelings as well as to encode concepts through visual signs comprehensible either by themselves or by others (Gelb, 1963); it is a tool of communication. Besides, as sound *(oral language)* is ephemeral, writing was invented to help language last through time (Clairis & Babiniotis, 2004).

Different cultures in the world use different writing systems. Learning to read in English, for example, is totally different from learning to read in Chinese or Arabic. Linguists distinguish between two different categories of writing systems and, hence, of encoding oral language: 1) logographic, which could further divided into pictographic, ideographic and abstract-logographic, and 2) phonographic, further divided into syllabic and alphabetic scripts (Köhler, 2008). However, the most common and basic categories are: a) logographic, b) syllabic, and c) alphabetic. Pictographic systems, for instance, are very rare, as, according to Sebba (2011), *"few if any existing languages have pictographic writing systems"*. The critical difference among writing systems is how the script codes the language units. Writing systems evolved from logographic through syllabic to alphabetic (Sebba, 2011).

a) Logographic systems

Logographic systems were the first that have been developed. In those systems, written symbols, defined as logograms, represent units of language with a conceptual content, such as words or morphemes. A logogram is a single written character representing a complete grammatical word. They are defined as logographic, because their main characteristic is that the written symbols they use do not include distinctive orthographic elements, but they are characterised by the direct correspondence between written form and phonological identity; they directly code meaning. Chinese and Japanese Kanji are of the most representative examples of logographic writing systems. The major disadvantage of logographic systems over the others is the difficulty to memorise the thousands of logograms required to represent all the words of a language.

b) Syllabic systems

Syllabic systems are the intermediate stage between logographic and alphabetic writing systems. The need to overcome the disadvantages of the logographic systems led to the development of syllabographic systems. Their basic principle is that spoken words can be analysed into oral language units with no conceptual meaning, such as syllables, which may then be represented in the written word and which are significantly less than the words of a language. Symbols typically represent syllables. Japanese Kana is an example of syllabic writing system, while generally syllabaries are relatively rare nowadays. Syllabaries are best suited to languages with relatively simple syllable structure, such as Japanese, as possible syllables in Japanese are no more than fifty to sixty.

c) Alphabetic systems

Alphabetic systems correspond to the last stage of writing development. In this case, the unit of oral language, which is represented by each written symbol, is the phoneme, while the unit of written language used to represent one or more phonemes is the grapheme. Phoneme is the smallest meaningless unit of sound that has differentiated value and with its contrast to other phonemes is changing the meaning of words (Clairis & Babiniotis, 2004). For example, the letters *c*, *p* and *r* differentiate the meaning of the English words *can*, *pan* and *ran* and, hence, are phonemes. Therefore, alphabets are rules of correspondence between printed symbols *(graphemes)* and speech sounds *(phonemes)*.

Currently, almost all European languages, including the Greek one, use alphabetic writing systems. The first alphabetic systems developed had characters only for consonantal sounds with no provision for vowels at all. Greeks were those, who denoted the vowels for the first time and created the first actual alphabetic script, where each letter represents a phoneme (Babiniotis, 2005). In many alphabetic systems, letters are actually less than phonemes.

The main advantage and effectiveness of alphabetic systems lies in the ability to represent in writing thousands of words of a language using only a small set of printed symbols. However, during the reading process, the reader should know the way phonemes are linked to graphemes. And, learning such a process is not easy. Furthermore, an additional difficulty is that consonant phonemes are not easy to be isolated, deducted and represented without a vowel phoneme following. This fact may also have contributed in the late development of alphabetic systems (Porpodas, 2002).

In addition, it is possible that a letter corresponds to one or more sounds. Thus, processing and memorising the identity of each letter as well as its position, order and orientation within the word is required, in order to recognise the word and access its meaning (Bakirtzis, 2005).

Despite their differences, alphabetic systems all work on the same principle, the association of a phoneme to a grapheme, which is the key to a productive writing system. Such a writing system should be characterised by flexibility and produce unlimited number of words from a small set of reusable symbols. For example, the 24 letters of the Greek or the 26 letters of the Latin alphabet correspond to very productive writing systems.

1.8. Consistent & Inconsistent Orthographies: Implications in the Reading Process

Languages vary in their degree of phonological consistency and that is why some are considered more consistent than others (Goswami, 2008, 2005). Orthographic transparency or phonological consistency describes to what extent a letter or a letter string in a word is pronounced equally in others. According to the degree to which a written language deviates from one-to-one grapheme to phoneme correspondence, the orthographic systems are classified into two categories:

a) *Shallow* or *regular* or *transparent* orthographic systems are those, where there is an almost one-to-one letter *(grapheme)* to sound *(phoneme)* correspondence and vice versa *(high degree of transparency)*. To put it in other words, a letter or letter cluster is always pronounced the same way and, conversely, a phoneme is almost always spelled the same way. Greek, Italian, German, and Spanish are of the most representative examples of transparent orthographies (Goswami, 2008).

b) *Deep* or *irregular* or *opaque* orthographic systems are those, where there is no one-to-one grapheme to phoneme correspondence, but a letter *(grapheme)* may have multiple pronunciations *(phonemes)* and vice versa, a phoneme can have multiple spellings *(low degree of transparency)*. English, Danish, French are among the most characteristic examples of opaque orthographies (Goswami, 2008; Ehri, 2005; Seymour, Aro & Erskine, 2003).

Goswami (2008), and Ziegler and Goswami (2005) claim that it is much easier to become aware of phonemes and acquire reading skills in consistent languages, where a letter is always equally pronounced, whereas it is relatively hard to learn about phonemes, if a letter can have multiple pronunciations.

According to Venezky (1995), grapheme-phoneme patterns can be classified into a) *invariant*, b) *variant-predictable*, and c) *variant-unpredictable*:

a) a grapheme corresponds to a single phoneme
b) a grapheme corresponds to two or more phonemes; a set of features determines the different pronunciation in each case *(e.g. the position within the word, adjacent letters, etc.)*.
c) a grapheme corresponds to two or more phonemes, but there are no rules to determine the different pronunciation.

The Greek orthographic system, which is the focus of the current study, is not entirely phonetic, but it has a morphophonemic nature. Most of its grapheme-phoneme inconsistencies are variant-predictable, as they are rule-learned (Porpodas, 1999).

Seymour, Aro and Erskine (2003) categorised the European languages using two dimensions: *orthographic depth* and *syllable complexity*. Shallow orthographies are consistent in terms of mappings between graphemes and phonemes, whereas deep languages exhibit inconsistencies, as aforementioned. Languages with simple syllabic structures contain open syllables (CV) with few consonant clusters, while, on the contrary, complex languages have mostly closed syllables (CVC) and complex consonant clusters (Ehri, 2005), like in syllables CCVC, CVCC, or CCVCC, frequent in English (Goswami, 2008). The Finnish language followed by the Greek one is the most consistent orthographic system with the simplest syllabic structure. On the other hand, the most deep and syllabically complex writing system is the English one, which is characterised by Ehri as a unique case (2005).

According to Porpodas (1999), the Greek language, which is the focus of the current study, is pretty transparent in reading, while semi-transparent in spelling. In reading, it is characterised by a high degree of consistency in mappings between letters and sounds reaching an almost one-to-one correspondence. Any inconsistencies that exist are guided by rules making, therefore, the process of learning its pronunciation easy. However, in spelling, there are several cases with one-to-many phonemes to graphemes correspondence.

The existing differences between the various orthographic systems led to the assumption that the degree to which an alphabetic system represents the phonology and is characterised as deep or shallow is inextricably related to the reading process. This assumption is widely known as the Orthographic Depth Hypothesis (Katz & Frost, 1992). According to this hypothesis, shallow orthographies support word recognition involving phonology. In contrast, deep orthographic systems encourage readers to use morphological information via the visual-orthographic structure of written words. That is why beginners have much more difficulties and are slower in learning to read in relatively deep orthographies. Porpodas (1999) supports that Greek children, even beginners, use phonological strategies for reading acquisition and, hence, they learn to read through a sequential decoding process, whereas they are mainly based on morphology knowledge, in order to acquire spelling ability.

Similarly, Goswami (2005) suggested that, when an orthography allows one-to-one correspondence between letters and sounds *(transparent orthography)*, children have few problems in decoding and they learn to read relatively quickly, while in opaque orthographies, where there is one-to-many correspondence between graphemes and phonemes, learning to read takes children longer and with significantly greater difficulties. More recently, in 2008, she argued that both syllable structure and orthographic transparency led to differences in the rate at which children acquire reading skills and in the reading strategies used. Children, who are learning to read phonologically consistent languages with simple syllable structure, like Finnish and Greek, acquire decoding skills more rapidly as soon as they go to school and receive instruction on grapheme-phoneme correspondence. Conversely, children, who are learning to read phonologically inconsistent languages with complex syllable structure, such as Danish, French and English, acquire decoding skills at a significantly slower rate. English pupils, in particular, display the slowest progress in reading because of the rather high degree of inconsistency that characterises the English orthography.

A number of studies suggested that learning to read in English is harder than learning to read in other more transparent European languages (Goswami, 2005; Goswami, Gombert & Fraca de Barrera, 1998; Goswami, Porpodas & Weelwright, 1997; Porpodas, 1999; Wimmer & Goswami, 1994). The most striking evidence comes from a study reported by Seymour, Aro and Erskine (2003). Seymour, Aro and Erskine (2003) in collaboration with other scientists representatives of the COST Action A8 network compared the reading performance of 1st grade children across 14 European countries. Participants were matched for school grade and the instructional programs for learning to read they attended *(phonics-oriented)*, while the word and nonword items used were matched for difficulty across languages. Results revealed that decoding skills almost reached the ceiling for transparent European languages. For instance, in Finnish, Greek, German, Italian and Spanish, the accuracy of decoding both words and nonwords exceeded by far 90%. However, 1st graders learning to read French, Danish and Portuguese seemed to be less efficient readers, with their accuracy levels ranging from 63% *(Danish nonwords)* up to 88% *(French nonwords)*. The reduced levels of decoding skills in these languages reflect their reduced orthographic consistency. Finally, children learning to read in English were the less efficient readers, as they demonstrated the slowest rate of reading acquisition, achieving only 34% decoding accuracy for words and 29% for nonwords. Even a year later, English children managed to achieve only 76% and 63% for words and nonwords, respectively, percents still far below those shown by readers of consistent languages. Seymour, Aro and Erskine suggested that the rate of reading development in English is more than twice as slow as in more transparent orthographies.

In response to differences in orthographic structure across languages, evidence show that children develop different reading strategies. In languages with consistent alphabetic orthographies, children rely heavily on grapheme-phoneme recoding, in order to become skilled readers, whereas in less consistent languages, they develop strategies at multiple "grain sizes" *(whole word recognition strategies, rime analogy strategies & grapheme-phoneme recoding strategies)*. For instance, children learning to read English, which has a highly irregular orthography, need to develop all these strategies in parallel. For example, they need to develop whole-word strategies, in order to read irregular words like "cough" and "yacht", rime analogy strategies, in order to read irregular words such as "light" and "night", and grapheme-phoneme recoding strategies, in order to read regular words like "cat" and "pen" (examples retrieved from Goswami, 2008). It is a fact though that smaller grain sizes *(e.g. phonemes)* tend to be more inconsistent, meaning that children are developing strategies at larger phonological units. If this is the case, readers of inconsistent languages are always faced with the following problem: when the phonological system is based on larger units, there are many more orthographic units to learn; namely, there are more words than syllables, more syllables than rimes, more rimes than graphemes, more graphemes than letters. As a consequence, reading skills develop at a much slower rate, in contrast to children learning to read more consistent scripts, who tend to develop the strategies required more quickly. (Ziegler & Goswami, 2005; Goswami, 2008).

Thus, it is concluded that the observed differences between the various alphabetic writing systems may reflect the degree of ease or difficulty in reading acquisition and learning to read (Goswami, 2008). Therefore, it would be a severe scientific mistake trying to generalise the results, interpret the reading process and organise the teaching methods of reading in a transparent orthography like Greek based on research outcomes from a deep orthographic system with a complex syllable structure, such as English. It is really important to take into consideration the particular orthographic features of each language as well as the way they affect reading development. Hence, interlinguistic research of reading acquisition and research in each single language seem to be the solution, in order to obtain safe results.

1.9. Factors that Influence the Reading Ability

As discussed earlier, the ability to read is among the main milestones of education and, hence, leads to success in life. Unfortunately, some people suffer from restricted reading skills. During the last decades, educationalists and sociologists carried out research regarding the reasons of school failure with terms of psychogenic factors. They believe that difficulties in reading acquisition derive from various combinations of extrinsic factors. Reading difficulties could also be associated with individual differences and the development of personality. According to Vernon (2010), *"whether or not children learn to read competently must depend on the manner in which their cognitive processes develop and function"* (p.5).

Vernon (1957, 1971, 2010) studied the whole field of reading disability, its nature and origins and suggested that the following factors, accepted by most educational psychologists, can influence the reading ability and cause reading failure:

- Inadequate readiness for reading
- Physical handicaps, such as defective vision or hearing
- Genetic factors
- Neurological deficits
- Speech and language deficiencies
- Limited vocabulary

- Personality factors, emotional difficulties and maladjustment
- Restricted experience due to social and cultural deprivation
- Social factors; socio-economic status
- Environmental factors
- Unfavorable home environment; lack of home care
- Lack of motivation to learn; lack of parental encouragement
- Restricted educational opportunities
- Irregular school attendance, absenteeism; frequent school or teacher changes
- Defective teaching methods and school organisation
- Teachers' quality; Inadequate teachers' training

Similarly, Pavlidis (1981, 1990, 2013) agrees that poor or backward readers are deficient in one or more of the following factors known to negatively affect reading success:

- Intelligence
- Heredity
- Neurological & biological factors
- Perinatal causes *(e.g. anoxia, breech delivery, premature birth, etc.)*
- Impaired vision or hearing
- Physical health
- Socio-economic background
- Psychological problems
- Bilingualism
- Cultural priorities
- Low motivation for learning
- Environmental factors
- Reduced educational opportunities; teachers' and school quality

- Absenteeism
- Family environment; parents' educational background

Reading failure could be, therefore, attributed to one or more of the above factors being adverse. However, this does not mean that intervention focusing on improving one or more of these negative factors will necessarily result in improved reading performance. It is noteworthy that certain factors claimed to affect the reading process do not indeed do so, i.e. the phonological theory, because, even when a student has reached the level of perfection in phonological awareness either via treatment or in absolutely phonologically consistent languages, the reading disability remains. Finally, some neurologists and psychiatrists argue that the barrier in learning and reading acquisition is the result of cerebral injury (Shaffer et al., 1980; Alacron et al., 2000).

Nevertheless, reading disability attributed to biological factors (dyslexia) should not be confused with other poor reading caused by low IQ or other environmental factors. The distinction between dyslexia and other poor reading is extensively treated in chapter 3 (p. 160-162).

Furthermore, other factors related with familiarity with written material also affect the reading ability:

- Topic and domain knowledge (Estévez Monzó & Galvo, 2002; Vicente & Wang, 1998)
- Contextual knowledge (Miller, Cohen & Wingfield, 2006)
- Vocabulary knowledge (Estévez Monzó & Galvo, 2002)
- Word familiarity (Lewellen et al., 1993)
- Exposure to print (Cunningham & Stanovich, 1990; 1997)
- Interest in the passages read (Miller, Cohen & Wingfield, 2006)

1.10. The Current Study

The reading process and its difficulties caused by genetic factors or text difficulty are the focus of this thesis. Given the importance of reading and the various factors that can positively or negatively influence the reading ability, the current study aims to investigate to what extent the reading process is affected by language structure and familiarity with text as well as by biological-constitutional factors. For this reason, two research projects have been designed. In this respect, in the first experiment the effect of text difficulty on reading performance was studied, while in the second experiment the effect of biological causes, namely dyslexia, was examined. Therefore, the factor that links the two studies is the reading process itself.

In more detail, in order to investigate the effect of text difficulty on reading performance, as it is influenced by familiarity with the language structure and the words of the text in normal population, the first study was designed, which compared the reading performance of Greek language teachers and 12th grade pupils in Ancient and Modern Greek texts. On the one hand, Modern Greek is familiar for both teachers and pupils, read and spoken in everyday life, whereas Ancient Greek is unfamiliar, read only in and for school purposes. On the other hand, teachers of Ancient Greek are far more experienced than pupils due to their studies and professional experience, and, hence, more familiarised with both Ancient and Modern Greek reading.

In order to investigate, beyond familiarity with text, the effect of biological factors on reading performance, special population was employed, namely a group of dyslexics, who have a constitutional reading deficit. Thus, the second study compared the performance of adult dyslexic university students and normal controls in reading Greek texts. In the same venue goes the second study, as dyslexics, even high-educated students, read far less than normal readers throughout their adult lives, as a consequence of their reading difficulties

(Stanovich, 1986; Leinonen et al., 2001; Finucci, 1985; Fidler & Everatt, 2012). Hence, they face 2 hurdles:

1) their constitutional difficulty in recognising words and especially unfamiliar, and
2) their relatively limited familiarisation with written word; because they read less, the words become less familiar, as opposed to controls who read more, and, thus, the words of the text become more familiar and easier for them to recognise.

Concluding, the link between the two different studies and the two seemingly different experiments is the reading process itself from normal achieving (high school pupils, university students, teachers) up to reading-disabled population (dyslexics), as to illuminate in a comprehensive way the reading process in the Greek language. In the subsequent two chapters, each research project will be separately presented and discussed, whereas in the last chapter a general discussion of the research outcomes in relation with the current literature will follow.

CHAPTER 2

Research Project 1: Reading Performance of Greek Language Teachers & 12th grade Pupils in Ancient & Modern Greek

2.1. INTRODUCTION

In the current chapter, an attempt is made to investigate the evolution of the Greek language since its beginnings as well as to compare the level of difficulty between Ancient and Modern Greek with regard to the reading process, as performed by experienced Greek language teachers and 12th grade pupils.

2.1.1. The Greek Language

The Ancient Greek language is one of the oldest and most studied in terms of grammar, syntax and its richness. Modern Greek is less studied and is a derivation and somehow a simplification of Ancient Greek. The Modern Greek is spoken in Greece by almost 11 million people living there and in Cyprus *(by the Greek-Cyprian community)* and it is the official language of Greece (Mennen & Okalidou, 2006). It is also spoken in parts of the Greek immigrant communities *(e.g. in the U.S.A., Canada, Australia, etc.)*.

Historically, as Jojeph and Tserdanelis (2003) mention, *"Greek speakers have settled all over the eastern Mediterranean, in Southern Italy, along the Black Sea coasts, in Egypt, the Levant, Cyprus, and much of Asia Minor"* (p.1). This geographical spread continued throughout the Hellenistic period, through the Byzantine and Medieval periods into the Modern era.

The first written documents of the Greek language are located in the 13th century B.C., but it is undoubted that the Greek language existed from a long time ago. These first written documents were using a writing system borrowed from the ancient civilisations of East

Mediterranean, known as Grammic B′, which was not an alphabetic, but a syllabic system instead. The collapse of the Mycenaean civilisation drove this system to extinction, and since the 8th century B.C. an alphabetic system was adopted, similarly borrowed from the East, but adapted to the features of the Greek language, however (Babiniotis, 2005).

Since the discovery and the application of the Greek alphabet, some aspects of the oral form of the Greek language have undergone evolutionary and developmental changes, as it is the case of every spoken language. However, the written form has remained substantially unchanged. Compared to other Indo-European languages, the changes in the Greek language have been quite moderate. Thus, many features of the spoken form have remained almost unchanged throughout its long history. Among the features that have remained relatively constant are the pronunciation, several grammatical forms, elements of syntax, etc. (Tobaidis, 1994).

At this point and before starting the analysis of the structure of Ancient and Modern Greek, it would be useful to define what is meant by the terms "Ancient Greek" and "Modern Greek" used throughout the current section.

By the term "Ancient Greek" the language used during the period of the history of the Greek language defined as Ancient Greek period is meant. The chronological borders of that era were between 1400 and 300 B.C. (Babiniotis, 2005). However, since the 8th century B.C., the Greek language was further divided into several dialects, which differed according to the geographical regions, where they were used, division that survived until the 5th century B.C. By that century, a dialect known as attic, because it was used in the broader area of Athens, began to dominate over the others and in the end of the 5th century B.C. it was established as the common language throughout Greece. The development of Athens and its emergence into a panhellenic political and cultural centre resulted in the spread of their language (Tobaidis, 1994). Consequently, in the current study, it would be impossible to describe the characteristics of each single Ancient Greek dialect. Thus, since the attic dialect or classic

Greek, as it is widely known, was the dominant one and the basic language used in every kind of written word *(literature, prose, poetry, philosophy, rhetoric, drama)*, in the present research, when talking about Ancient Greek, the attic dialect will be meant and its structure will be presented in comparison to Modern Greek.

By the term “Modern Greek” the language recognised by the Greek state as the official one is meant. In 1976, the Greek government was convinced for the need for a formal language based on the oral language used by the majority of Greeks for their communication. Hence, in the present study, when the term “Modern Greek” is mentioned, the language used throughout Greece for both oral and written communication from its recognition as the formal language of Greece in 1976 until now will be meant (Babiniotis, 2005; Tobaidis, 1994).

The Greek language is a unique example of language with uninterrupted historical continuity and such a structural coherence that allows us to talk about a unified Greek language from antiquity until now; it had an uninterrupted oral and written tradition. Greek population, within the same geographical borders, has been continuously speaking and writing the same script and the same orthography for about 40 centuries. However, this does not imply that Ancient Greek is phonologically, grammatically and lexically identical as the language used in the beginning of the 21st century. Modifications in terms of pronunciation, grammar and syntax as well as in the vocabulary have been made, but the structural character did not change so much, so as not to be understood that it is the same language (Babiniotis, 2005).

2.1.2. The Structure of the Greek Language

The structure of the Greek language is a very important issue, because it is directly related to learning to read in Greek. As aforementioned, Greek script has a long history. The writing system of ancient Greece remains and is written and read in present-day Greece, although Modern Greek differs somewhat from Ancient Greek (Nakanishi, 1990). Generally, it could be said that Modern Greek does not differ from Ancient Greek in the development of new linguistic features, but it is somehow a simplification of Ancient Greek. This simplification has occurred between the end of the 4^{th} century B.C. and the 4^{th} century A.C., whereas since then changes have been minimal (Tobaidis, 1994).

The Ancient Greek orthography was entirely phonetic. This means that each phoneme was represented by a particular grapheme. However, evolutionary over time, the writing system stopped being phonetic, as in Modern Greek there are phonemes, which are represented by several letters, such as the phoneme [i] represented in writing by the letters *ι, η, υ, ει, οι,* and *υι*. Such inconsistencies are due to the change of the pronunciation of several letters, while their graphemic representations remained the same since antiquity. These changes were unavoidable, however, since every spoken language goes before written and is evolving, in order to be able to express the continuously changing human relations and experiences. Yet, the written language cannot follow the changes that occur in its oral form without formal state intervention, gradually making the correspondence between sounds and letters more distant and complicated *(creating distance between writing and pronunciation)*. Hence, Modern Greek orthography is considered historical to some extent, having as a result Greek language being written not the way it is pronounced today, but the way it was pronounced 25 centuries ago (Clairis & Babiniotis, 2004; Tobaidis, 1994; Hoffmann, Debrunner & Scherer, 1997).

It is obvious, therefore, that Ancient Greek language had a much more regular correspondence between phonemes and graphemes *(high regular orthography)* than Modern Greek, which is also considered a phonologically consistent language, however. But, since the Greek language had an uninterrupted oral and written tradition and Greeks never stopped speaking their language (Babiniotis, 2005), Ancient Greek is now pronounced using Modern Greek pronunciation. The ideal pronunciation of Ancient Greek though is that proposed by Erasmus, the so-called *Erasmian* pronunciation, which suggests *"a return to a reconstructed classical pronunciation"* (Dillon, 2001, p.324). The Erasmian pronunciation reflects the precise pronunciation of Ancient Greek and was spread in Europe (Hoffman, Debrunner & Scherer, 1997; Allen, 1987). However, as Greeks read Ancient Greek with Modern Greek pronunciation, there is no point trying to describe the phonology of Ancient Greek as it used to be in antiquity, but the pronunciation with which it is pronounced today. Thus, a Greek speaker, even if never taught Ancient Greek, is expected to be able to decode Ancient Greek script the same way he does, when he copes with Modern Greek.

2.1.2.1. Phonological System

Ancient and Modern Greek use the same alphabet. The phonological system of Greek consists of 24 letters used to represent a few decades of phonemes. Greek sounds depending on the vocal position during their articulation are divided into vowels and consonants (Clairis & Babiniotis, 2004; Tsopanakis, 1994). Seven (7) out of the 24 letters are vowels (α, ε, ι, η, υ, ο, ω) and seventeen (17) are consonants (β, γ, δ, ζ, θ, κ, λ, μ, ν, ξ, π, ρ, σ, τ, φ, χ, ψ). The phonemes of the Greek language along with their graphemic representations as well as their allophones are given in the following tables:

Table 1. Consonants produced in the Greek language

Graphemes	Phonemes	e.g.	Allophones	e.g.
π	p	**π**αιδί /**p**eδi/ (= child)	-	-
τ	t	**τ**οίχος /**t**ixos/ (= wall)	-	-
κ	k	**κ**άλλη /**k**ali/ (= beauty)	c	**κ**αιρός /**c**eros/ (= weather)
μπ	b	**μπ**αμπάς /**b**abas/ (= dad)	ᵐb	α**μπ**έλι /aᵐ**b**eli/ (= vineyard)
ντ	d	**ντ**ύνω /**d**ino/ (= dress)	ⁿd	πά**ντ**α /paⁿ**d**a/ (= always)
γκ	g	**γκ**ρεμός /**g**remos/ (= cliff)	ɟ ᵑg	κάγγελο /ka**ɟ**elo/ (= fence) αγγούρι /aᵑ**g**uri/ (= cucumber)
μ	m	**μ**αμά /**m**ama/ (= mom)	-	-
ν	n	**ν**ερό /**n**ero/ (= water)	ɲ	μπά**νι**ο /ba**ɲ**o/ (= bath)

			ŋ	άγχος /a**ŋ**xos/ (= stress)
β	v	**β**ιβλίο /**v**ivlio/ (= book)	-	-
γ	γ	**γ**άτα /**γ**ata/ (= cat)	j	**γ**ιαγιά /**j**aja/ (= granny)
δ	δ	**δ**ρόμος /**δ**romos/ (= street)	-	-
φ	f	**φ**ωτιά /**f**otia/ (= fire)	-	-
θ	θ	**θ**άλασσα /**θ**alasa/ (= sea)	-	-
χ	x	**χ**αρά /**x**ara/ (= joy)	ç	**χ**έρι /**ç**eri/ (= hand)
σ, ς	s	**σ**πίτι /**s**piti/ (= house)	z	**σ**βήνω /**z**vino/ (= erase)
ζ	z	ζιζάνιο /**z**izanio/ (= weed)	-	-
λ	l	**λ**ύκος /**l**ikos/ (= wolf)	ʎ	**λ**ιοντάρι /**ʎ**odari/ (= lion)
ρ	r	νε**ρ**ό /ne**r**o/ (= water)	-	-
ξ	ks	ξένος /**ks**enos/ (= stranger)	-	-
ψ	ps	**ψ**άρι /**ps**ari/ (= fish)	-	-
τσ	ts	ταρά**τσ**α /tara**ts**a/ (= terrace)	-	-
τζ	dz	**τζ**άκι /**dz**aci/ (= fireplace)	-	-

C, ɟ, ç, and *j* occur as allophones of *k, g, x,* and *γ* in front of the vowels *i* and *e*; *ʎ*, and *ɲ* occur as allophones of *λ*, and *n* before a sequence of *i* and another vowel both belonging within a single syllable; *ŋ* occur as allophone of *n* adopting the place of articulation of following fricatives; *z* occurs as allophone of *s* in front of voiced consonants (Mennen & Okalidou, 2006; Joseph & Tserdanelis, 2003); finally, ^{m}b, ^{n}d, and ^{ŋ}g sometimes occur as prenasalised allophones of *b, d,* and, *g*, respectively. It is noteworthy that these latter allophones can be used freely alternatively (Clairis & Babiniotis, 2004).

Table 2. Vowels & diphthongs produced in the Greek language

Graphemes	Phonemes	e.g.	Allophones	e.g.
ι, η, υ, ει, οι, υι	i	σπ**ί**τι /sp**i**ti/ (= house)	ç j	π**οι**ος /p**ç**os/ (= who) χωρ**ιό** /xor**jo**/ (= village)
ε, αι	e	ν**ε**ρό /n**e**ro/ (= water)	-	-
α	a	γ**ά**τα /γ**a**ta/ (= cat)	-	-
ο, ω	o	μ**ω**ρό /m**o**ro/ (= baby)	-	-
ου	u	**ου**ρανός **/u**ranos/ (= sky)	(w)	φρά**ου**λα /fra**w**la/ (= strawberry)
αυ	af	**αυ**τός **/af**tos/ (= he)	av	**αύ**ριο /**av**rio/ (= tomorrow)
ευ	ef	**ευ**χή **/ef**çi/ (= wish)	ev	**εύ**λογος /**ev**logos/ (= plausible)
ηυ	if	κατ**ηύ**θυνα /kat**if**θina/ (= I directed)	iv	**ηύ**ρα **/iv**ra/ (= I found)
αϊ, άι, αη	ai	κελ**αη**δώ /cel**ai**δο/ (= twitter)	-	-
εϊ	ei	θ**εϊ**κός /th**ei**kos/ (= divine)	-	-
όι	oi	κορ**όι**δο /kor**oi**δο/ (= sucker)	-	-

Ç and *j* occur as allophones of *i,* if not stressed, when it is found between voiceless consonants and vowels and in front of other vowels, respectively. In the second case, the phoneme *i* is realised as semi-vowel [j]. Sometimes but not necessarily, the semi-vowel *w* occurs as allophone of *u*, when vowel goes before (Clairis & Babiniotis, 2004).

As obvious, Greek orthography is fairly transparent, since most letters consistently represent the same sound. Some of the inconsistencies in the correspondence between phonemes and graphemes are the following with regard to vowels, in particular:

a) Some sounds can be represented by different letters or combinations of letters:

Phoneme **[i]** can be represented by the letters ***ι, η, υ, ει, οι***, and ***υι***.

Phoneme **[o]** can be represented by the letters ***ο,*** and ***ω***.

Phoneme **[e]** can be represented by the letters ***ε,*** and ***αι***.

Phoneme **[s]** can be represented by the letters ***σ,*** and ς.

b) Some letters are not pronounced and are almost soundless:

The double ***λλ*** is pronounced as **[l].**

The double ***κκ*** is pronounced as **[k].**

The double ***νν*** is pronounced as **[n].**

The double ***σσ*** is pronounced as **[s].**

The double ***μμ*** is pronounced as **[m].**

The double ***ρρ*** is pronounced as **[r].**

Letter ***π*** is silent, when it appears between ***μ*** and ***τ***.

c) Sometimes, the same letters can represent different phonemes:

Letter ***υ*** can be pronounced as **[i], [f],** and **[v].**

Letter ***ι*** can be pronounced as **[i]** or **[j].**

Letter ***τ*** can be pronounced as **[t]** or **[d].**

Letter ***π*** can be pronounced as **[p]** or **[b].**

Letter ***κ*** can be pronounced as **[k]**, **[c]**, or **[g], [ɟ].**

Letter ***σ*** can be pronounced as **[s]** or **[z].**

Another characteristic of the Greek language is the existence of many homonyms, words that sound exactly the same, but may have different spelling and totally different meaning. For instance, *τύχη /tiçi/* (= luck), and *τείχη /tiçi/* (= walls) in Modern Greek, which have exactly the same pronunciation, or the words *εἰ* /i/ (= if) and *εἶ* /i/ (= you are) in Ancient Greek. The existence of many homonym words hinders the reading process, as the reader should be totally aware of the word differences, in order to draw meaning from text. This is even harder in Ancient Greek, where minimum differences exist between homonyms, different intonation marks, for instance, that make the word recognition process even more difficult.

2.1.2.2. Syllable Structure

The Greek language is characterised by simple syllabic structure (Nikolopoulos et al., 2006). The characteristic of languages with simple syllabic structure is that they contain open consonant-vowel (CV) syllables with few consonant clusters (Ehri, 2005). Hence, the dominant form of the Greek syllables is the open CV syllable (CVCV, CVCCV, CVCVCV, VCCVCV, etc.), ending with a vowel (Nikolopoulos, 2006; Petrou, 2005). However, not all the consonants of the Greek language are allowed to be at the end of a word. Basically, the only two consonants encountered at the end of words are *ν* /n/ and *ς* /s/, and that occurs as they are required to denote a grammatical function of the particular word, e.g. *δάσκαλος* (= teacher), where the letter /s/ denotes the masculine gender of the word. Except for these two consonants, the consonant *ρ* /r/ is also allowed to appear at the end of Ancient Greek words, e.g. *ἔαρ* (= spring). Yet, Modern Greek has several loan words from English, e.g. *κομπιούτε**ρ*** (= computer), that allow some other consonants, too, to appear at the end of the syllables of such words (Koutsougera, 2008). On the other hand, the onset of Greek syllables allows several consonant combinations, for instance, with the sequence /s/ + /p, t, k, f/ + /l, r/, e.g. ***σκλ**άβος /**skl**avos/* (= slave), ***σπρ**ώχνω /**spr**oxno/* (= push), or cluster of two consonants /ps, pr, tr, kr, pl, tm, fl, xr, pn, pt/, e.g. ***πρ**ωί /**pr**oi/* (= morning), ***κρ**ύο /**kr**io/* (= cold), ***χρ**ώμα /**xr**oma/* (= colour) etc. Many consonant clusters can, also, appear in the middle of a word, whereas it is also possible for clusters of four consonants to occur, as well, e.g. *εκστρατεία /e**kstr**atia/* (= campaign), *ευστροφία* /e**fstr**ofia/ (= versatility) (Mennen & Okalidou, 2006).

2.1.2.3. Accents & Other Diacritical Marks

Another main feature of the Greek language, either Ancient or Modern Greek, is the existence of accent. The accent of Ancient Greek was *"prosodic" or "melodic"*, meaning that the stressed syllable was pronounced at a different pitch of the voice. Conversely, intonation of Modern Greek is *"dynamic"*, that is, the stressed syllable of the word is more emphasised than the others and is articulated with greater intensity and loudness (Allen, 1987; Tobaidis, 1994; Arapopoulou & Chriti, 2007). The accent in both Ancient and Modern Greek falls on one of the 3 last syllables of the word, whereas on which of the three is determined by morphology (Mennen & Okalidou, 2006).

Each Ancient Greek word, even monosyllabic ones, has an intonation mark, which is placed over the vowel or diphthong of the syllable stressed. Ancient Greek has a polytonic system using many diacritical marks for accents. In detail, the 3 intonation marks of Ancient Greek were a) the **acute** accent **(΄)**, which indicated that the syllable was pronounced in a more acute tone, b) the **grave** accent **(`)**, which indicated the absence of acute tone, and the **circumflex (῀)**, which is a combination of acute and grave accent, indicating that the voice was raising and then falling. Except for the intonation marks, Ancient Greek has 2 breathings as well: a) the **smooth** breathing **(᾿)** and the **rough** breathing **(῾)**. A vowel or a diphthong or the consonant *ρ* at the beginning of a word always includes a breathing, which must be indicated on the top. If both accent and breathing signs are on a vowel, the breathing is placed to the right of the intonation mark *(e.g. ἄ, or ἅ),* whereas the circumflex is placed above *(e.g. ἆ)* (Tobaidis, 1994; Nakanishi, 1990).

In Modern Greek, each word that consists of 2 or more syllables needs an intonation mark. Monosyllabic words do not need accent except for specific cases, such as the interrogative adverbs *πού /pu/* or the disjunctive conjunction *ή /i/* and others. The accent of Modern Greek **(΄)** looks like the acute accent of Ancient Greek and is similarly placed over the vowel or the diphthong of the syllable stressed (Triantafillidis, n.d.).

Except for the different intonation marks, another major difference is that in Ancient Greek the accent was not stable in a word, but a set of complex rules determined both the type and its placement within the word. Conversely, in Modern Greek, there is a tendency the intonation mark to remain on the same syllable of the word during declension (Oikonomou, 1999).

This intonation system was generalised and remained in use until 1982, when spelling reforms led to the establishment of the so-called monotonic system, which indicates only one intonation mark, as aforementioned. The reason of such a simplification was mainly the fact that learning the polytonic system was a hard and demanding process. Besides, the variety of intonation marks was for several centuries an exclusive feature of writing, while it did not influence the pronunciation at all. The acute accent was pronounced exactly the same with circumflex, whereas neither smooth nor rough breathing was pronounced (Tobaidis, 1994; Joseph & Tserdanelis, 2003).

Another diacritical mark of Ancient Greek is the so called iota subscription *(the sign under ᾳ);* it is in fact another form of iota (i) and it is added below 3 specific vowels, *α, η*, and *ω* resulting in *ᾳ, ῃ*, and *ῳ* (Nakanishi, 1990).

The following table (table 3) briefly describes the main differences between the Ancient and Modern Greek language in terms of grammatical and syntactic features. It is obvious that Ancient Greek is more complex than Modern, since it requires the knowledge of more grammatical rules, more complex syntax, and greater familiarity with multiple intonation marks and breathings for fluent and successful word recognition as well as for extracting meaning from text.

Table 3. Main Differences between Ancient & Modern Greek

Ancient Greek	Modern Greek
SYNTAX	
Dense and complex written form	Analytic written form
Subordinate (dependent) clause predominates; Use of clauses that are dependent on others and cannot stand alone	Coordinate clause predominates (parataxis); Juxtaposition of syntactic units that are not dependent one on another
Tight and disciplined expression	Loose structure
Words in a sentence are more irregularly placed compared to Modern Greek	Place of words in a sentence is more regular
Participles used quite frequently, in a variety of forms and tenses	Usage of participles is not frequent
GRAMMAR	
Distinction of vowels into short & long	No distinction of vowels
Polytonic system (Intonation marks & breathings)	Monotonic system
Complex consonant clusters	Simplification of consonant clusters and appearance of new diphthongs
Singular, plural & dual form	No dual form
5 cases (nominative, genitive, dative, accusative, vocative)	4 cases; there is no dative case
4 verb moods (Indicative, Subjunctive, Optative, Imperative)	Indicative is mainly used and partially Imperative & Subjunctive
Wide use of infinitives and participles	There are no infinitives; Restricted use of participles
3 verb voices (Active, Passive &Middle)	There is no Passive voice
Peculiar, irregular noun declension (3rd declension)	Simplification of the declension of the nouns
Augment & reduplication in verbs	Augment is retained only when it is stressed & reduplication is eliminated
3 verb stems (Present, Past, and Perfect) from which the other tenses are formed	2 verb stems (Present & Past)
Existence of the final –ν /n/	Elimination of the final –ν /n/

2.1.3. Reading Performance of Teachers of Ancient Greek & 12th grade Pupils

Reviewing the literature, it is noteworthy that none study until today has ever compared the reading performance of teachers of Ancient Greek and 12th grade pupils in terms of reading speed, accuracy and comprehension in both Ancient and Modern Greek. Neither in other languages, the reading performance of teachers was ever compared to that of pupils. Furthermore, no objective comparisons exist for the level of difficulty between Ancient and Modern Greek in terms of the aforementioned reading components *(speed, accuracy & comprehension)*.

According to the structure of both Ancient and Modern Greek described above, and given that Modern Greek is more familiar to both teachers and pupils, because it is read and spoken not only for educational purposes, but in everyday life and for communication purposes as well, one should expect that both groups would experience more difficulties in Ancient Greek that is read in school and for school purposes only, and, thus, is rather unfamiliar. Therefore, they are expected to perform better in Modern Greek *(read faster, comprehend better and make less reading errors)*.

In addition, despite the lack of research evidence in the specific field, research findings indicate that the more experienced teachers will perform better than pupils in all reading tasks. Precisely, teachers were expected to read faster, comprehend better and make less reading errors than pupils in both Ancient and Modern Greek materials, as they are more experienced and familiarised, especially with Ancient Greek, as well as they have more enriched vocabulary, more grammatical and syntactic skills and domain specific knowledge.

According to the Lexical Quality Hypothesis proposed by Perfetti and Hart (2002), comprehension depends on high quality word representations that include well-specified orthographic, phonological and semantic-syntactic information. Skilled readers know more about words, namely their pronunciation, their spelling and their meaning, than less skilled. This suggests that vocabulary knowledge plays a major role in reading comprehension.

Perfetti and Hart (2002) concluded that experience with words is critical for the development of reading skills.

Research has shown that vocabulary size could account for decoding, word recognition as well as reading comprehension. Ouellette (2006) investigated the relation between vocabulary and the distinct reading skills *(decoding, visual word recognition and comprehension)* in a group of 60 4th grade pupils, and found that vocabulary breadth could predict decoding and word recognition ability, whereas reading comprehension is predicted by vocabulary depth. Muter et al. (2004), in their longitudinal study, found that vocabulary knowledge and grammatical skills account for reading comprehension even in beginning readers. Other evidence in support is reported by Sénéchal et al. (2006), Estévez Monzó and Calvo (2002) and Nation (1993), who argued that good knowledge of vocabulary facilitates reading comprehension. And, as Stanovich (1986) mentions, *"vocabulary knowledge is involved in a reciprocal relationship with reading ability"*, whereas it is noteworthy that this relationship *"continues throughout reading development and remains in force for even the most fluent adult readers"* (p.379).

Research with young adult population totally confirmed such findings. Baddeley and colleagues (1985), using a sample of adults with wide range of abilities, concluded that vocabulary could reliably predict reading comprehension. Cunningham, Stanovich and Wilson (1990) reported that vocabulary plays a significant role in reading comprehension of college students (R^2 = .58). More recently, Braze et al. (2007) investigated whether vocabulary knowledge could account for reading comprehension differences in adolescents and young adult readers. Their results were also consistent with those of research in children, as they similarly found that the strength of vocabulary supports reading comprehension. Landi (2010) also concluded that word knowledge is critical for reading comprehension. Similarly, Lewellen and her colleagues (1993) concluded that college students with greater lexical familiarity were more efficient in language processing. Hence, teachers, who undoubtedly possess a richer vocabulary compared to pupils, are expected to decode faster and more accurately, as well as to attain higher level of reading comprehension.

Additionally, there is plenty of evidence that exposure to print could predict skills involved in reading (McBride-Chang et al., 1993; Cunningham & Stanovich, 1990, 1991, etc.). Cunningham and Stanovich (1990) using the Title Recognition Test (TRT), designed to measure print exposure, investigated whether children's exposure to print could be linked to word recognition ability. Indeed, they found that individual differences in word recognition are partially determined by print exposure differences. McBride-Chang and colleagues (1993) using the same instrument went a step beyond focusing on whether print exposure could predict reading comprehension. They concluded that print exposure was indeed a significant predictor of reading comprehension.

As cited in Stanovich (1986), Ehri (1984,1985) has shown that there is an effect of print exposure on knowledge of sound structure and metalinguistic functioning, while others assumed that understanding of more complex syntactic structures is likely to be affected by exposure to print (Stanovich & Cunningham, 1992; Mann, 1986; Perfetti, 1985). Cunningham and Stanovich (1997) linked print exposure to the development of processes and knowledge bases that facilitate reading comprehension *(vocabulary, familiarity with complex syntactic structures)*. Furthermore, volume of reading experience seems to facilitate the development of reading skill (Stanovich, 1986), meaning that less skilled readers are less exposed to reading, while skilled readers are highly exposed to print.

More recently, research with university students participating confirmed such findings. Acheson and colleagues (2008) investigated whether there is a relationship between exposure to print and reading skills in college students, who are considered to be a highly literate population engaged in extensive reading. They found a clear relationship between exposure to print and reading achievement. However, exposure to print was not found to have a reliable relationship with reading speed and sentence comprehension, a finding that is attributed to ceiling effect, though, since the range of abilities of the college students included in the research was restricted as far as it refers to a highly literate population engaged in extensive reading. In 2000, Chateau and Jared examined the impact of print exposure on word recognition processes of two groups of university students. Results revealed that differences in exposure to print lead to differences in the word recognition processes even among young adult readers. Print exposure was similarly found to be strongly associated with reading comprehension in skilled adult readers (Landi, 2010). Research with older adult participants reached similar findings. Payne and colleagues (2012) found that the degree of exposure to print of older adults, who are characterised by a decline in their cognitive abilities, facilitates not only word recognition, but also reading comprehension, operating as a compensatory "reserve" mechanism.

Finally, there is evidence that domain and topic knowledge is considerably related with reading ability. Miller and colleagues (2006) found a significant correlation between contextual knowledge and reading efficiency indicating that the more we know about a specific topic, the more efficient the reading process is rendered. Hence, individuals with contextual knowledge read faster and comprehend better, whereas they concluded that interest in the written material read constitutes an additional *"motivational influence"* for superior reading performance (p.1366). Similar findings were also reported by McNamara and Kintsch (1996), who found that prior knowledge about a topic enhances reading comprehension and facilitates drawing inferences.

2.1.4. Focus of the present study

It is obvious from the literature review that no study until today has ever compared the reading performance between Greek language teachers and 12th grade pupils in Ancient and Modern Greek, or in any other language either. Also, no objective comparisons exist for the level of difficulty between Ancient and Modern Greek in terms of reading speed, accuracy *(types and amount of errors made)* and level of reading comprehension.

Based on the research evidence confirming the relationship of reading ability with vocabulary size, exposure to print, domain specific knowledge and familiarity with text, intuitively, one should expect that the far more experienced language teachers, who have studied at least 4 years and have been teaching for 5 years minimum being daily exposed to Ancient and Modern Greek, are more familiar with both the structure and vocabulary of the two languages, so they will be faster and more proficient readers.

On the other hand, both teachers and pupils are expected to have superior reading performance in Modern Greek, taking into consideration the structure of the two languages as described above, which indicates that Ancient Greek is more complex than Modern Greek despite their common phonological consistency, and since they speak, read and write the latter in their daily life and not for educational purposes only.

Thus, the aim of the first research project designed was to find out whether indeed teachers performed better that pupils in reading Ancient and Modern Greek texts and whether both groups performed better in Modern than in Ancient Greek. Gaps in the existing literature led to the research hypotheses presented below.

2.2. METHODOLOGY

2.2.1. Hypotheses

Comparing a group of teachers of Ancient Greek to a group of 12th grade pupils, the following series of hypotheses and null hypotheses were set up:

1) H_1: Pupils will make more reading errors (quantity) than teachers, when reading Ancient and Modern Greek.

H_0: Pupils will not make more reading errors (quantity) than teachers, when reading Ancient and Modern Greek.

2) H_1: Pupils will make different kind of reading errors (quality) than teachers.

H_0: Pupils will not make different kind of reading errors (quality) than teachers.

3) H_1: Pupils will read more slowly than teachers in all reading materials.

H_0: Pupils will not read more slowly than teachers in all reading materials.

4) H_1: Pupils will attain lower level of reading comprehension than teachers.

H_0: Pupils will not attain lower level of reading comprehension than teachers.

5) H_1: Within each group, participants will read faster, comprehend better and make less reading errors in Modern than in Ancient Greek.

H_0: Within each group, participants will not read faster, comprehend better and make less reading errors in Modern than in Ancient Greek.

2.2.2. Design

The present study is an "experimental" research, which means that researchers control and manipulate the conditions they are interested in. Thus, the independent variable is controlled and manipulated by the researcher and then the effect on the dependent variable or variables is observed (Cohen, Manion, & Morisson, 2009, p.272). In the current study, the independent variables were the different levels of the grouping variable *(teachers & pupils)*, while the set of dependent variables were the categories and subcategories of reading errors, speed and comprehension. The level of the grouping variables was controlled and manipulated in the study. All logical procedures in conducting experimental research were followed *(e.g. hypotheses, design, sampling, validity & reliability of the instrument, pilot study, etc.)*.

The current experimental design was an "Independent Measures" or "Between Groups" design, because data derived from different groups of participants. Such a design aims to test the differences between the levels of the grouping variable (independent variable) on each dependent variable. Furthermore, as it was of major interest for the present study to see how each group behaved under the different reading conditions (Ancient & Modern Greek), analyses at a "Repeated Measures" or "Within Subject" design *(same participants exposed in different experimental conditions)* were also carried out.

2.2.3. Participants

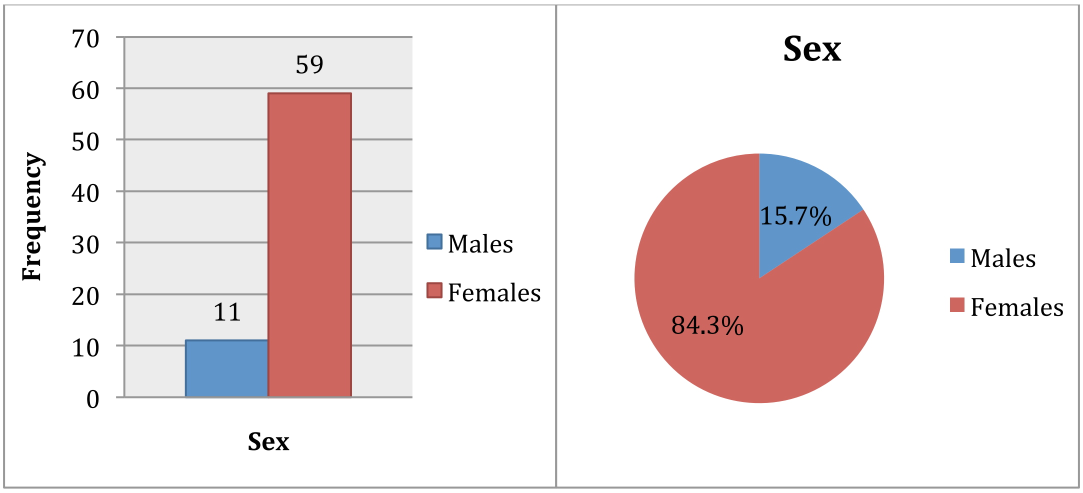
Seventy (70) individuals took part in the current study from the broad urban area of Larissa (Greece). Fifty-nine (59) of them were females and eleven (11) males, representing percents of 84.3% and 15.7%, respectively.

Table 1. Male & female participants

SEX	Frequency	Percent	Valid Percent	Cumulative Percent
Male	11	15.7	15.7	15.7
Female	59	84.3	84.3	100.0
Total	70	100.0	100.0	

Table 1 shows the frequency of male and female participants along with the percent represented by each sex. As obvious, the majority of participants were females, namely 59 (84.3%) compared to 11 (15.7%) males (see also figure 1).

Figure 1. Number & percentage of male & female participants



For the needs of the current research participants were divided into two (2) groups:

1. The first group consisted of 35 experienced teachers of Ancient Greek, who have been teaching for more than five (5) years (see table & figure 2). Seven (7) of them were males and twenty-eight (28) females (see table & figure 3). Their age ranged from 32.5 up to 58.9 years old, mean age 46.4, SD 7.93 (see table & figure 4).
2. The second group equally consisted of 35 pupils of the 12th grade (see table & figure 2). Four (4) of them were males while thirty-one (31) were females (see table & figure 3). Their age ranged from 17 up to 18.2 years old, mean age 17.7, SD 0.36 (table & figure 4).

Table 2. Participants per group

GROUP	Frequency	Percent	Valid Percent	Cumulative Percent
Teachers	35	50.0	50.0	50.0
Pupils	35	50.0	50.0	100.0
Total	70	100.0	100.0	

Table 2 shows the frequency of teachers of Ancient Greek and 12th grade pupils participating along with the percent represented by each group. The same number of teachers (N = 35) and pupils (N = 35) took part in the current research, each group representing 50% of the total participants (see also figure 2).

Figure 2. Number & percentage of participants per group

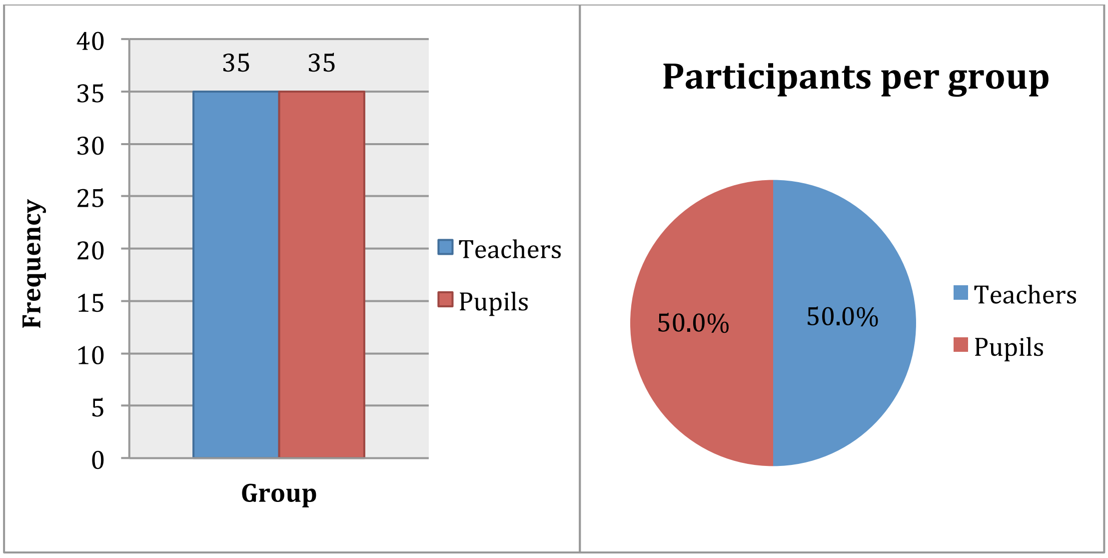


Table 3. Male & female participants per group

SEX / GROUP		Frequency	Percent	Valid Percent	Cumulative Percent
Teachers	Male	7	20.0	20.0	20.0
	Female	28	80.0	80.0	100.0
	Total	35	100.0	100.0	
Pupils	Male	4	11.4	11.4	11.4
	Female	31	88.6	88.6	100.0
	Total	28	100.0	100.0	

Table 3 shows the frequency of male and female participants per group along with the percent represented by each sex in each group. In both groups, the vast majority of participants were females, namely 28 (80%) and 31 (88.6%), respectively, compared to 7 (20%) males in the former and 4 (11.4%) in the latter group.

Figure 3. Number & percentage of male & female participants per group

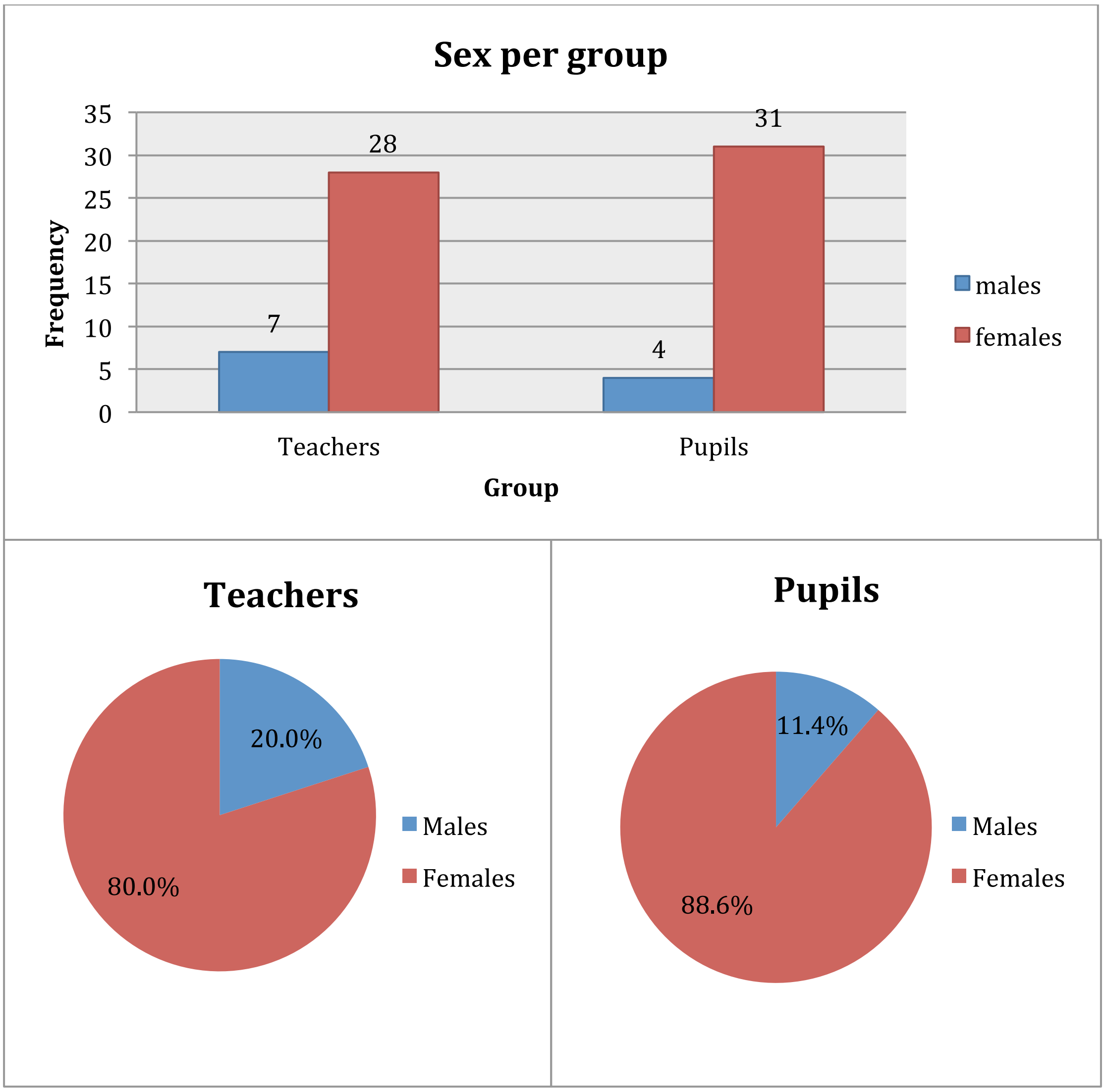


Table 4. Age per group

GROUP	N	Range	Minimum	Maximum	Mean	Std. Deviation
Teachers	35	26.4	32.5	58.9	46.4	7.93
Pupils	35	1.2	17.0	18.2	17.7	0.36

Figure 4. Age range per group

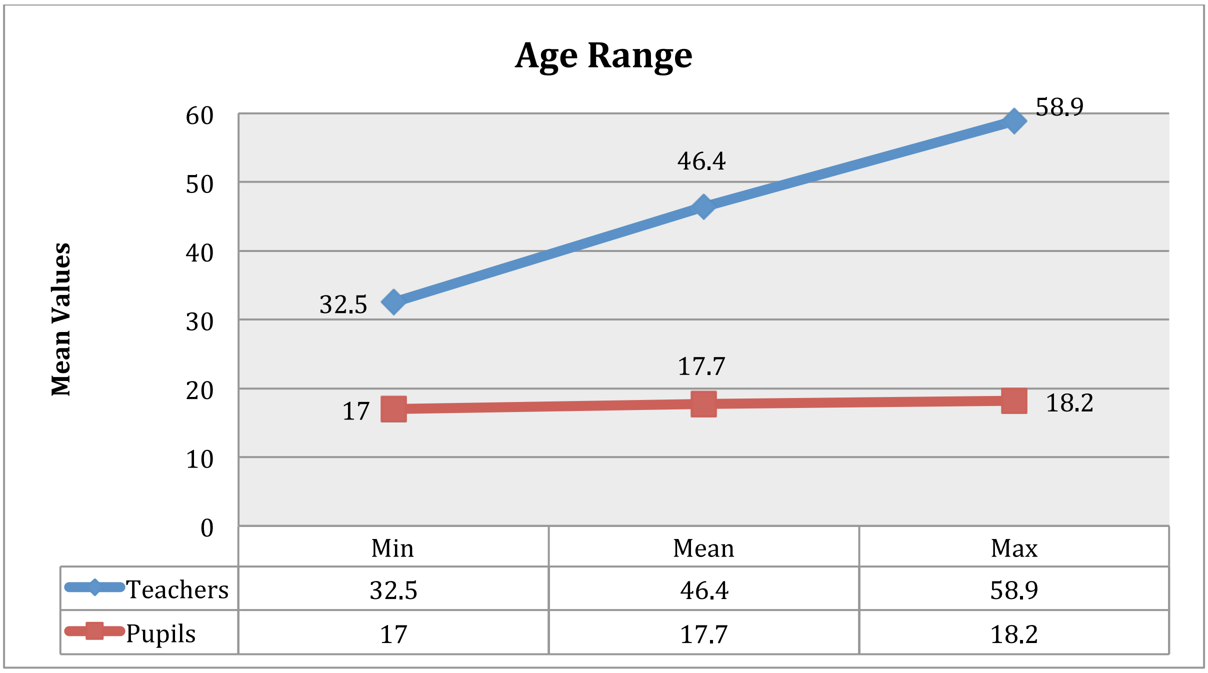


Table and figure 4 show the mean age of both groups along with the minimum and maximum age values defining the age range per group. The mean age of teachers was 46.4 years old, whereas the mean age of pupils was 17.7. The youngest teacher was 32.5 years old, while the oldest 58.9. In the pupils' group, the youngest and the oldest participants were 17 and 18.2 years old, respectively.

2.2.4. Sampling Method & Participants' Selection Criteria

When designing a research, it is necessary to carefully decide on the sampling strategy that is going to be used. Researchers need to early determine the population, which will be the focus of the research, since factors like expense, time, and accessibility frequently hinder them from gaining access in the whole population (Cohen, Manion & Morisson, 2009).

A main issue that arises is how large the sample should be. Sample sizes depend on various factors, such as the aim of the study, the number of variables and statistical tests to be used, the size and heterogeneity of the target population, and other factors. (Cohen, Manion & Morisson, 2009). The sample size of the present research complies with Borg and Gall's suggestions that experimental methodologies require sample sizes of no fewer than fifteen cases (Borg & Gall, 1979, as cited in Cohen, Manion & Morisson, 2009, p.102). In the current research 70 individuals took part.

Teachers of Ancient Greek and pupils of the 12th grade were selected based on the "Cluster" sampling method. This method is used in small-scale research, when the target population is quite large and dispersed, and, therefore, difficult to access and test every single case. Cluster sampling belongs to probability sampling methods. Such methods seek representativeness of the wider population and have a measure of randomness built into them indicating a degree of generalisability (Cohen, Manion & Morisson, 2009, p.110).

In this case, the whole population of teachers of Ancient Greek and pupils of the 12th grade was difficult to be accessed, so the sampling was addressed to specific high schools of different socio-economic areas of Larissa, Greece. The desired population of 12th grade pupils was obtained from 2 of the biggest high schools of the area counting more than 400 pupils each, whereas the target population of teachers was obtained from 5 out of the 11 public high schools of Larissa. All 12th grade pupils with average or above average performance in Ancient and Modern Greek and all teachers of Ancient Greek with teaching experience of more than five years were given the opportunity to participate.

However, it is noteworthy that, as far as it concerns teachers of Ancient Greek, a main characteristic of the population is that there are more women than men, who choose the specific occupation. The reference to certain numerical data from the Greek Ministry of Education and Lifelong Learning will prove it. For instance, in the school year 1992-93, 13787 out of 17887 Greek language teachers in public schools were females, while the remaining 4100 were males (Maragoudaki, 2001). Given in percentage, 77.1% were women and 22.9% were men. Furthermore, from a total number of 18994 Greek language teachers registered in chronological order until the 31st of December 1995, only 3374 (17.8%) were males, whereas 15620 (82.2%) were females (Maragoudaki, 2001). Notice: The reason why reference is made to so older dates is that prerequisite for teachers' participation in the current study was teaching experience of more than 5 years, and, hence, the most recent graduates and beginners in teaching were excluded. Besides, taking into consideration that Greek language teachers do not easily find an occupation strictly relevant to their studies, as in only 44.3% of the cases there is a match between studies and occupation, according to an article published in “Ethnos” newspaper (Kavadias, 2010), and that the average job search in Greece reaches almost 4 years, according to data from the Organisation for Economic Co-operation and Development (OECD) in August 2008, it was necessary to exclude the whole 2000s decade. The aforementioned proportions of male and female teachers of Ancient Greek were reflected in the sample. Thus, following the gender ratio of on average 80% females to 20% males, 28 out of 35 participants in the teachers’ group were women (80%) and the remaining 7 were men (20%).

Similarly, a main feature of the pupils, who attend Ancient Greek classes, is that girls outnumber boys, as more girls choose to follow *Theoretical* studies. Talking again with numerical data, during the school year 2000-2001, from a total number of 27072 pupils of the 12^{th} grade attending *Theoretical* classes 21180 (78%) were females, while only 5892 (22%) males (Maragoudaki, 2002). The ratio is also confirmed by a study regarding the seniors of a specific Greek county during the school year 2001-2002, where only 88 (27%) out of a total number of 332 pupils that were attending Ancient Greek classes were males, whereas 244 (73%) were females (Terzopoulos, 2003). Other evidence reinforcing the existence of more girls than boys in classes of Ancient Greek is that, according to the National Statistics Office of Greece, in the school year 2001, more than half female pupils (53.34%) selected *Theoretical* studies, while the rest 44.66% was distributed in the other 2 directions of studies *(Positive and Technological)*. Conversely, during the same school year, only 21.92% of the boys followed *Theoretical* studies, whereas the remaining 78.09% of male pupils were directed to practical studies. These proportions of male and female pupils were approximately reflected in the sample and, hence, 31 out of 35 pupils participating were girls (88.6%), and the remaining 4 were boys (11.4%).

2.2.5. Inclusion Criteria

All participants had to fulfill the following criteria, as stated in Pavlidis (1990):

i) Normal IQ *(average or above average).*

ii) Normal or corrected vision and hearing.

iii) Greek being their native language.

iv) Average or above average socio-economic background: Individuals from the lowest socio-economic status were excluded from the study, in order to minimise any potential social adversity. Thus, pupils should have at least one employed parent, while at least one of their parents should have graduated from high school (more details are given in table 5 below). Notice: *This criterion did not apply to teachers of Ancient Greek, as they all were employed and, hence, they were expected to have average or above average socio-economic background.*

Table 5. Pupils' socio-economic background

Pupils	**Parents' employment history**		**Parents' education history**	
	Both parents employed	One parent employed	Both parents high school graduates	One parent high school graduate
	57%	43%	74%	26%

v) Adequate educational opportunities.

vi) Not on any psychoactive medication known to affect cognitive processes or within its washout period.

vii) No overt emotional problems, which influence their performance.

viii) No overt neurological handicaps that could account for reading problems *(i.e. brain injury, brain malformation, brain tumor, seizure).*

The IQ of teachers of Ancient Greek and 12th grade pupils was not tested, because, as both groups consisted of normal and high-educated population, they were expected to have at least normal IQ.

An additional criterion for the participation of the teachers was teaching experience of more than five years, whereas prerequisite for the inclusion of the 12th grade pupils was to have average or above average school performance *(particularly in Ancient & Modern Greek)*, in order to be competitive to the teachers, who, in fact were expected to have better performance. To be more precise, the vast majority of teachers (86%) had teaching experience of more than 10 years, while only 14% had teaching experience of 5 up to 10 years (see table 6 below). With regard to the pupils' group, all participants had above average performance in both Ancient and Modern Greek, whereas it is noteworthy that a significant percent of pupils (37.1%) had almost excellent school performance in both subjects, as indicated by their grades (see table 7).

Table 6. Teachers' teaching experience (in years)

Teaching Experience	Teachers
5 – 10 years	14.3%
10 – 20 years	31.4%
20 – 30 years	42.9%
over 30 years	11.4%

Table 7. Pupils' school performance in Ancient & Modern Greek

School performance (grade)	Pupils
15 – 18 (75 – 90)	62.9%
18 – 20 (90 – 100)	37.1%

2.2.6. Sampling Areas

As previously mentioned, participants were selected from the broad urban area of Larissa, Greece. The specific area was chosen for the sampling, because:

- Larissa is among the five biggest cities of Greece and the mean socio-economic background is average or above average.
- The access to the sample was easier, while at the same time it wasn't extra time or money consuming (Cohen, Manion & Morisson, 2009).

2.2.7. Participants & Ethical Consideration

All essential ethical matters were taken into consideration in the framework of the present research, which are thoroughly described below:

2.2.7.1. Introduction

Regarding the participation of humans and mainly pupils in the current study, there have been taken into consideration:

a) The guidelines of the Greek Institute of Education concerning the undertaking of research with students in secondary education.
b) The University of Northampton Ethics Code and Procedures (2009).
c) The Code of Ethics and Conduct of the British Psychological Society (B.P.S., 2009) as well as the Ethical Principles of the British Psychological Society for conducting research with human participants (B.P.S., 2009).
d) The Greek Law for the protection of personal data, which is in accordance with the European Legislation (Laws 2472/1997 and 3471/2006).

2.2.7.2. General Responsibilities

The physical, social and psychological welfare of the participants was protected and not affected by the research (University of Northampton Ethics Code and Procedures, 2009). All participants were treated with respect, without any judgments being expressed. They were also ascertained that the tapes used during the experimental procedure would remain in the possession of the examiner and that nobody would get access to them except for the examiner.

2.2.7.3. Informed Consent

The vast majority of participants were over eighteen (18) years old. However, as within the group of pupils there were a few participants under eighteen (18), an enhanced Criminal Records Bureau check was needed and a certificate was obtained.

Potential participants were informed in written about the nature, the aims, the utility, the duration and the possible consequences of the research (Appendix 3). The information letter was given to them at least 24 hours before freely deciding whether to take part in the research or not and before being asked to complete and sign a consent form (Appendix 4). They were kindly requested to contact the researcher, if they wished to take part (University of Northampton Ethics Code and Procedures, 2009).

The research was based on the freely given informed consent of the participants. There was no coercion and ample opportunity was offered to them, in order to decide to take part. An informed consent signed by the parents (Appendix 5) was also needed for participants under 18 years old (University of Northampton Ethics Code and Procedures, 2009).

Participants were informed that they might withdraw from the research at anytime without any reason, warning or penalty. They were also informed that, as their record of participation was to remain with the researcher after the completion of the research, they had to consent to this. Otherwise, their record of participation would be destroyed (University of Northampton Ethics Code and Procedures, 2009).

Finally, contact details of the researcher and supervisors were provided for further information, if participants wished so.

2.2.7.4. Conduct of the Research

There was no element of deception in the current research (University of Northampton Ethics Code and Procedures, 2009).

Testing took place in an accessible and suitable setting that provided private, comfortable and safe place for both the participant and the researcher. For the group of pupils, the testing took place in a quiet and suitable classroom of their own school, in order to feel comfortable and safe, but after the end of the courses and after the permission of the head-teacher of the school has been obtained.

Each participant was individually tested, while he/she was tape-recorded but only with his/her permission in written.

Furthermore, participants were made aware that they might stop the testing at any time without any warning and withdraw from the research. They were also given the opportunity to withdraw their material from the research as well (University of Northampton Ethics Code and Procedures, 2009).

Confidentiality and anonymity of data was ensured. Personal details were kept confidential and separate from the data, stored in a locked filing cabinet and password protected computer. Participants were informed that their personal details would be only kept for the sole purpose of the research and that their identity would be kept anonymous. However, as the data was to be retained by the researcher, the participant should consent to this (see Appendix 4). Otherwise, personal data would be destroyed 12 months after the completion of the research. To ensure confidentiality participants were allocated codes and their personal details were kept separately and secure (University of Northampton Ethics Code and Procedures, 2009).

Finally, the data protection legislation was faithfully followed and the research complies with the Data Protection Act (University of Northampton Ethics Code and Procedures, 2009).

2.2.7.5. Feedback

All participants were given the opportunity to receive a summary and feedback on the results of the research together with contact details of the researcher in case that any subsequent matters arise. If there are matters raised that may trouble the participants, advice and assistance will be given to them.

2.2.8. Gaining Access to the Sample

Another key issue to be decided in research is the access to the sample, which should be not only permitted, but practicable as well (Cohen, Manion, & Morisson, 2009). The process followed is presented below.

For the selection of the pupils, the head-masters of the schools were informed in written about the nature, the aims and the utility of the research and they were asked for their permission, in order to visit their schools and seek for potential participants. The class teachers were also informed about the aim of the study and were asked to select pupils whose educational performance in Ancient and Modern Greek was average or above average. They were also kindly requested to give information about the family of each pupil, their socio-economic background, their educational, developmental and personal history, in order for the sample to be as similar as possible. Besides, classroom teachers were the best placed to identify those pupils whose performance in Ancient and Modern Greek was average or above average, something that was an additional criterion for their participation, as discussed earlier. Pupils were selected following their teachers' suggestions, as research has shown that the daily observation of the pupils by their teachers can provide a valid as well as accurate enough evaluation of their abilities and skills (Harlen, 2005; Meisels et al., 2001; Reeves, Boyle, & Christie, 2001; Kenny & Chekaluk, 1993; Johnston, Afflerbach & Weiss, 1993; Wolf, 1993; Coladarci, 1986; Hopkins, George & Williams, 1985; Cunningham, 1982). For instance, Johnston, Afflerbach & Weiss (1993) mention that teachers' assessments are normally valid, as 3 out of every 4 pupils evaluated by their teachers as learning disabled are usually placed in special education (p.92), while they concluded that the *"observations of students behaviour influenced teachers' assessments"* (p.107), as most of them placed observation in the first position for acquiring knowledge about their students (p.113).

The information letter was also sent to the parents of the pupils informing them about the aim of the study, the experimental procedure as well as giving details of the academic qualifications of the researcher and contact information in case that any matter arise. They were also ensured that the participation of their children was voluntary and that their written consent was necessary before testing. Moreover, they were asked to give additional information regarding their child's social and educational behaviour, in order to guarantee to the greatest possible extent the similarity of the sample. Research has shown that information given by parents for their child's behaviour is both reliable and valid (Oliver et al., 2002; Wiener & Sunohara, 1998; Saudino et al., 1998; Bricker et al., 1988; Chamberlain & Reid, 1987; Achenbach & Edelbrock, 1981). Bricker et al. (1988) found that children's assessment by their parents was in full agreement with that made by professionals (p.62), as parents are more familiar with their children behaviour (p.56), findings similar to earlier studies as well (Knobloch et al., 1979; Frankenburg et al., 1976).

Fifty-five (55) information letters accompanied by the relevant consent forms were sent to the parents of the pupils and fifty (50) of them, a percentage of 90.9%, were returned with their written consent. Thirty-five (35) pupils, who fulfilled all the criteria for participating in the current research, were selected. All pupils were very cooperative and found the experimental procedure very interesting and amusing. The majority of them did enjoy the idea of being recorded and did like to read in front of the microphone. However, despite their positive attitude, they were reassured that the tapes would remain with the examiner and that nobody would be allowed to get access to their material.

On the other hand, for the selection of the teachers of Ancient Greek, as far as it concerned adult population, each of them was informed in written about the aims of the research and the experimental procedure, and was asked for his voluntary participation. After freely deciding to participate, they were asked to complete and sign the relevant consent form. They were also assured that their identity would be kept anonymous and that personal information would be confidential.

Concerning the teachers' group, in contrast to the group of pupils, it wasn't necessary to gather information about their socio-economic background or their educational, developmental and personal history, as they all were educated and employed. Consequently, their socio-educational status was expected to be at least average or above average.

Gaining access to the group of teachers was much more difficult, as several of them were hesitating. Their major doubt was the protection of their identity and personal details, in spite of all the assurances given by the researcher. Moreover, several of them did not like the idea of being tape recorded during reading, even though they were ensured that the tapes would remain with the researcher for the sole purposes of the research and that nobody else would be allowed to get access to them. Their attitude is understandable though, because after years of teaching experience, they felt as if they were taking an exam.

Sixty-five (65) information letters accompanied by the relevant consent forms were sent to the teachers, in order to find a sufficient number willing to participate. Forty-five (45) of those consent forms, a percentage of 69.2%, were returned signed. Then, thirty-five (35) teachers, who fulfilled the criteria for taking part in the current research, were selected. However, three (3) others, also selected to participate, decided to withdraw during the experimental procedure, as they had the right to, while five (5) stopped the testing, in order to get more assurances about the anonymity of their identity and the confidentiality of the information given during the experimental procedure.

2.2.9. Experimental Procedure

For the group of pupils, the testing took place in an accessible, suitable and quiet classroom of their own schools, in order to feel comfortable and safe, but definitely after the end of the daily courses and after the permission of the head-teacher has been obtained. Regarding the group of teachers, testing took place in accessible and suitable settings that provided private, comfortable and safe place for both the participant and the researcher *(e.g. the teacher's home)*. All participants were individually tested in reading. The majority of them completed the testing in one session, whereas, as aforementioned, some teachers stopped the experimental procedure, in order to get more assurances about the anonymity and confidentiality of their personal details. Based on their performance, reading speed, comprehension and accuracy were evaluated. The school classroom or the room, in which testing took place was full-lighted, empty and secluded and as away as possible from other external disturbances. For the testing, each participant entered the classroom/room alone and sat on a desk, where only the reading material, a tape recorder and the microphone of the computer were in front of him, in order to record his performance.

Each participant was asked to read an Ancient Greek text and its correspondent translation in Modern Greek (Appendix 7) while he/she was tape-recorded. As discussed earlier, the Ancient Greek text was expected to be more difficult *(more complex vocabulary and syntax, larger sentences, polytonic system)* for all participants to read *(lower reading speed, more reading errors made)* and understand *(lower level of reading comprehension)* than the Modern Greek text.

Participants read each piece of text while they were timed *(for 1 minute)* and tape-recorded for further analysis. The end of the reading task was determined by the time limit of 1 minute, because the aim was to measure the reading speed per 1 minute. That is why the time limit of 1 minute was chosen. The purpose was to find out whether differences exist between groups as well as between Ancient and Modern Greek in terms of reading speed, accuracy as well as the kind and the amount of errors made. After reading each text for 1 minute, they also had to answer in relative reading comprehension questions *(up to 7 questions for each text depending on the quantity of the text read in a minute),* but without given the opportunity to go back and confirm their answer, aiming to investigate the differences in the level of comprehension between and within groups (Appendix 7).

The texts were presented in a counterbalanced fashion, in order to neutralise the possible order effect. In detail, the order in which the texts were given was different for each participant, as to minimise the possibility that it could influence their reading performance (see table 7).

Table 7. Teachers & Pupils: Counterbalanced Fashion

COUNTERBALANCED FASHION				
1	Ancient Greek Aloud	Ancient Greek Silently	Modern Greek Silently	Modern Greek Aloud
2	Modern Greek Silently	Modern Greek Aloud	Ancient Greek Aloud	Ancient Greek Silently
3	Ancient Greek Silently	Ancient Greek Aloud	Modern Greek Aloud	Modern Greek Silently
4	Modern Greek Aloud	Modern Greek Silently	Ancient Greek Silently	Ancient Greek Aloud

The duration of the experimental procedure was approximately 10-12 minutes. Each text was read for 1 minute (aloud & silently), with 2-3 minutes for answering the reading comprehension questions and a resting-preparation time of 2 minutes between texts.

Table 8. Duration of the testing procedure

READING MATERIALS		TIME (min)
Ancient Greek	Aloud or Silent Reading	1
	Silent or Aloud Reading	1
	Reading Comprehension Questions	2 – 3
	Resting & Preparation	2
Modern Greek	Aloud or Silent Reading	1
	Silent or Aloud Reading	1
	Reading Comprehension Questions	2 – 3
	TOTAL TIME	**10 - 12**

2.2.10. Materials

The materials used during the experimental procedure were the following:

2.2.10.1. Reading Materials

a) Reading texts:

Participants read two (2) texts of varying difficulty (Appendix 7):

- Ancient Greek
- Modern Greek

The Modern Greek text was the corresponding translation of the Ancient Greek text. Participants were not aware of that before testing. Texts were not selected from the official textbooks used in Greek high schools, in order to be as unfamiliar as possible for both groups. The translation of the Ancient Greek text was used instead of any other Modern Greek material, in order to establish a similar level of difficulty, since both texts had exactly the same content. However, the Modern Greek text was expected to be more familiar to both teachers and pupils, and, thus, easier for them to read because of its simpler structure *(grammar, syntax, intonation, etc.)* as well as because of the greater daily exposure and familiarisation of both groups to Modern Greek, as opposed to the Ancient Greek text, which was expected to be more unfamiliar, and, as a result, more difficult to read *(more complex structure, limited exposure and familiarisation)*.

Furthermore, the text difficulty of both texts was evaluated via the various readability formulas and their results are given below:

Table 9. Readability Formulas

Readability Formula	Ancient Greek text	Modern Greek text
Flesch Reading Ease score	– 37.6[1] Impossible to comprehend	– 42.2[1] Impossible to comprehend
Gunning Fog	63[2] Extremely difficult to read	64.8[2] Extremely difficult to read
Flesch-Kincaid Grade Level	57.6[3] College graduate and above	59.4[3] College graduate and above
The Coleman-Liau Index	– 18[4]	– 18[4]
Automated Readability Index	57.3[5] College graduate	59.6[5] College graduate
Linsear Write Formula	78.8[6] College Graduate and above	81[6] College Graduate and above

[1] Scores below 0: Extremely confusing.

[2] Scores above 12: Too hard for most people to read.

[3, 4] Scores above 12: College graduate and above.

[5] This formula tests the understandability of texts. Scores above 12: College graduates or above.

[6] Scores above 12: College graduate and above.

All readability formulas take into account the “technical” parameters of the text *(e.g. sentence length, syllables per word, number of characters in words, etc.)* while at the same time they totally ignore familiarity of the reader with a particular reading material. Such is the case for Modern Greek, which is daily used, thus, very familiar, as opposed to Ancient Greek that is not used in the daily communication, and, hence, is unfamiliar. That is why readability formulas gave the same or very similar readability values to the Ancient Greek text and its translation to Modern Greek.

b) Reading Comprehension: All participants answered in reading comprehension questions *(up to 7)* for each piece of text. They were advised from the beginning that they should read for meaning. Thus, they were all reading for the same purpose (Appendix 7).

2.2.10.2. Tape Recorder

All participants were **tape-recorded** during aloud reading for further analysis of the reading errors.

2.2.10.3. Chronometer

A **chronometer** was used during reading for the evaluation of participants' reading speed.

2.2.10.4. Reading Speed & Comprehension Scoring Sheet

A **scoring sheet** was used to record participants' reading speed and comprehension data (Appendix 9). The reading speed of each participant (words/1΄) as well as the level of reading comprehension (% of correct answers) were calculated and recorded on the specific scoring sheet. It also included personal information about the participants *(e.g. age, sex, etc.)*. For anonymity and confidentiality reasons, their names did not appear on the scoring sheet, but they were allocated codes instead. Therefore, it was impossible for any participant to be identified.

2.2.10.5. "Reading Errors Analysis Instrument"

The present study uses a different instrument than other studies do for the analysis of the reading errors made by the participants. The reading performance of the participants was recorded, categorised and analysed based on **"The Reading Errors Analysis Instrument"** (Appendix 10), which has been developed in 2005 by Prof. G. Th. Pavlidis, focusing on reading in the Greek language. This instrument is looking in detail not only at all possible types of reading errors, but also at the reading speed and level of comprehension. It includes **13 main categories** of reading errors with several **subcategories** and **3 special categories**.

Categories & Subcategories of Reading Errors: All the reading errors categories along with their subcategories are provided in table 10:

Table 10. Categories of Reading Errors

Categories	**Subcategories**	**Example**
1. Hems		**Ττ**τώρα *(= now)* – participant "drags" the letter **τ**
2. Repetitions	a) Letter Repetition	**γ** – γρήγορος *(= fast)*
	b) Syllable Repetition	**τώ**– τώρα *(= now)*
	b) Word Repetition	**τώρα** – τώρα *(= now)*
3. Syllabication		απο φα σίζω *(= I decide)*
4. Substitutions	a) Letter Substitution	"τ**έ**ρα" instead of "τ**ώ**ρα" *(= now)*
	b) Syllable Substitution	"**κέ**ρα" instead of "**τώ**ρα" *(= now)*
	b) Word Substitution	**"μέρα"** *(= day)* instead of **"τώρα"***(= now)*
5. Reversals	a) Letters Reversal	"α**γρ**εί" instead of "α**ργ**εί" *(= he is late)*
	b) Syllables Reversal	**"μάδε"** instead of **"δέμα"** *(= package)*
	c) Words Reversal	"**πάμε τώρα**" instead of "**τώρα πάμε**" *(= let's go now)*
6. Omissions	a) Letter Omission	"τ_ρα" instead of "τ**ώ**ρα" *(= now)*
	b) Syllable Omission	"__ρα" instead of "**τώ**ρα" *(= now)*
	c) Word Omission	A word of a sentence is omitted
7. Additions	a) Letter Addition	"τώ**τ**ρα" instead of "τώρα" *(= now)*
	b) Syllable Addition	"τώ**πα**ρα" instead of "τώρα" *(= now)*
	c) Word Addition	A non-existing word is added
8. Misintonation		"αμεσ**ώ**ς" instead of "αμ**έ**σως" *(= immediately)*
9. Endings		"πήγ-**ε**" *(= **he** went)* instead of "πήγ-**α**" *(= **I** went)*
10. Punctuation	a) Punctuation Substitution	A punctuation mark is substituted by another
	b) Punctuation Omission	A punctuation mark is omitted
	c) Punctuation Addition	A punctuation mark is added
11. Point Marks		"**αι**τός" instead of "**αϊ**τός" *(= eagle)*
12. Line Missing		Participant misses a whole line

13. Repetitions of Errors	a) Letter Substitution Repetition b) Syllable Substitution Repetition c) Word Substitution Repetition d) Letters Reversal Repetition e) Syllables Reversal Repetition f) Words Reversal Repetition g) Letter Omission Repetition h) Syllable Omission Repetition i) Word Omission Repetition j) Letter Addition Repetition k) Syllable Addition Repetition l) Word Addition Repetition m) Misintonation Repetition n) Ending Repetition o) Punctuation Substitution Repetition p) Punctuation Omission Repetition q) Punctuation Addition Repetition r) Point Mark Repetition	Participant repeats an error of the previous categories and subcategories

<u>Special Categories of Reading Errors</u>: The 3 special categories of reading errors are given in table 11 below. Special categories are not counted in the total sum of reading errors, as their existence requires the pre-existence of another error as well.

<u>Table 11</u>. Special Categories of Reading Errors

Special Categories
1. Pseudo-Words
2. Corrected Errors
3. Non-Corrected Errors

The reading errors could be further divided into 2 categories: a) **Timing Errors** and b) **Accuracy Errors**. Timing errors include those of the above categories that negatively influence the speed of reading without affecting accuracy. These errors are *Hems*, *Syllabication* and *Repetitions*. On the other hand, accuracy errors have impact in the accuracy of reading *(what is read differs from what is actually written)*. *Substitutions, Omissions, Additions, Reversals, Misintonation* and *Punctuation* constitute Accuracy errors.

<u>Table 12</u>. Timing & Accuracy Errors

Timing Errors	**Accuracy Errors**
Hems	Substitutions
Syllabication	Omissions
Repetitions	Additions
	Reversals
	Endings
	Misintonation
	Punctuation
	Point Marks

2.2.10.6. Scoring Sheet for Reading Errors

A **scoring sheet** including all 13 categories of reading errors along with their several subcategories as well as the 3 special categories was used for recording and further analysis of the reading errors made by each participant (Appendix 11). This scoring sheet also contained personal information for each participant *(e.g. age, sex, group, etc.)*. However, participants' names did not appear on the scoring sheet. Instead of the name, they were allocated codes, in order to ensure anonymity and confidentiality of personal information. On the present scoring sheet there were also recorded: the number of **correct words** *(correctly read words)* and **incorrect words** *(incorrectly read words)*, **the sum of errors for each category** as well as **the total sum of all reading errors**.

2.2.11. Reliability & Validity of the Instrument used

Reliability and validity of the instrument used were thoroughly evaluated. Prof. Pavlidis himself was responsible for the training on the "Reading Errors Analysis Instrument". Each trainee was assessed in comparison to other trainees. Training was finished only when the accuracy of each trainee was very high, namely 95% or above.

Reliability: Reliability was assessed by testing-retesting. In a pilot study conducted before undertaking the main research, the same people were tested at two different points of time and the scores produced were similar (Field, 2009; Pallant, 2007; Cohen, Manion & Morisson, 2009). Of course, reading scores could not be identical, because reading errors as well as reading speed and comprehension possibly vary depending on mood, fatigue, stress, etc.

Validity: The structure of the Greek language is specifically determined by a great number of grammatical rules. Therefore, the actual error categories derived by these objective rules as well as by the criteria commonly used in the international literature irrespective of language (e.g. fluency). In the analysis I included only the categories of errors that could be objectively determined, i.e. by grammatical rules.

The validity of Pavlidis' "Reading Errors Analysis Instrument" is well established by its ability to accurately discriminate between dyslexics and non-dyslexics and by its wide use, including PhDs and MPhils, awarded even by British Universities (e.g. Petrou, 2005; Bakirtzis, 2005; Goula, 2001; Giannouli, 2001, etc.).

2.2.12. Quantitative Analysis

After having recorded all the reading errors made, percents were calculated, as to be quantitatively analysed. In order to have comparable values, it was necessary to transform the resulting error values to number of errors per 100 words (%), because of the different number of words per reading material. Reading speed, comprehension and reading errors data were analysed with the appropriate statistical tests of SPSS 20.

2.2.13. Qualitative Analysis

The purpose of the qualitative analysis was to investigate the kind of reading errors that participants have made, namely to find out the more and less frequent categories. The qualitative analysis focused on the categories, where a certain amount of reading errors have been made, excluding those ones, where none or a very limited number of errors was recorded. Besides, it would be difficult to assess differences between groups, when minimum errors were found. Furthermore, Greek is a consistent language with a transparent orthography, a fact that explains why certain types of errors are rare in Greek.

2.3. STATISTICAL ANALYSIS – RESULTS

2.3.1. Introduction

In the current chapter, the results that describe the quantitative and qualitative differences found between and within groups are presented. The results regarding the differences in the reading performance of Greek language teachers and 12th grade pupils will be presented in relation to: a) an Ancient Greek text, and b) a Modern Greek text. Analyses have been carried out between groups as well as between the different reading conditions (Ancient & Modern Greek).

2.3.2. Comparison Between Teachers of Ancient Greek & 12th grade Pupils

In the current section comparisons have been made between teachers of Ancient Greek and pupils of the 12th grade, in terms of reading speed, comprehension and accuracy. The individual reading performance of teachers and pupils while reading Ancient and Modern Greek texts is given in Appendix 12.

2.3.2.1. Reading Speed & Comprehension Between Teachers & Pupils

Before proceeding to the main statistical analysis, in order to investigate which reading speed and comprehension variables were statistically significantly different between groups, it was necessary to check the normality of the sample:

Assessing Normality: Normality tests revealed that both groups had a normal distribution on reading speed and comprehension variables ($p > .05$). Normality was further confirmed by the shapes of the corresponding plots and histograms. Therefore, the Independent-samples t-test was used, in order to determine which variables significantly differentiated the two groups. The results are presented per reading material:

a) Ancient Greek

- **Comparing Reading Speed Between Groups**

H_1: Pupils of the 12th grade will read more slowly than the more experienced teachers in Ancient Greek.

H_0: Pupils of the 12th grade will not read more slowly than the more experienced Teachers in Ancient Greek.

Ancient Greek: Aloud Speed Difference Between Groups

On average, pupils of the 12th grade read Ancient Greek faster (M = 135.4 words/1′, SE = 3.66) than teachers of Ancient Greek (M = 119.3, SE = 2.2). The speed difference was highly significant, $t(56) = 3.78$, $p < .001$, $r = .45$.

This finding suggests that the experimental hypothesis should be rejected, as pupils read significantly faster than teachers in Ancient Greek unlike prediction **(Hypothesis rejected).**

- **Comparing Reading Comprehension Between Groups**

H_1: Pupils of the 12th grade will attain lower level of reading comprehension in Ancient Greek than the more experienced teachers.

H_0: Pupils of the 12th grade will not attain lower level of reading comprehension in Ancient Greek than the more experienced teachers.

Ancient Greek: Comprehension Difference Between Groups

Mean Findings suggested that there was no significant difference in reading comprehension between teachers (M = 53.2, SE = 3.22) and pupils (M = 56.5, SE = 3.30), $t(68) = 0.72$, $p > .05$, $r = .09$.

The experimental hypothesis should be rejected, as there was no significant difference in the level of reading comprehension between teachers and pupils in Ancient Greek **(Hypothesis rejected)**.

Table 1. Ancient Greek: Reading Speed & Comprehension Differences Between Teachers & Pupils

Ancient Greek		**GROUP**				
	Teachers		**12th grade Pupils**			
Variables	**Mean**	**SD**	**Mean**	**SD**	**Ratio %**	**p-value**
Reading Speed	**119**	12.97	**135**	21.65	**88**	**.000**
Reading Comprehension %	**53%**	19.07	**56%**	19.52	**95**	**.238**

Ancient Greek: Reading Speed & Comprehension Differences Between Groups

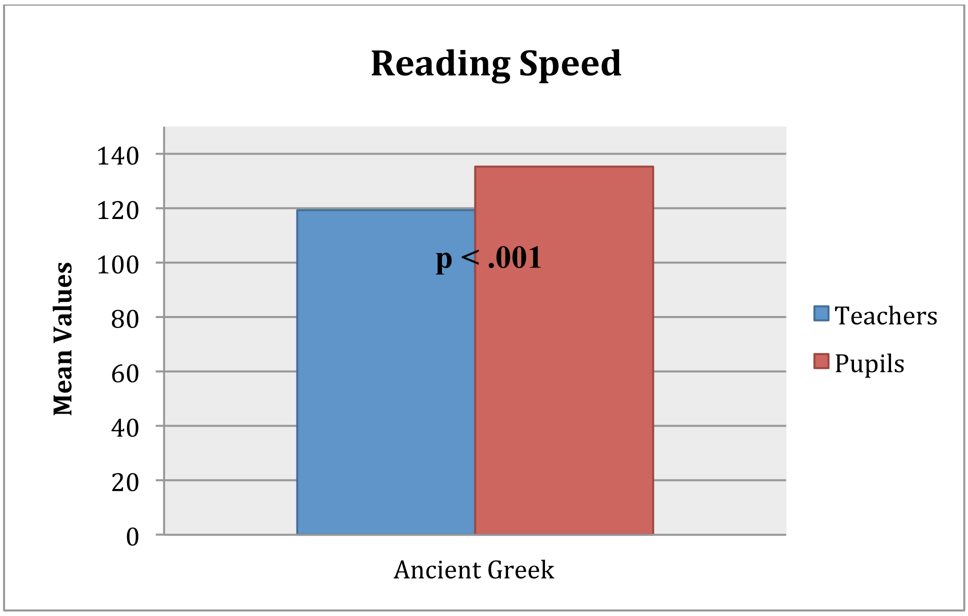


Figure 1(a). Mean values representing reading speed (words/1΄) of teachers and pupils in Ancient Greek. Pupils' reading speed was significantly higher than teachers' ($p < .001$).

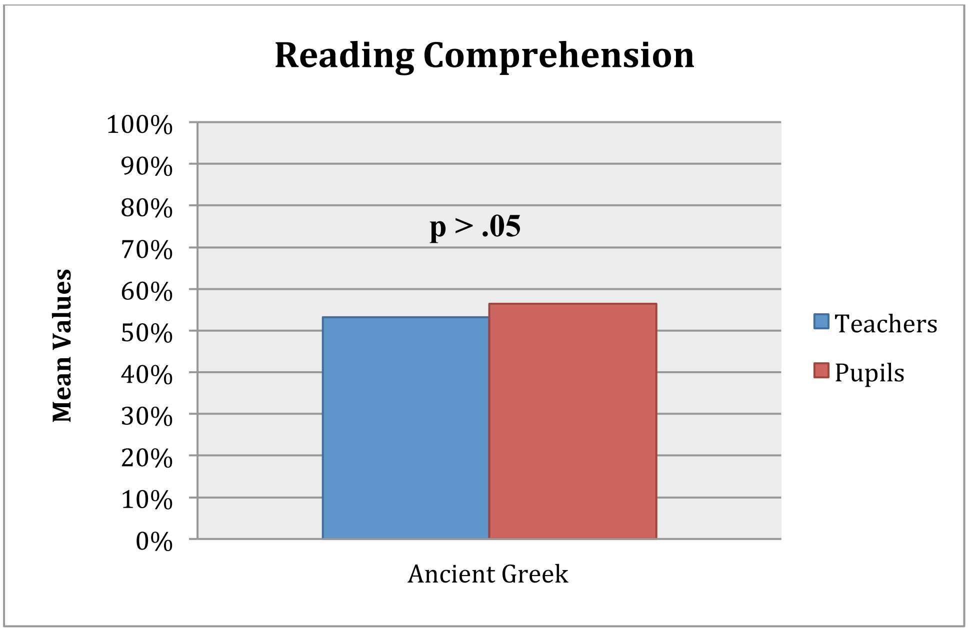


Figure 1(b). Mean values representing reading comprehension levels (%) attained by both groups in Ancient Greek. Although pupils comprehended slightly better, the difference between groups was not significant ($p > .05$).

b) Modern Greek

- **Comparing Reading Speed Between Groups**

H_1: Pupils of the 12th grade will read more slowly than the more experienced teachers in Modern Greek.

H_0: Pupils of the 12th grade will not read more slowly than the more experienced teachers in Modern Greek.

Modern Greek: Aloud Speed Difference Between Groups

As suggested by Mean Findings, pupils of the 12th grade read Modern Greek significantly faster ($M = 179.6$, $SE = 3.18$) than teachers of Ancient Greek ($M = 154.9$, $SE = 2.97$), $t(68) = 5.70$, $p < .001$, also representing a large-sized effect, $r = .57$.

This finding suggests that the experimental hypothesis should be rejected, as pupils read significantly faster than teachers in Modern Greek, unlike prediction **(Hypothesis rejected).**

- **Comparing Reading Comprehension Between Groups**

H_1: Pupils of the 12^{th} grade will attain lower level of reading comprehension in Modern Greek than teachers.

H_0: Pupils of the 12^{th} grade will not attain lower level of reading comprehension in Modern Greek than teachers.

Modern Greek: Comprehension Difference Between Groups

As occurs by Mean Findings, there was no significant difference in the level of reading comprehension between teachers (M = 71.7, SE = 3.45) and pupils (M = 78.5, SE = 2.96) in Modern Greek, $t(68) = 1.50$, $p > .05$, $r = .18$.

The experimental hypothesis should be rejected, as there was no significant difference in the level of comprehension between groups in Modern Greek **(Hypothesis rejected)**.

Table 2. Modern Greek: Reading Speed & Comprehension Differences Between Teachers & Pupils

Modern Greek			**GROUP**			
	Teachers		**12^{th} grade Pupils**			
Variables	**Mean**	**SD**	**Mean**	**SD**	**Ratio %**	**p-value**
Reading Speed	**155**	17.55	**180**	18.80	**86**	**.000**
Reading Comprehension %	**72%**	20.40	**78%**	17.48	**92**	**.070**

Modern Greek: Reading Speed & Comprehension Differences Between Groups

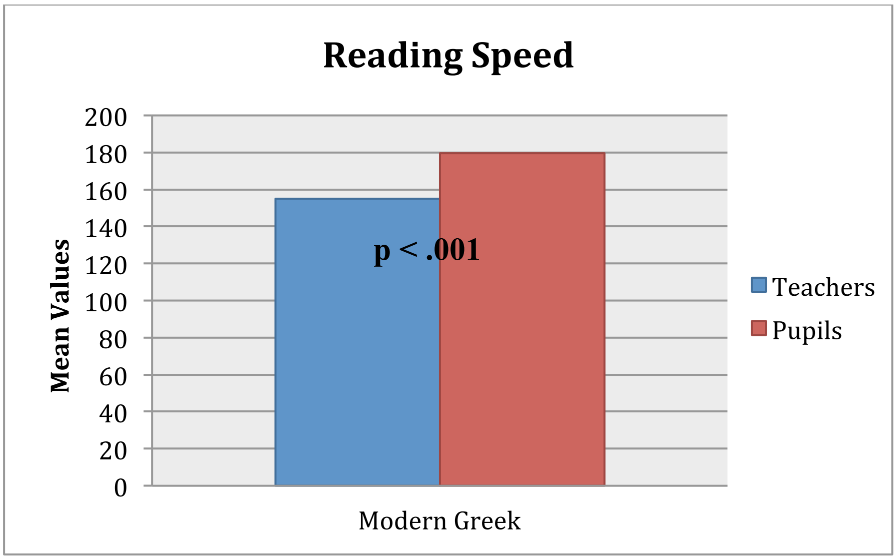


Figure 2(a). Mean values representing reading speed (words/1′) of teachers and pupils in Modern Greek. Pupils' reading speed was significantly higher than teachers' ($p < .001$).

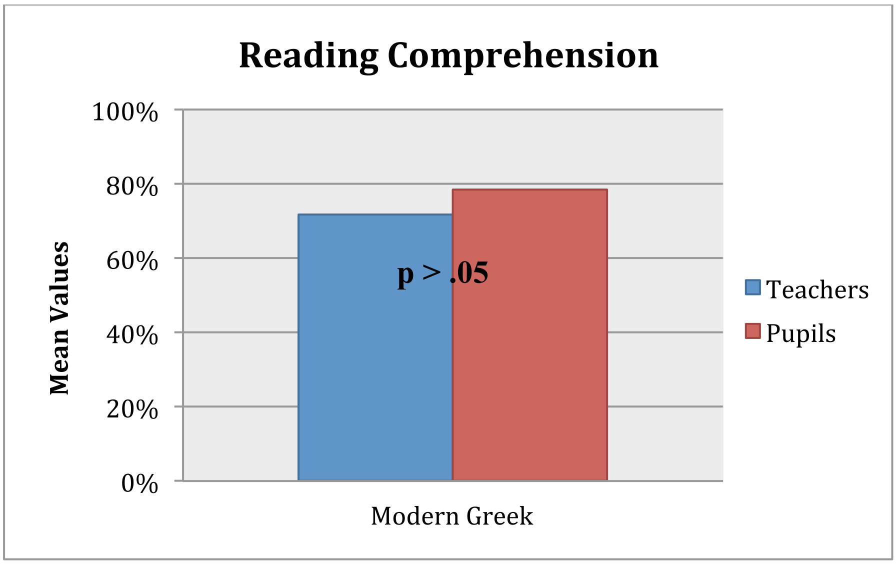


Figure 2(b). Mean values representing reading comprehension levels (%) attained by both groups in Modern Greek. Even though pupils attained higher level of reading comprehension, the difference between groups was not statistically significant ($p > .05$).

Summary: Reading Speed & Comprehension Between Groups

The following table cumulatively represents the reading speed of both groups in all reading conditions.

Table 3(a). Overall Reading Speeds of Teachers & Pupils

Reading Speed	Teachers				Pupils				
Reading Speed	Mean	SD	Min	Max	Mean	SD	Min	Max	Ratio %
Ancient Greek	**119**	13	92	150	**135**	22	73	163	**88**
Modern Greek	**155**	18	113	189	**180**	19	128	214	**86**

Ratio values (teachers' speed/pupils' speed %) suggest that teachers' reading speed lagged 12% and 14% behind pupils' in Ancient and Modern Greek, respectively.

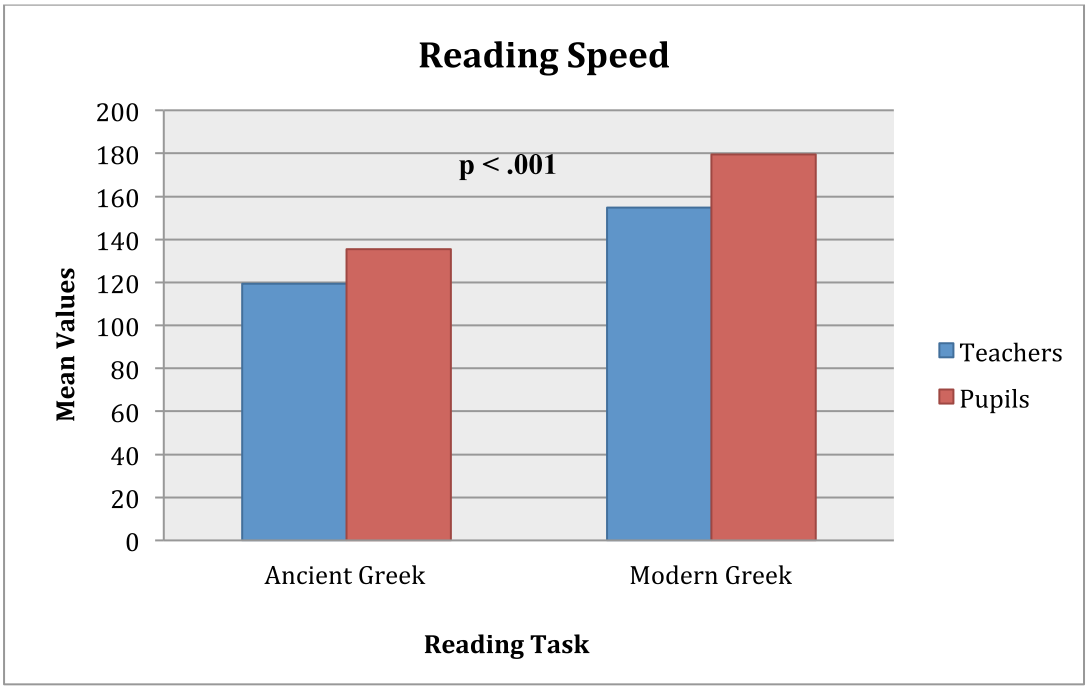


Figure 3(a). Mean values representing the reading speeds (words/1´) of teachers and pupils in both reading materials administered to them during the testing procedure. Obviously, pupils' reading speed was significantly higher than teachers' in both Ancient and Modern Greek ($p < .001$).

The following table represents the level of reading comprehension (%) of both groups in all reading conditions.

Table 3(b). Overall Reading Comprehension of Teachers & Pupils

Reading Comprehension

	Teachers				**Pupils**				
Reading Comprehension	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Ratio %**
Ancient Greek	**53%**	3	0	100	**56%**	3	0	100	**95**
Modern Greek	**72%**	3	20	100	**78%**	3	40	100	**92**

Looking at the ratio values (teachers' comprehension/pupils' comprehension %) teachers lacked 5% and 8% in reading comprehension of Ancient and Modern Greek, respectively, compared to pupils.

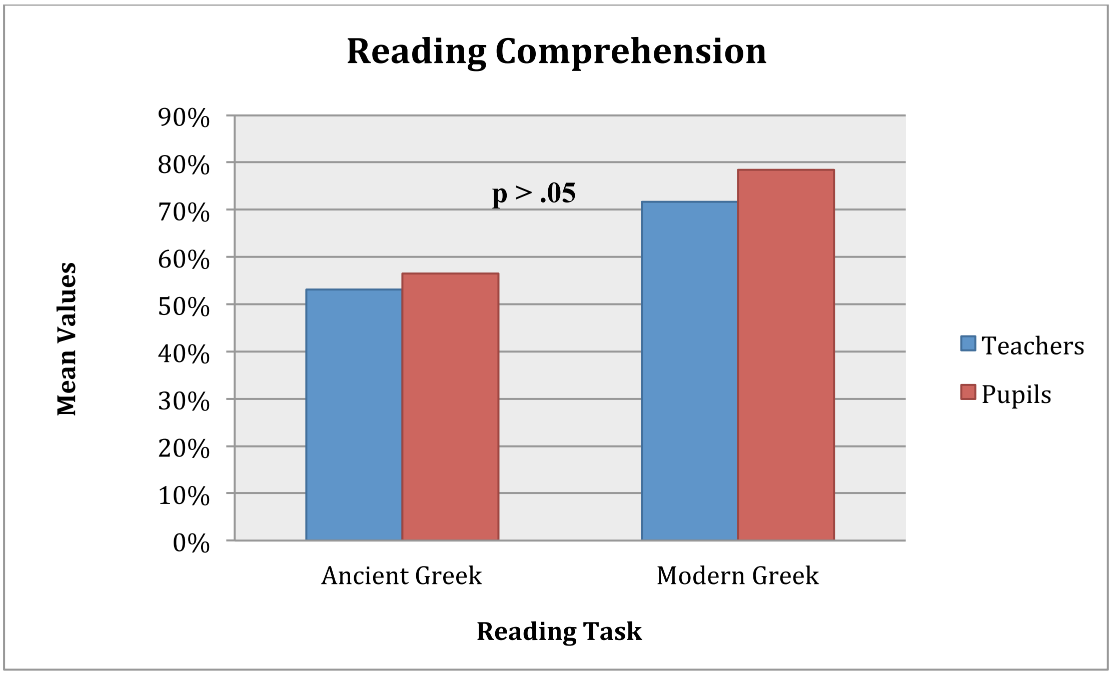


Figure 3(b). Mean values representing the level of reading comprehension (%) attained by both groups in either reading material administered to them. On average, the level of reading comprehension of pupils was higher than teachers' in both reading tasks, although not significantly ($p > .05$).

To sum up, the variable that highly differentiated teachers of Ancient Greek and pupils of the 12th grade in either Ancient or Modern Greek was reading speed ($p < .001$) having a strong effect to the population at the same time.

Table 3(c). Variable highly differentiating the 2 groups: Significance & effect size

Reading Variables	Ancient Greek		Modern Greek	
	p	**r**	**p**	**r**
Reading Speed	< .001	.45	< .001	.57

2.3.2.2. Reading Accuracy Between Teachers & Pupils

Before proceeding to the main statistical analysis, in order to find out which reading errors variables statistically significantly differentiated teachers of Ancient Greek and pupils of the 12th grade, the normality of the sample should be explored. For participants' individual reading performance see Appendix 12.

Assessing Normality: Based on normality tests and looking at the shapes of the appropriate histograms and plots, it was determined that the scores of both groups on the vast majority of reading errors variables were not normally distributed ($p < .05$). From all reading errors variables only Wrong Words, Accuracy and Total Errors were consistently normal ($p > .05$) across groups. Therefore, both the Independent-samples t-test and the Mann-Whitney test seemed appropriate, in order to determine which reading errors variables significantly differentiated the 2 groups. Computing variables using the log transformation in an attempt to correct problems with normality minimum changes occurred. Only Timing Errors became normal after the log transformation for both groups. However, analysing the transformed data using parametric tests no changes occurred in the level of significance as compared to that found using non-parametric ones (see Appendix 13). Results are presented per reading material:

a) Ancient Greek

Main Hypothesis tested

H_1: Pupils of the 12th grade will make more reading errors than the more experienced teachers, when reading Ancient Greek.

H_0: Pupils of the 12th grade will not make more reading errors than the more experienced teachers, when reading Ancient Greek.

Sub-Hypotheses tested: Several sub-hypotheses have been tested related to each single category of reading errors. These sub-hypotheses followed the pattern:

H_1: Pupils of the 12th grade will make more *Hems, Repetitions, Syllabication, Substitutions, etc*. than teachers, when reading Ancient Greek.

H_0: Pupils of the 12th grade will not make more *Hems, Repetitions, Syllabication, Substitutions, etc*. than teachers, when reading Ancient Greek.

Ancient Greek: Hems

12th grade pupils made more hesitation errors (M = 3.54) than teachers of Ancient Greek (M = 0.92), when reading Ancient Greek. *Hems* errors in pupils (Mdn = 2.47) highly differed from teachers (Mdn = 0.81), $U = 283.500$, $z = –3.893$, $p < .001$, $r = –.47$.

Ancient Greek: Repetitions

Pupils of the 12th grade made more Repetitions errors (M = 3.29) than teachers of Ancient Greek (M = 1.27), when reading Ancient Greek. *Repetitions* errors in pupils (Mdn = 2.74) highly differed from teachers (Mdn = 0.00), $U = 307.500$, $z = –3.657$, $p < .001$, $r = –.44$.

Ancient Greek: Syllabications

12th grade pupils made more Syllabication errors (M = 0.89) than teachers of Ancient Greek (M = 0.16), when reading Ancient Greek. *Syllabication* errors in pupils (Mdn = 0.67) differed significantly from teachers (Mdn = 0.00), $U = 310.000$, $z = –4.198$, $p < .001$, $r = –.50$.

Ancient Greek: Substitutions

12th grade pupils made more Substitutions errors (M = 0.91) than teachers (M = 0.43) in Ancient Greek. *Substitutions* errors significantly differentiated the former (Mdn = 0.68) from the latter group (Mdn = 0.00), *U* = 440.000, z = –2.211, p < .05, r = –.26.

Ancient Greek: Omissions

Pupils made more Omissions errors (M = 1.03) than teachers (M = 0.46), when reading Ancient Greek. *Omissions* errors significantly differentiated the former (Mdn = 0.81) from the latter group (Mdn = 0.00), *U* = 397.000, z = –2.607, p < .05, r = –.31.

Ancient Greek: Misintonation

12th grade pupils misplaced the intonation mark in more words of the Ancient Greek text (M = 0.56) than teachers of Ancient Greek (M = 0.00). *Misintonation* errors highly differentiated pupils (Mdn = 0.00) from teachers (Mdn = 0.00), *U* = 332.500, z = –4.472, p < .001, r = –.53.

Ancient Greek: Endings

Pupils of the 12th grade made on average more errors in the endings of the words of the Ancient Greek text (M = 1.48) than teachers (M = 0.48). *Endings* errors highly differentiated the former (Mdn = 0.89) from the latter group (Mdn = 0.00), *U* = 341.500, z = –3.303, p < .001, r = –.39.

Ancient Greek: Pseudo-Words

The group of pupils pronounced more Pseudo-words while reading Ancient Greek (M = 1.01) than the teachers' group (M = 0.25). *Pseudo-Words* errors highly differentiated pupils (Mdn = 0.74) from teachers (Mdn = 0.00), *U* = 309.500, z = –3.783, p < .001, r = –.45.

Ancient Greek: Wrong Words

Pupils of the 12th grade incorrectly read significantly more words of the Ancient Greek text (M = 9.34, SE = 1.07) than teachers (M = 3.41, SE = 0.34), *t*(41) = 5.29, p < .001, r = .64.

Ancient Greek: Total Errors

Pupils of the 12th grade made significantly more reading errors in total while reading Ancient Greek (M = 12.84, SE = 1.46) than the more experienced teachers of Ancient Greek (M = 4.62, SE = 0.53), $t(43) = 5.29$, $p < .001$, r = .64.

Ancient Greek: Timing Errors

12th grade pupils made more timing errors in Ancient Greek (M = 7.75) than teachers of Ancient Greek (M = 2.35). *Timing Errors* in pupils (Mdn = 7.32) highly differed from teachers (Mdn = 1.72), $U = 209.000$, z = –4.745, $p < .001$, and did represent a large-sized effect, r = –.57.

Ancient Greek: Accuracy Errors

Pupils made significantly more accuracy errors while reading Ancient Greek (M = 5.29, SE = 0.63) than the more experienced teachers (M = 2.27, SE = 0.27), t(46) = 4.41, $p < .001$, r = .54.

These findings suggest that all experimental hypotheses regarding the above categories of reading errors, which were found to be significantly more in pupils, can be accepted as true **(Hypotheses accepted)**. Even though pupils did not make significantly more reading errors in each single reading errors category, the main experimental hypothesis should be accepted as true, as pupils of the 12th grade made significantly more reading errors in total ($p < .001$), when reading Ancient Greek, than the more experienced teachers of Ancient Greek **(Hypothesis accepted)**.

The following table includes the reading errors categories that significantly differentiated teachers and pupils in Ancient Greek:

Table 4. Reading Errors Differences Between Teachers & Pupils in Ancient Greek

Ancient Greek	**GROUP**							
	Teachers			**Pupils**				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio %**	**p-value**
Hems	0.92	0.90	0.81	3.54	3.82	2.47	**26**	**.000**
Repetitions	1.27	1.85	0.00	3.29	2.81	2.74	**39**	**.000**
Syllabication	0.16	0.60	0.00	0.89	1.00	0.67	**18**	**.000**
Substitutions	0.43	0.73	0.00	0.91	1.09	0.68	**47**	**.013**
Omissions	0.46	0.60	0.00	1.03	0.89	0.81	**45**	**.004**
Misintonation	0.00	0.00	0.00	0.56	0.77	0.00	**0**	**.000**
Endings	0.48	0.72	0.00	1.48	1.36	0.89	**32**	**.000**
Pseudo Words	0.25	0.41	0.00	1.01	1.03	0.74	**25**	**.000**
Wrong Words	3.41	2.03	3.45	9.34	6.32	8.04	**37**	**.000**
Total Errors	4.62	3.12	4.08	12.84	8.63	11.76	**36**	**.000**
Timing Errors	2.35	2.17	1.72	7.75	5.87	7.32	**30**	**.000**
Accuracy Errors	2.27	1.60	2.36	5.29	3.72	5.04	**43**	**.000**

Ratio values (teachers' errors/pupils' errors %) shown in the table indicate that pupils' reading performance in Ancient Greek lagged from 53% up to 100% behind teachers', meaning that they made from 53% to 100% more reading errors than teachers in Ancient Greek. As far as it concerns the 3 last reading errors categories (overall categories), they made 64% more reading errors in total, 70% more timing and 57% more accuracy errors compared to teachers.

Ancient Greek: Reading Error Differences Between Groups

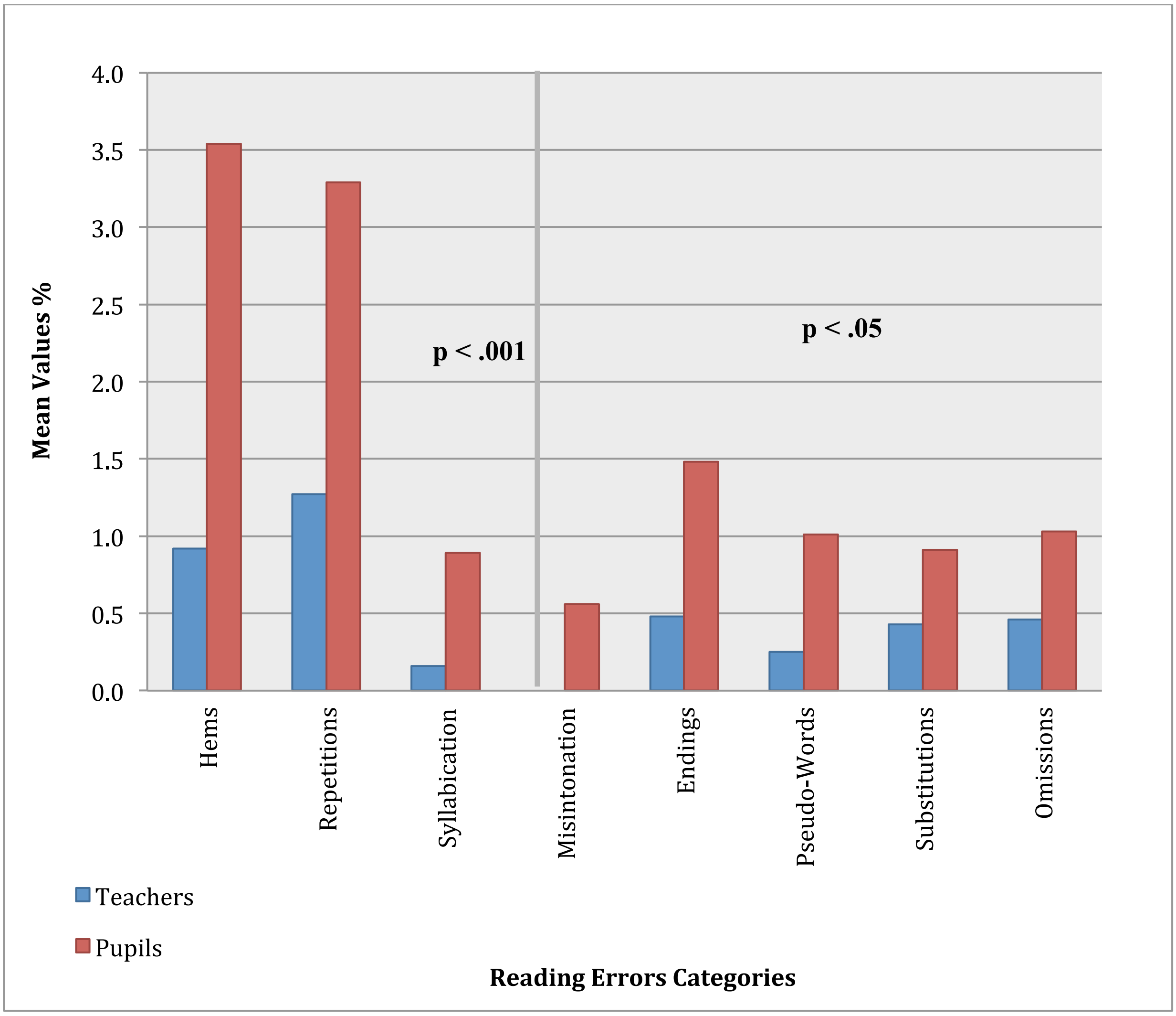


Figure 4(a). Mean values representing the reading errors made by both groups. Statistically significant differences were found between groups in the above categories. The errors that highly differed in teachers from pupils were Hems, Repetitions, Syllabication, Misintonation, Endings, and Pseudo-Words ($p < .001$).

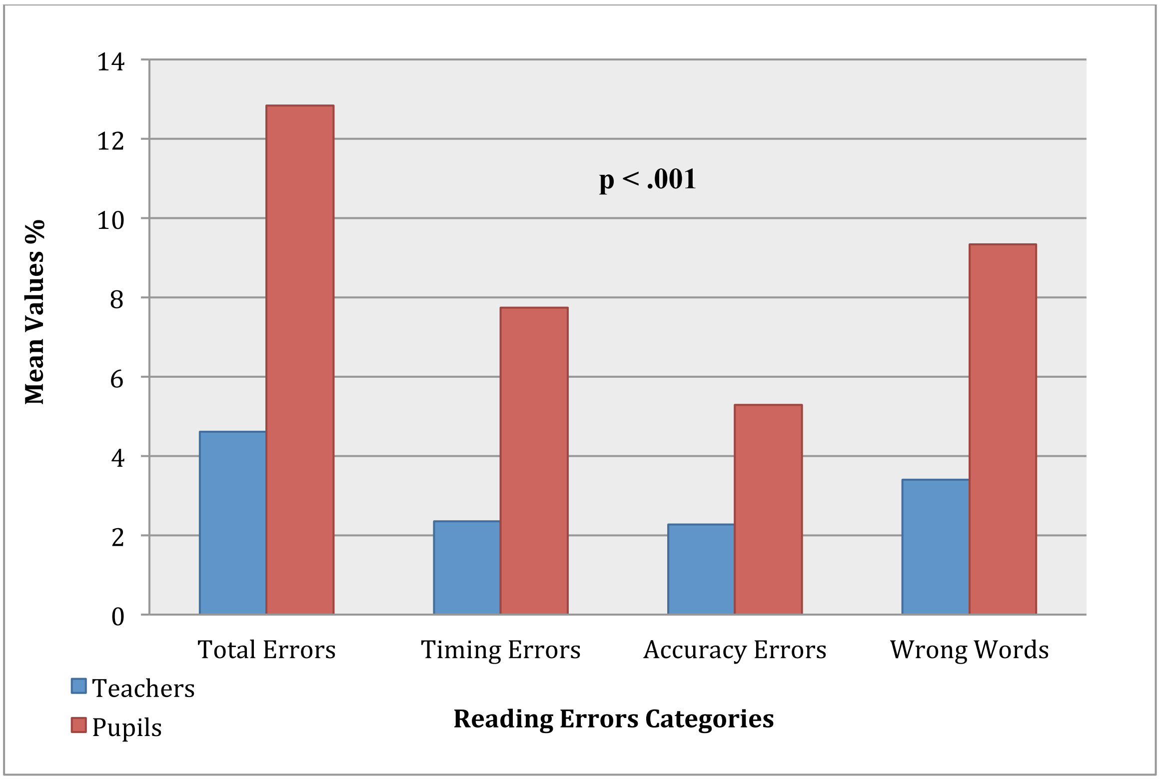


Figure 4.4(b). Mean values representing the total percent of reading errors made by both groups, their timing and accuracy errors, as well as the amount of words that they incorrectly read. Highly significant differences were found between teachers and pupils ($p < .001$).

b) Modern Greek

Main Hypothesis tested

H_1: Pupils of the 12th grade will make more reading errors than teachers, when reading Modern Greek.

H_0: Pupils of the 12th grade will not make more reading errors than teachers, when reading Modern Greek.

Sub-Hypotheses tested: Several sub-hypotheses have been tested in relation to each single category of reading errors. These sub-hypotheses followed the pattern:

H_1: Pupils of the 12th grade will make more *Hems, Repetition, Syllabication, Substitutions, etc.* than teachers, when reading Modern Greek.

H_0: Pupils of the 12th grade will not make more *Hems, Repetition, Syllabication, Substitutions, etc.* than teachers, when reading Modern Greek.

Modern Greek: Repetitions

Pupils of the 12th grade made more Repetitions errors (M = 2.29) than teachers of Ancient Greek (M = 1.12), when reading Modern Greek. *Repetitions* errors in pupils (Mdn = 1.87) significantly differed from teachers (Mdn = 0.06), U = 401.500, z = –2.530, p < .05, r = –.30.

Modern Greek: Syllabication

12th grade pupils made more Syllabication errors (M = 0.20) than teachers of Ancient Greek (M = 0.05), when reading Modern Greek. *Syllabication* errors significantly differentiated pupils (Mdn = 0.00) from teachers (Mdn = 0.00), U = 496.000, z = –2.160, p < .05, r = –.26.

Modern Greek: Wrong Words

The group of pupils incorrectly read significantly more words of the Modern Greek text (M = 3.23, SE = 0.36) than the group of teachers (M = 1.85, SE = 0.23), t(59) = 3.25, p = .001, r = .39.

Modern Greek: Total Errors

Pupils of the 12th grade made significantly more reading errors in total while reading Modern Greek (M = 5.02, SE = 0.57) than the more experienced teachers of Ancient Greek (M = 3.09, SE = 0.46), t(68) = 2.62, p < .05, r = .30.

Modern Greek: Timing Errors

12th grade pupils made more timing errors while reading Modern Greek (M = 3.55) than the more experienced teachers of Ancient Greek (M = 1.84). Timing Errors significantly differentiated the former (Mdn = 2.99) from the latter group (Mdn = 1.39), U = 358.500, z = –2.993, p = .001, r = –.36.

These findings suggest that the experimental hypotheses regarding the above categories of reading errors, which were found to be significantly more in pupils, can be accepted as true **(Hypotheses accepted)**. Although pupils did not make significantly more reading errors in each single category and even though the error rates were considerably low for both groups, the main experimental hypothesis should be accepted, as 12th grade pupils made significantly more reading errors in total ($p < .05$), when reading Modern Greek, than the more experienced Greek language teachers **(Hypothesis accepted)**.

The following table includes the reading errors categories that significantly differentiated teachers and pupils in Modern Greek:

Table 5. Reading Errors Differences Between Teachers & Pupils in Modern Greek

Modern Greek	**GROUP**							
	Teachers			**Pupils**				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio %**	**p-value**
Repetitions	1.12	1.37	0.06	2.29	2.09	1.87	**49**	**.005**
Syllabication	0.05	0.23	0.00	0.20	0.40	0.00	**25**	**.021**
Wrong Words	1.85	1.38	1.75	3.23	2.11	2.78	**57**	**.001**
Total Errors	3.09	2.72	2.40	5.02	3.38	4.50	**62**	**.005**
Timing Errors	1.84	2.17	1.39	3.55	2.91	2.99	**52**	**.001**

As it could be concluded from the ratio values (teachers' errors/pupils' errors %), pupils' reading performance in Modern Greek lagged from 38% up to 75% behind teachers', meaning that they made from 38% to 75% more reading errors. Regarding the 2 last reading errors categories (overall categories), they made 38% more reading errors in total and 48% more timing errors compared to teachers.

Modern Greek: Reading Error Differences Between Groups

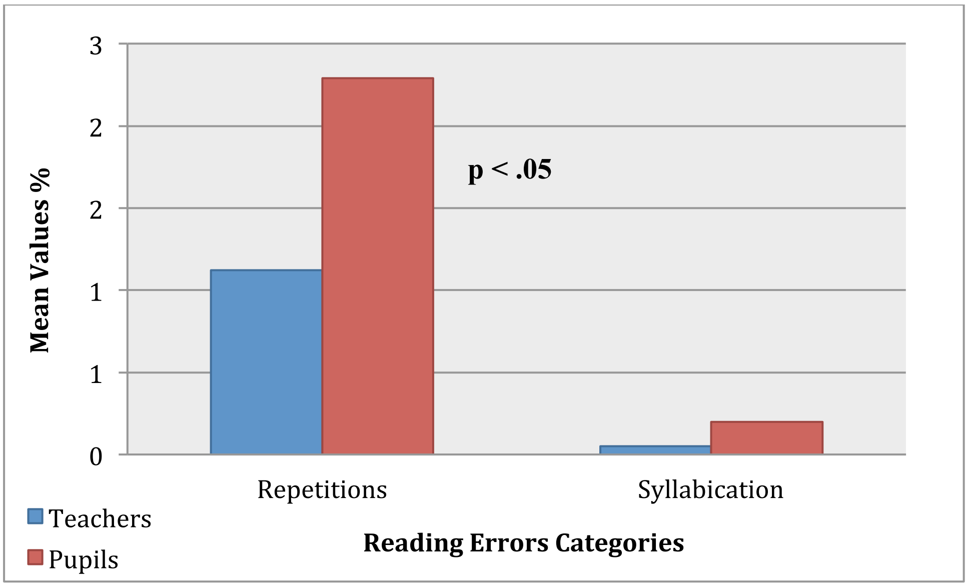


Figure 5(a). Mean values representing the reading errors made by each target group. Statistically significant differences were found between groups in the above categories ($p < .05$).

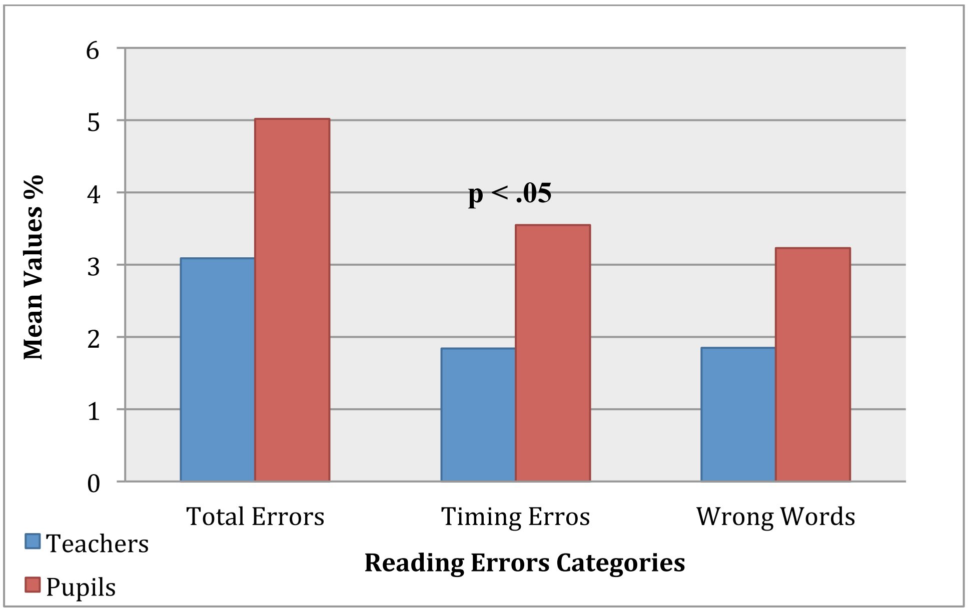


Figure 5(b). Mean values representing the total percent of reading errors made by both groups, the percent of timing errors, as well as the words they incorrectly read. Statistically significant differences were found between groups ($p < .05$).

Summary: Reading Errors Between Teachers & Pupils

To sum up, the reading errors variables that highly differentiated teachers from pupils ($p < .001$) having a strong effect to the population at the same time were Hems, Repetitions, Syllabication, Endings, Misintonation, Pseudo-Words, Wrong Words, Timing, Accuracy and Total Errors but only for Ancient Greek. In Modern Greek, the level of significance was constrained at $p < .05$, whereas the categories of reading errors where significant differences have been found were limited (see table 6).

Table 6. Reading errors variables differentiating the 2 groups: Significance & effect size

Reading Errors	Ancient Greek		Modern Greek	
	p	r	p	r
Hems	< .001	–.47	–	–
Repetitions	< .001	–.44	< .05	–.30
Syllabication	< .001	–.50	< .05	–.26
Endings	< .001	–.39	–	–
Misintonation	< .001	–.53	–	–
Pseudo-Words	< .001	–.45	–	–
Wrong Words	< .001	.64	= .001	.39
Timing Errors	< .001	–.57	= .001	–.36
Accuracy Errors	< .001	.54	*ns*	–
Total Errors	< .001	.64	< .05	.30

2.3.3. Within Groups: Comparison Between Ancient & Modern Greek

In the current section comparisons have been made, within each group, between the different reading materials in terms of reading accuracy, speed, and comprehension, in order to find out whether participants performed better in Ancient or Modern Greek. The individual reading performance of teachers and pupils is given in Appendix 12.

2.3.3.1. Reading Speed & Comprehension Within Groups

Before proceeding to the main statistical analysis, in order to investigate whether there were differences within each group between the different reading materials in terms of reading speed and comprehension, it was necessary to explore the normality of the sample.

Assessing Normality: Since the same groups were tested in different reading conditions, the Paired-samples t-test or its non parametric equivalent Wilcoxon signed-rank test seemed appropriate for the next step of the statistical analysis based on the sampling distribution. These tests are appropriate for comparisons within a group, which has been examined in 2 different experimental conditions (Field, 2009, p.325). According to Field (2009, p.329), in order to establish normality, the differences between scores in Ancient and Modern Greek should be computed and then checked for. The results are presented per group:

a) Teachers

H_1: Within the teachers' group, participants will read faster and comprehend better in Modern than in Ancient Greek.

H_0: Within the teachers' group, participants will not read faster and comprehend better in Modern than in Ancient Greek.

Normality tests revealed that teachers' comprehension difference between Ancient and Modern Greek variables was not normal ($p < .05$), while aloud and silent speed differences were normal ($p > .05$). Computing log transformation for reading comprehension did not make any difference in terms of normality. Consequently, the Wilcoxon signed-rank test and the Paired-samples t-test were respectively used for the analysis.

Teachers: Aloud Speed Difference Between Ancient & Modern Greek

As occurs by Mean Findings, teachers of Ancient Greek read the Modern Greek text significantly faster ($M = 154.86$, $SE = 2.97$) than the Ancient Greek text in the aloud condition ($M = 119.29$, $SE = 2.19$), $t(34) = –15.45$, $p < .001$, $r = .94$.

Teachers: Silent Speed Difference Between Ancient & Modern Greek

Mean findings suggested that Greek language teachers read the Modern Greek text significantly faster ($M = 258.69$, $SE = 10.25$) than the Ancient Greek text in the silent condition ($M = 180.09$, $SE = 7.12$), $t(34) = –10.88$, $p < .001$, $r = .88$.

Teachers: Comprehension Difference Between Ancient & Modern Greek

As suggested by Mean Findings, teachers' level of reading comprehension was significantly higher after having read Modern (Mdn = 71.00) than Ancient Greek (Mdn = 57.00), $T = 28.00$, $z = –4.314$, $p < .001$, $r = –.52$.

Findings suggest that the experimental hypothesis should be accepted, as teachers read significantly faster and attained significantly higher level of comprehension in Modern than in Ancient Greek **(Hypothesis accepted)**.

Table 7. Teachers' Reading Speed & Comprehension Differences Between Ancient & Modern Greek

Teachers	**Reading Condition**						
	Ancient Greek		**Modern Greek**		**Ancient – Modern Greek**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Reading Speed Aloud	119	12.97	155	17.55	**–36**	**77**	**.000**
Reading Speed Silent	180	42.14	259	60.65	**–79**	**69**	**.000**
Reading Comprehension	53%	19.07	72%	20.40	**–19%**	**74**	**.000**

Ratio values (Ancient Greek /Modern Greek speed % - Ancient Greek /Modern Greek comprehension %) indicate that teachers' reading speed (aloud & silent) and comprehension in Ancient Greek lagged 23%, 31% and 26% behind Modern, respectively.

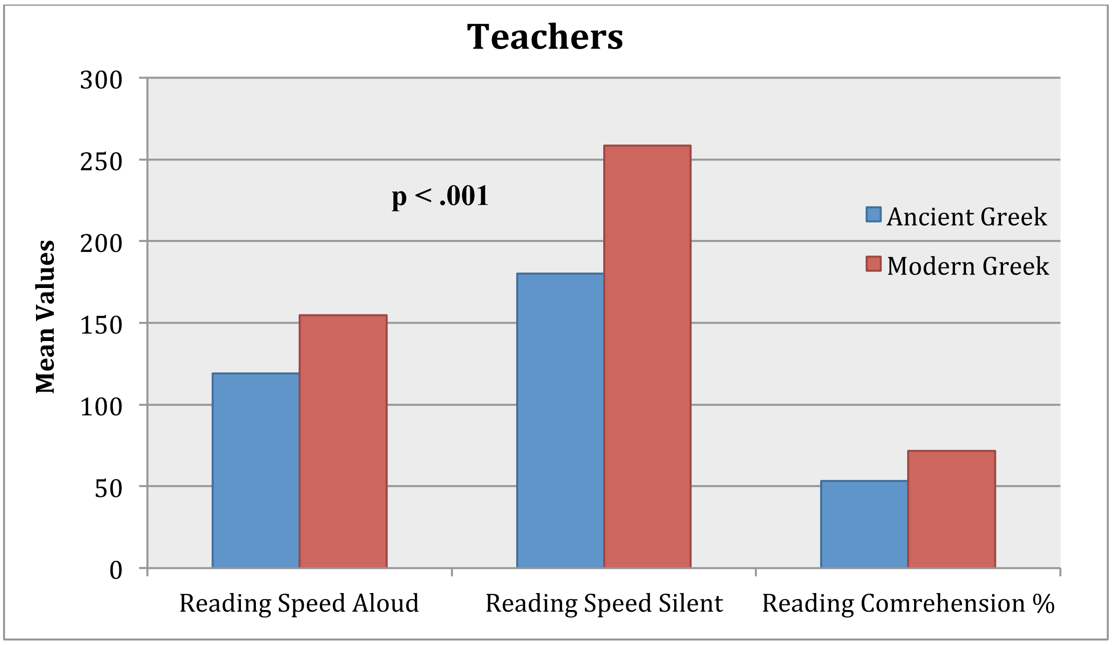


Figure 7. Mean values representing teachers' reading speed (words/1΄) and level of reading comprehension (%) attained in both Ancient and Modern Greek. In general, teachers read significantly faster and comprehended significantly better in Modern than in Ancient Greek ($p < .001$).

b) Pupils

H_1: Within the pupils' group, participants will read faster and comprehend better in Modern than in Ancient Greek.

H_0: Within the pupils' group, participants will not read faster and comprehend better in Modern than in Ancient Greek.

According to normality tests, pupils' speed and comprehension differences between Ancient and Modern Greek variables were all normal ($p > .05$), and, therefore, the Paired-samples t-test was used for the analysis.

Pupils: Aloud Speed Difference Between Ancient & Modern Greek

Mean Findings suggested that pupils of the 12^{th} grade read Modern Greek highly faster ($M = 179.64$, $SE = 3.18$) than Ancient Greek in the aloud condition ($M = 135.40$, $SE = 3.66$), $t(34) = -19.54$, $p < .001$, $r = .96$.

Pupils: Silent Speed Difference Between Ancient & Modern Greek

As suggested by Mean Findings, 12^{th} grade pupils read Modern Greek significantly faster ($M = 281.11$, $SE = 9.36$) than Ancient Greek in the silent condition ($M = 196.74$, $SE = 10.91$), $t(34) = -13.89$, $p < .001$, $r = .92$.

Pupils: Comprehension Difference Between Ancient & Modern Greek

As occurs by Mean Findings, pupils attained significantly higher level of reading comprehension after having read Modern ($M = 78.49$, $SE = 2.96$) than Ancient Greek ($M = 56.49$, $SE = 3.30$), $t(34) = -5.93$, $p < .001$, also representing a large effect size, $r = .71$.

Findings suggest that the experimental hypothesis should be accepted, as 12^{th} grade pupils read significantly faster and comprehended significantly better in Modern than in Ancient Greek **(Hypothesis accepted)**.

Table 8. Pupils' Reading Speed & Comprehension Differences Between Ancient & Modern Greek

Pupils	**Reading Condition**						
	Ancient Greek		**Modern Greek**		**Ancient – Modern Greek**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Reading Speed Aloud	135	21.65	180	18.80	**–44**	**75**	**.000**
Reading Speed Silent	197	55.39	281	64.54	**–84**	**70**	**.000**
Reading Comprehension	56%	19.52	78%	17.48	**–22%**	**72**	**.000**

As suggested by the ratio values (Ancient/Modern Greek speed % - Ancient/Modern Greek comprehension %), pupils' reading speed (aloud & silent) and comprehension in Ancient Greek lagged 25%, 30% and 28% behind Modern, respectively.

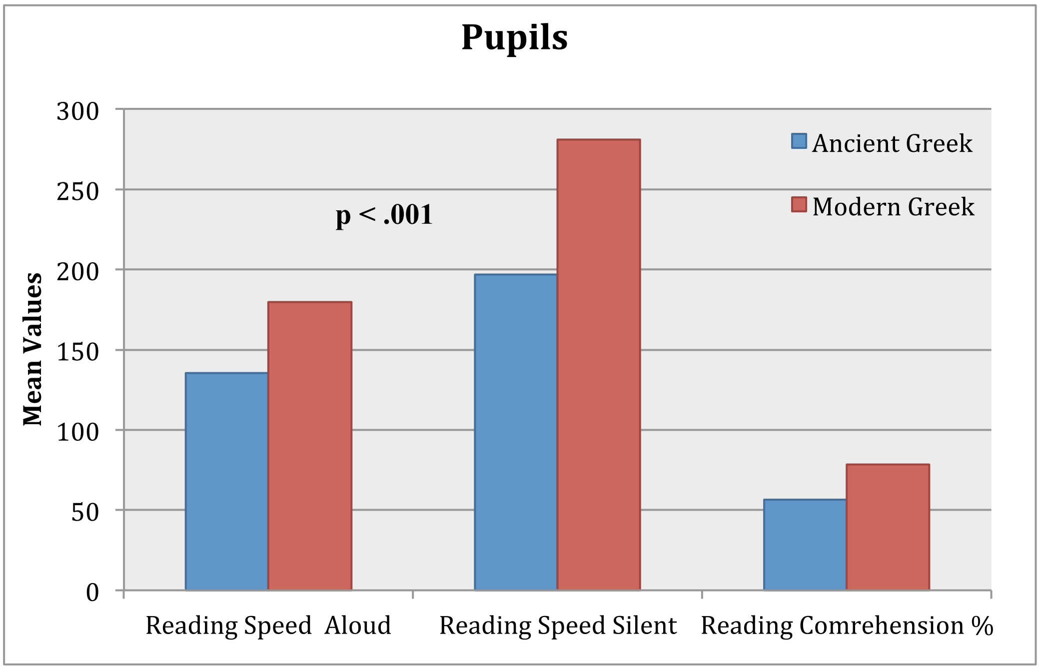


Figure 8. Mean values representing pupils' reading speed (words/1΄) and level of comprehension (%) attained in both Ancient and Modern Greek. On average, pupils read significantly faster and comprehended significantly better in Modern than in Ancient Greek ($p < .001$).

Summary: Reading Speed & Comprehension Between Ancient & Modern Greek

The following table cumulatively represents the reading speed and level of comprehension of both groups in Ancient and Modern Greek.

Table 9. Overall Reading Speed & Comprehension Differences Between Ancient & Modern Greek

Group	**Reading Condition**									
	Ancient Greek				**Modern Greek**				**Ancient-Modern Greek**	
	Mean		**SD**		**Mean**		**SD**		**Mean Difference**	
Variables	**Teachers**	**Pupils**	**Teachers**	**Pupils**	**Teachers**	**Pupils**	**Teachers**	**Pupils**	**Teachers**	**Pupils**
Reading Speed Aloud	**119**	**135**	13	22	**155**	**180**	18	19	**–36**	**–44**
Reading Speed Silent	**180**	**197**	42	55	**259**	**281**	61	65	**–79**	**–84**
Reading Comprehension	**53%**	**56%**	19	20	**72%**	**78%**	20	17	**–19%**	**–22%**

In an overall view, both groups read significantly faster ($p < .001$) and attained significantly higher level of reading comprehension ($p < .001$) in Modern than in Ancient Greek. These findings are evident in the following figures as well:

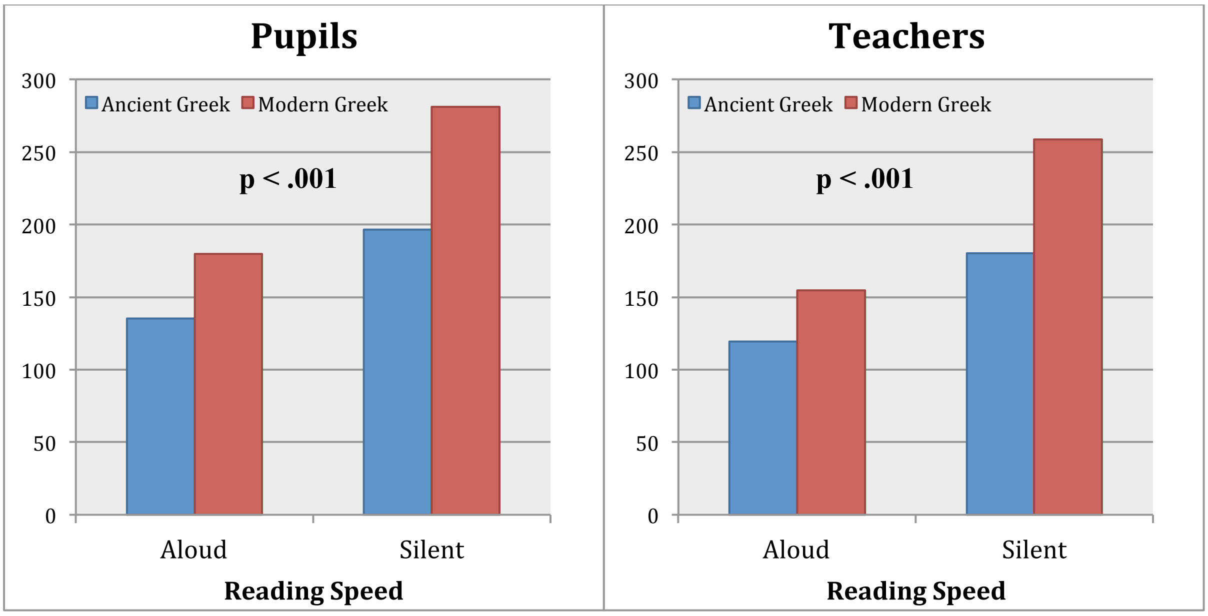
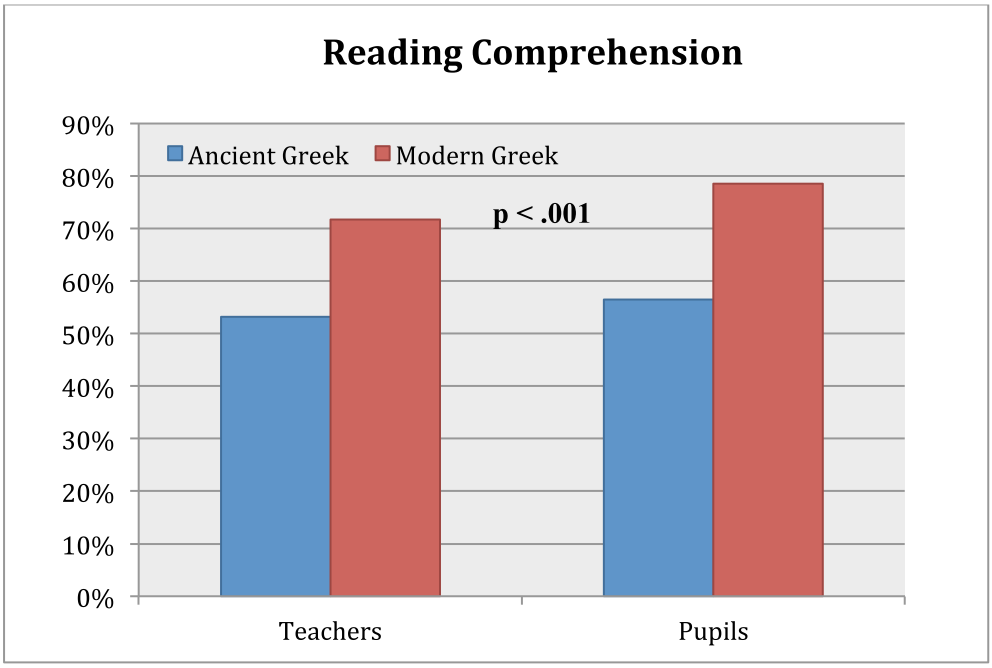
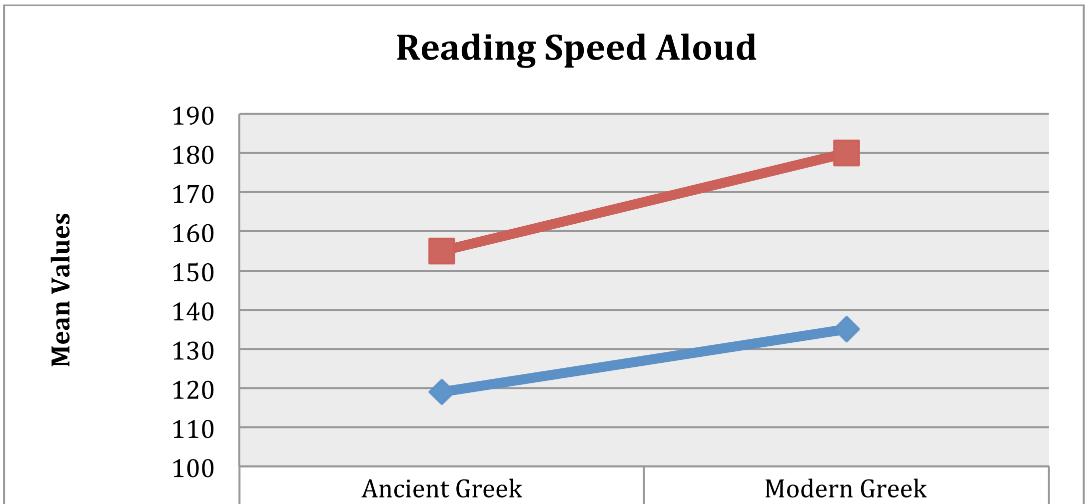


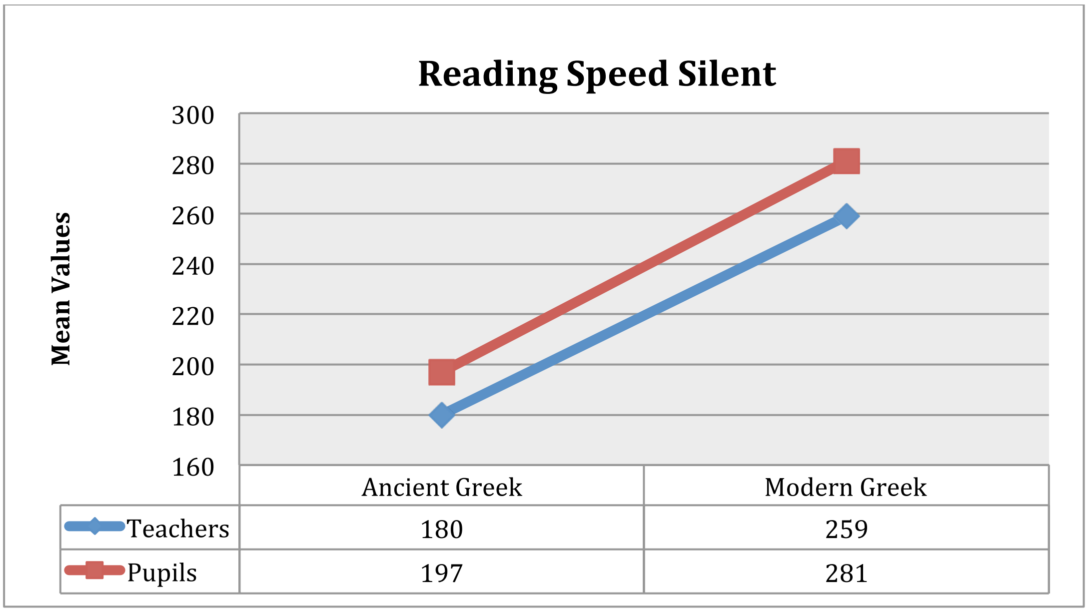
Figure 9(a). Mean values representing the reading speed (aloud & silent) of teachers and pupils in both Ancient and Modern Greek materials. Both groups read significantly faster in Modern Greek ($p < .001$).



<u>Figure 9(b)</u>. Mean values representing the level of reading comprehension (%) attained by the 2 groups in both Ancient and Modern Greek. Both groups comprehended significantly better in Modern Greek ($p < .001$).



	Ancient Greek	Modern Greek
Teachers	119	135
Pupils	155	180



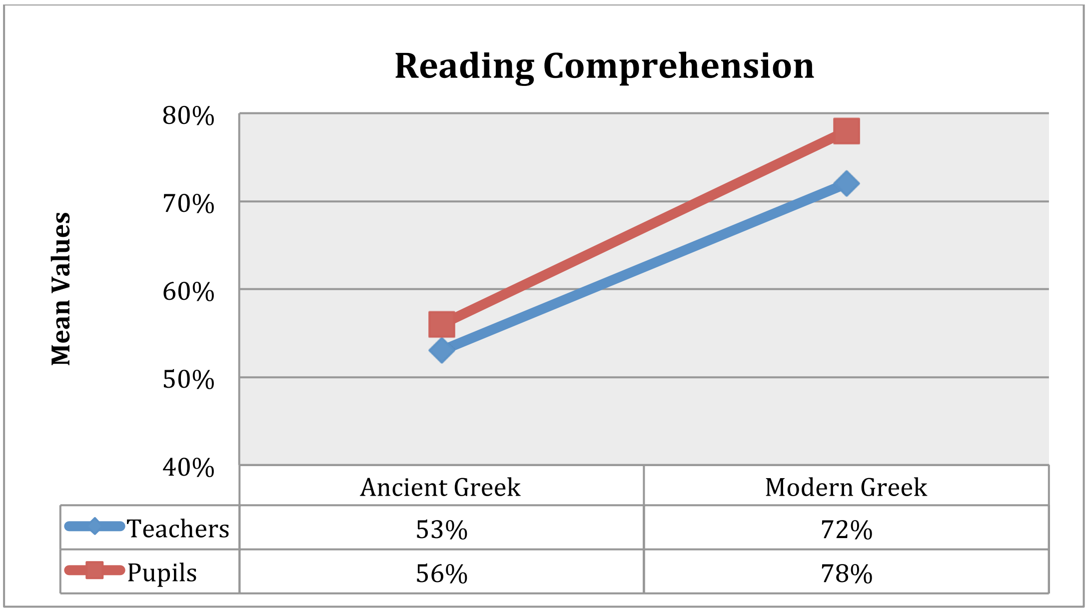


Figure 9(c). As obvious from the above figures, teachers and pupils were similarly affected in terms of reading speed by the reading material (Ancient or Modern Greek). Teachers read 12% and 31% faster the Modern Greek text in the aloud and silent condition, respectively. Similarly, pupils read 14% and 30% faster the Modern Greek material aloud and silently, respectively. A similar pattern was found with regard to reading comprehension. Teachers and pupils comprehended 26% and 29% better, respectively, the Modern Greek text. In addition, it is remarkable that pupils were consistently faster and better comprehenders than their teachers.

2.3.3.2. Reading Accuracy Within Groups

Before proceeding to the main statistical analysis, in order to find out whether there were differences, within each group, between Ancient and Modern Greek in terms of reading errors, it was necessary to explore the normality of the sample. The results are presented per group:

a) Teachers

Main Hypothesis tested

H_1: Within the teachers' group, participants will make more reading errors in Ancient than in Modern Greek.

H_0: Within the teachers' group, participants will not make more reading errors in Ancient than in Modern Greek.

Sub-Hypotheses tested: Several sub-hypotheses have been tested related to each single category of reading errors. These sub-hypotheses followed the pattern:

H_1: Within the teachers' group, participants will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* in Ancient than in Modern Greek.

H_0: Within the teachers' group, participants will not make more *Hems, Repetitions, Syllabication, Substitutions, etc.* in Ancient than in Modern Greek.

Based on normality tests, half of teachers' reading errors differences between Ancient and Modern Greek were not normal ($p < .05$), whereas the remaining were normal ($p > .05$). Thus, both parametric and non-parametric tests were used for the analysis.

The reading errors that significantly differed in quantity between Ancient and Modern Greek for the teachers' group were the following:

Hems

The group of teachers made significantly more *Hems* errors in Ancient (Mdn = 0.81) than in Modern Greek (Mdn = 0.60), $T = 83.00$, $z = -1.914$, $p < .05$, $r = -.23$.

Omissions

Teachers of Ancient Greek made significantly more *Omissions* errors while reading Ancient (Mdn = 0.00) than Modern Greek (Mdn = 0.00), $T = 29.00$, $z = –2.461$, $p < .05$, $r = –.29$.

Endings

Teachers made significantly more errors in *Endings* while reading Ancient (Mdn = 0.00) than Modern Greek (Mdn = 0.00), $T = 1.00$, $z = –3.352$, $p < .001$, $r = –.40$.

Punctuation

The teachers' group made significantly more *Punctuation* errors in Ancient (Mdn = 0.00) than in Modern Greek (Mdn = 0.00), $T = 20.00$, $z = –2.272$, $p < .05$, $r = –.27$.

Point Marks

Teachers made significantly more *Point Marks* errors while reading Ancient (Mdn = 0.00) than Modern Greek (Mdn = 0.00), $T = 11.00$, $z = –1.958$, $p < .05$, $r = –.23$.

Wrong Words

The group of teachers read significantly more *Wrong Words* in Ancient (M = 3.41, SE = 0.34) than in Modern Greek (M = 1.85, SE = 0.23), $t(34) = 4.36$, $p < .001$, $r = .60$.

Total Errors

Teachers of Ancient Greek made significantly more reading errors in total while reading Ancient (M = 4.62, SE = 0.53) than Modern Greek (M = 3.09, SE = 0.46), $t(34) = 2.29$, $p < .05$, $r = .37$.

Accuracy Errors

Teachers of Ancient Greek made significantly more accuracy errors while reading Ancient (M =2.27, SE = 0.27) than Modern Greek (M = 1.11, SE = 0.14), $t(34) = 4.15$, $p < .001$, $r = .58$.

These findings suggest that all experimental hypotheses regarding the above categories of reading errors, which were found to be significantly more in Ancient Greek, can be accepted as true **(Hypotheses accepted)**. Even though teachers did not make significantly more errors in each single reading errors category in Ancient Greek and although their error rates were considerably low in both Ancient and Modern Greek, the main experimental hypothesis should be accepted, as they were significantly less accurate in Ancient than in Modern Greek **(Hypothesis accepted)**.

The following table includes the reading errors categories that were significantly more in Ancient than in Modern Greek:

Table 10. Teachers' Reading Errors Differences Between Ancient & Modern Greek

Teachers	**Reading Condition**						
	Ancient Greek		**Modern Greek**		**Ancient – Modern Greek**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Hems	0.92	0.90	0.62	1.07	**0.30**	**67**	**.028**
Omissions	0.47	0.60	0.17	0.42	**0.30**	**36**	**.006**
Endings	0.48	0.72	0.04	0.15	**0.44**	**8**	**.000**
Punctuation	0.36	0.63	0.11	0.25	**0.24**	**31**	**.010**
Point Marks	0.25	0.46	0.06	0.23	**0.19**	**24**	**.025**
Wrong Words	3.41	2.03	1.85	1.38	**1.56**	**54**	**.000**
Accuracy Errors	2.27	0.27	1.11	0.14	**1.16**	**49**	**.000**
Total Errors	4.62	3.12	3.09	2.72	**1.53**	**67**	**.028**

As suggested by the ratio values (Modern/Ancient Greek errors %), teachers' reading performance in Ancient Greek lagged from 33% up to 92% behind Modern, meaning that they made from 33% up to 92% more reading errors in Ancient Greek. Regarding the 2 last overall categories, teachers made 51% more accuracy errors and 33% more reading errors in total in Ancient Greek compared to Modern.

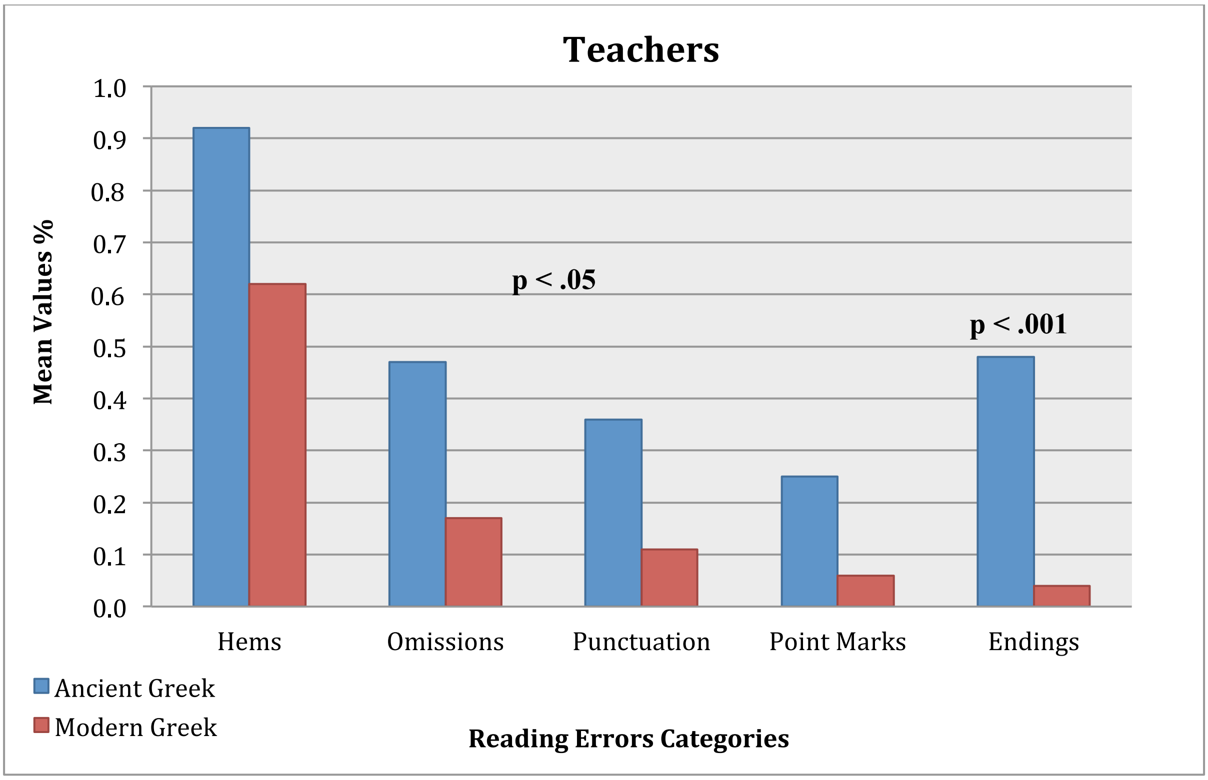


Figure 10(a). Mean values representing teachers' reading errors in both Ancient and Modern Greek. Statistically significant differences were found between Ancient and Modern Greek in the above categories ($p < .05$). Endings highly differed in quantity between Ancient and Modern Greek ($p < .001$).

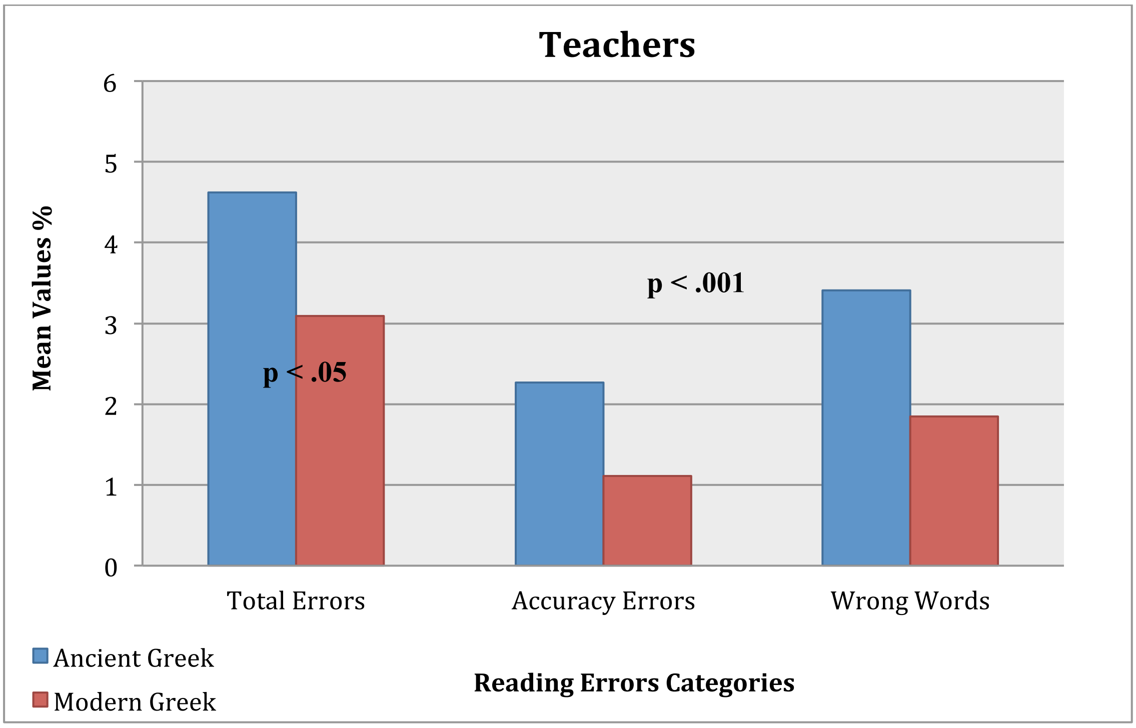


Figure 10(b). Mean values representing the total percent of teachers' reading errors in Ancient and Modern Greek, their accuracy errors as well as the amount of words they incorrectly read. Statistically significant differences were found between Ancient and Modern Greek in the total amount of reading errors ($p < .05$), whereas Accuracy Errors and Wrong Words highly differed between the 2 reading materials ($p < .001$).

b) Pupils

Main Hypothesis tested

H_1: Within the pupils' group, participants will make more reading errors in Ancient than in Modern Greek.

H_0: Within the pupils' group, participants will not make more reading errors in Ancient than in Modern Greek.

Sub-Hypotheses tested: Several sub-hypotheses have been tested related to each single category of reading errors. These sub-hypotheses followed the pattern:

H_1: Within the pupils' group, participants will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* in Ancient than in Modern Greek.

H_0: Within the pupils' group, participants will not make more *Hems, Repetitions, Syllabication, Substitutions, etc.* in Ancient than in Modern Greek.

Based on the outcomes of normality tests, almost half of pupils' reading errors differences between Ancient and Modern Greek were not normal ($p< .05$), whereas the remaining were normal ($p > .05$). For this reason, both parametric and non-parametric tests were used for the analysis.

The reading errors that significantly differed in quantity between Ancient and Modern Greek for the group of pupils were the following:

Hems

The group of pupils made highly more Hems errors in Ancient (Mdn = 2.47) than in Modern Greek (Mdn = 0.56), $T = 4.00$, $z = -4.862$, $p < .001$, $r = -.58$.

Repetitions

Pupils of the 12th grade made significantly more *Repetitions* errors while reading Ancient (M = 3.29, SE = 0.47) than Modern Greek (M = 2.29, SE = 0.35), $t(34) = 1.88$, $p < .05$, $r = .31$.

Syllabication

Pupils made highly more *Syllabication* errors in Ancient Greek (M = 0.89, SE = 0.17) than in Modern Greek reading (M = 0.20, SE = 0.07), $t(34) = 4.49$, $p < .001$, $r = .61$

Substitutions

The pupils' group made significantly more *Substitutions* errors in Ancient (M = 0.91, SE = 0.18) than in Modern Greek (M =0.41, SE = 0.08), $t(34) = 2.40$, $p < .05$, $r = .38$.

Omissions

12th grade pupils made highly more *Omissions* errors while reading Ancient Greek (M = 1.03, SE = 0.15) than Modern (M = 0.20, SE = 0.06), $t(34) = 5.54$, $p < .001$, $r = .69$.

Misintonation

Pupils of the 12th grade made significantly more *Misintonation* errors while reading Ancient Greek (Mdn = 0.00) than Modern Greek (Mdn = 0.00), $T = 0.00$, $z = -3.518$, $p < .001$, $r = -.42$.

Endings

Pupils made highly more errors in the *Endings* of the words while reading Ancient (Mdn = 0.89) than Modern Greek (Mdn = 0.00), $T = 12.00$, $z = -4.349$, $p < .001$, $r = -.52$.

Punctuation

The pupils' group made significantly more *Punctuation* errors in Ancient (Mdn = 0.00) than in Modern Greek reading (Mdn = 0.00), $T = 0.00$, $z = -3.059$, $p < .001$, $r = -.37$.

Point Marks

Pupils made significantly more *Point Marks* errors, when reading Ancient (Mdn = 0.00) than Modern Greek (Mdn = 0.00), $T = 5.00$, $z = -3.623$, $p < .001$, $r = -.43$.

Pseudo-Words

12th grade pupils read significantly more *Pseudo-Words* in Ancient (M = 1.01, SE = 0.17) than in Modern Greek (M = 0.26, SE = 0.06), $t(34) = 4.22$, $p < .001$, $r = .59$.

Non-Corrected Errors

Pupils left significantly more of their errors uncorrected in Ancient Greek (Mdn = 94.12) than in Modern Greek reading (Mdn = 75.00), $T = 72.50$, $z = -3.291$, $p < .001$, $r = -.39$.

Wrong Words

The pupils' group read significantly more *Wrong Words* in Ancient (Mdn = 8.04) than in Modern Greek (Mdn = 2.78), $T = 15.50$, $z = -4.906$, $p < .001$, $r = -.59$.

Timing Errors

12th grade pupils made significantly more *Timing Errors* in Ancient (M = 7.75, SE = 0.99) than in Modern Greek (M = 3.55, SE = 0.49),$t(34) = 4.96$, $p < .001$, $r = .65$.

Accuracy Errors

Pupils of the 12th grade made significantly more *Accuracy Errors* while reading Ancient (M = 5.29, SE = 0.63) than Modern Greek (M = 1.43, SE = 0.16),$t(34) = 6.59$, $p < .001$, $r = .75$.

Total Errors

Pupils of the 12th grade made highly more reading errors in total while reading Ancient Greek (Mdn = 11.76) than Modern Greek (Mdn =4.50), $T = 23.00$, $z = -4.783$, $p < .001$, $r = -.57$.

These findings suggest that all experimental hypotheses regarding the aforementioned categories of reading errors, which were found to be significantly more in Ancient Greek, should be accepted as true **(Hypotheses accepted)**. Even though pupils did not make significantly more errors in each single reading errors category in Ancient Greek, the main experimental hypothesis should be accepted, as they made significantly more reading errors in total in Ancient than in Modern Greek **(Hypothesis accepted)**.

The following table includes the reading errors categories that were significantly more in Ancient Greek:

Table 11. Pupils' Reading Errors Differences Between Ancient & Modern Greek

Pupils	**Reading Condition**						
	Ancient Greek		**Modern Greek**		**Ancient – Modern Greek**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Hems	3.54	3.82	1.01	1.25	**2.53**	**31**	**.000**
Repetitions	3.29	2.81	2.29	2.09	**1.00**	**70**	**.034**
Syllabication	0.89	1.00	0.20	0.40	**0.69**	**22**	**.000**
Substitutions	0.91	1.01	0.41	0.50	**0.50**	**45**	**.011**
Omissions	1.03	0.89	0.20	0.33	**0.83**	**19**	**.000**
Misintonation	0.56	0.77	0.07	0.19	**0.49**	**13**	**.000**
Endings	1.48	1.36	0.12	0.26	**1.36**	**8**	**.000**
Punctuation	0.34	0.67	0.11	0.30	**0.23**	**32**	**.000**
Point Marks	0.44	0.55	0.05	0.15	**0.39**	**11**	**.000**
Pseudo-Words	1.01	1.03	0.26	0.35	**0.75**	**26**	**.000**
Non-Corrected Errors	91.11	11.46	70.29	33.94	**20.82**	**77**	**.000**
Wrong Words	9.34	6.32	3.23	2.11	**6.11**	**35**	**.000**
Timing Errors	7.75	5.87	3.55	2.91	**4.20**	**46**	**.000**
Accuracy Errors	5.29	3.72	1.43	0.95	**3.86**	**27**	**.000**
Total Errors	12.84	8.63	5.02	3.38	**7.82**	**39**	**.000**

Ratio values (Modern/Ancient Greek errors %) suggest that pupils' reading performance in Ancient Greek lagged from 23% up to 92% behind Modern, meaning that they made from 23% up to 92% more reading errors in Ancient Greek. Regarding the 3 last overall categories, pupils made 54% more timing, 73% more accuracy errors and 61% more reading errors in total in Ancient Greek compared to Modern.

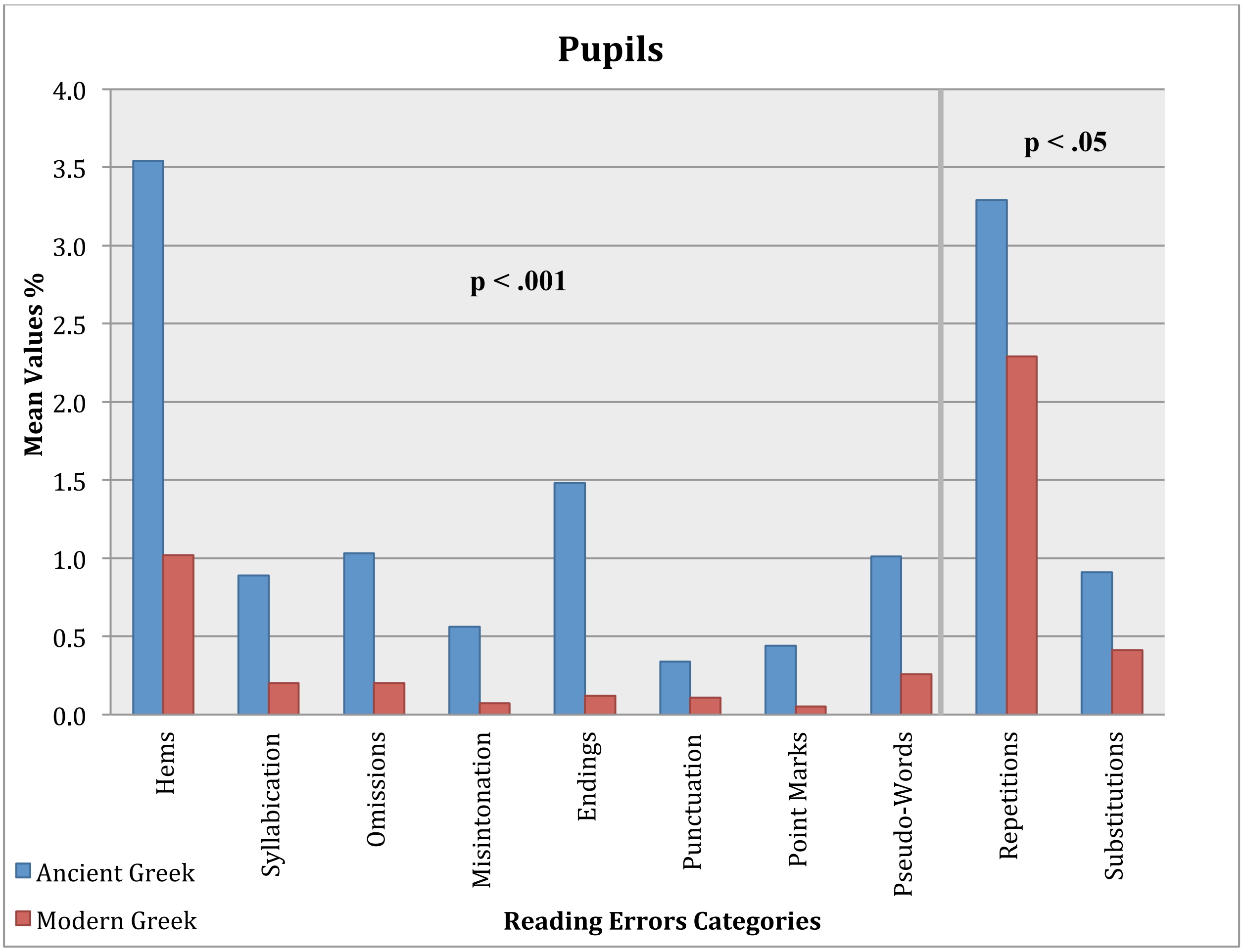


Figure 11(a). Mean values representing pupils' reading errors in both Ancient and Modern Greek. Statistically significant differences were found between the 2 reading conditions in the above categories ($p < .05$). The errors that highly differed between Ancient and Modern Greek were Hems, Syllabication, Omissions, Misintonation, Endings, Punctuation, Point Marks & Pseudo-Words ($p < .001$).

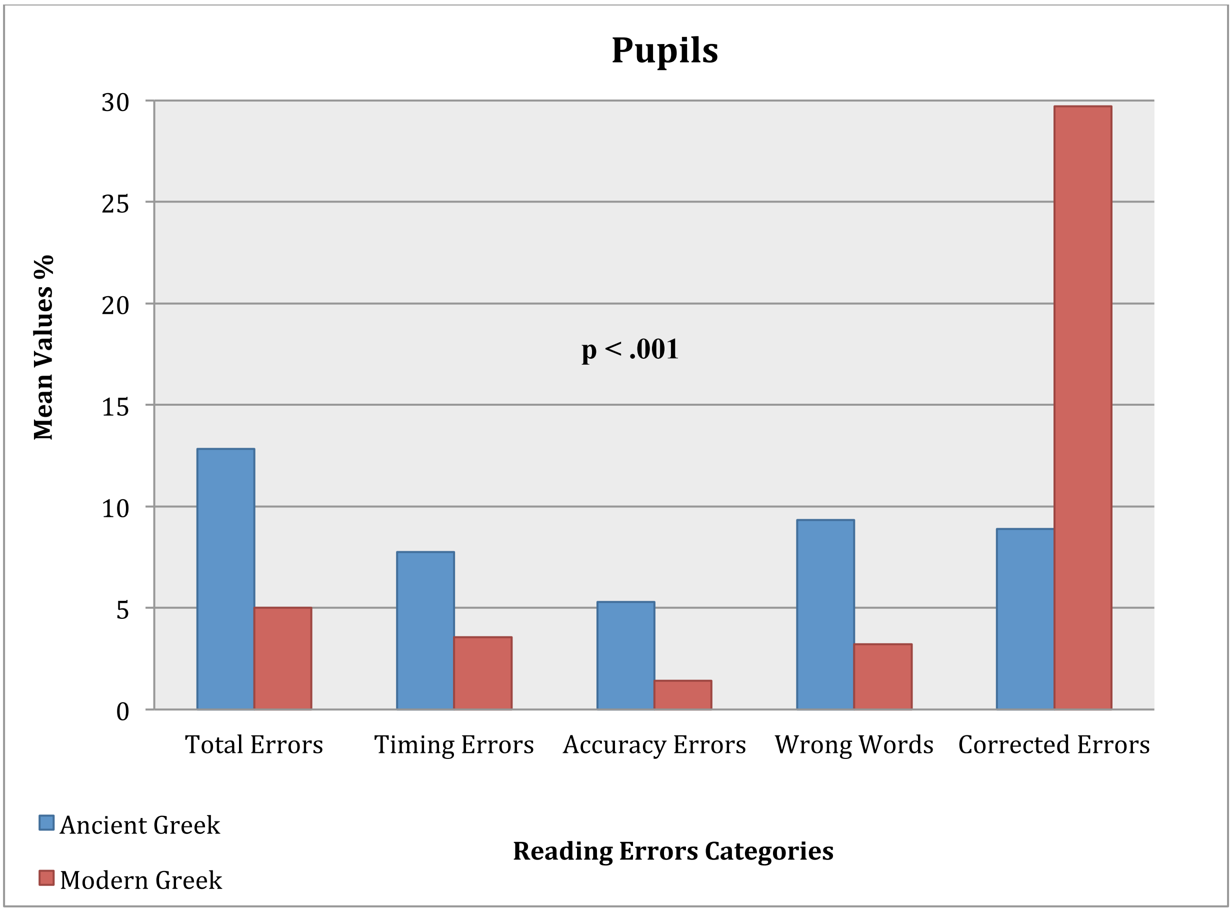


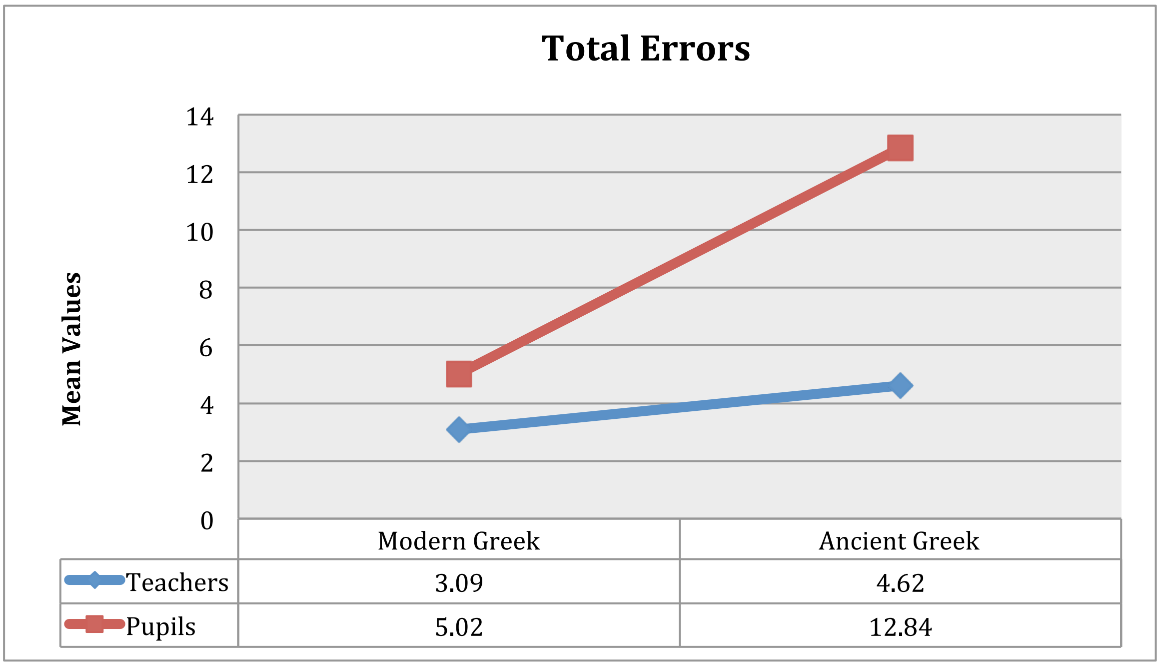
Figure 11(b). Mean values representing the total percent of pupils' reading errors in Ancient and Modern Greek, the Timing and Accuracy errors, the amount of words they incorrectly read, as well as the percent of Corrected Errors. Highly significant differences were found between Ancient and Modern Greek ($p < .001$).

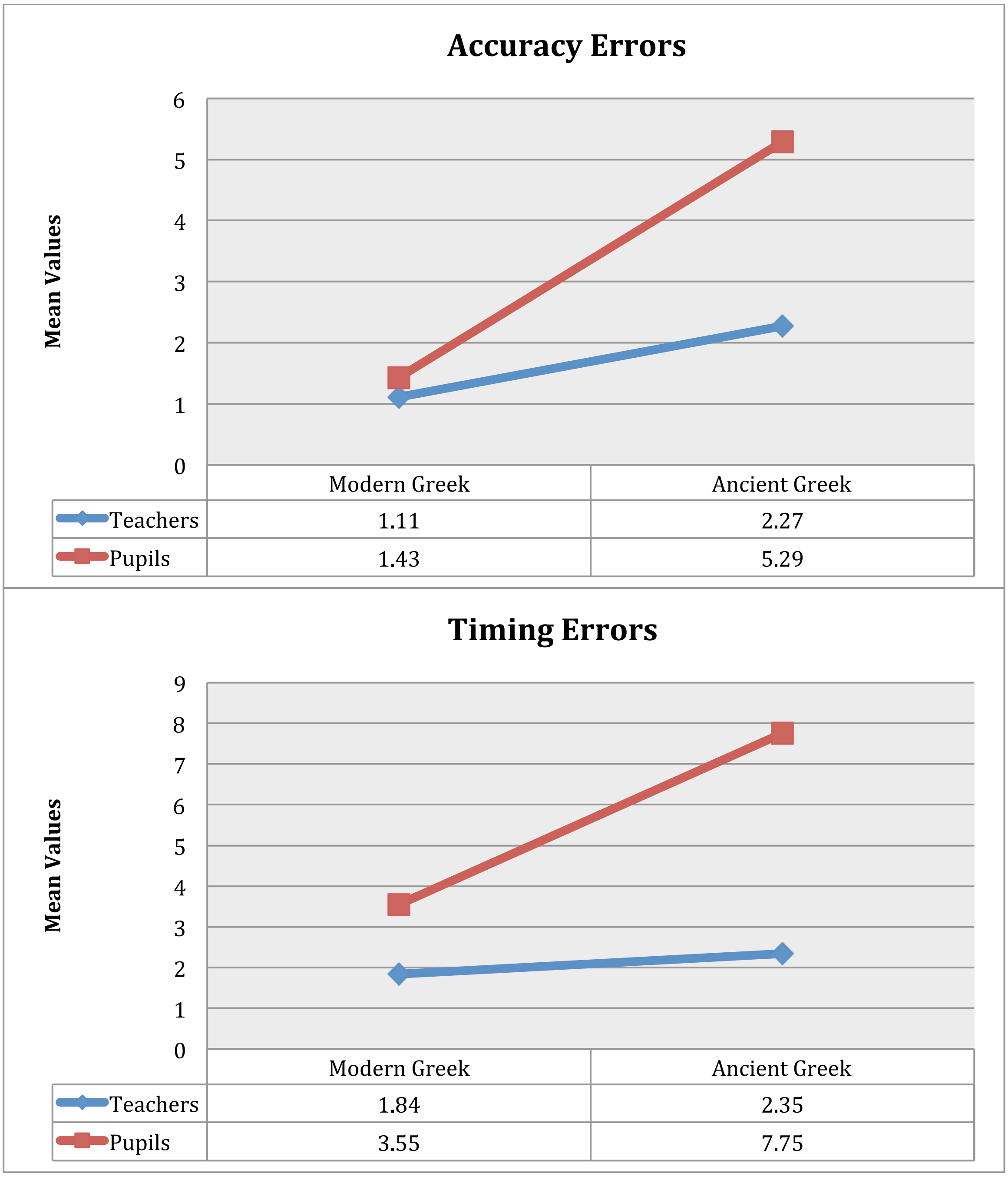
Summary: Reading Errors Between Ancient & Modern Greek

To sum up, pupils' reading errors that highly differed in quantity between Ancient & Modern Greek ($p < .001$) having a strong effect to the population at the same time were Hems, Syllabication, Omissions, Endings, Misintonation, Point Marks, Pseudo-Words, Wrong Words, Non-Corrected Errors, Timing, Accuracy and Total Errors. For the group of teachers, the reading errors that highly differed in Ancient from Modern Greek ($p < .001$) were restricted to Endings, Wrong Words and Accuracy Errors. In general, within the teachers' group, the level of significance was constrained at $p < .05$, whereas the categories of reading errors where significant differences have been found between the 2 reading conditions were limited to half compared to pupils.

Table 12. Reading Errors Differentiating the 2 Reading Conditions: Significance & effect size

Reading Errors	**Pupils**		**Teachers**	
	p	**r**	**p**	**r**
Hems	< .001	–.58	< .05	–.23
Syllabication	< .001	–.61	–	–
Omissions	< .001	–.69	< .05	–.29
Endings	< .001	–.52	< .001	–.40
Pseudo-Words	< .001	.59	–	–
Wrong Words	< .001	–.59	< .001	–.60
Non-Corrected Errors	< .001	–.39	–	–
Timing Errors	< .001	.65	*ns*	–
Accuracy Errors	< .001	.75	< .001	.58
Total Errors	< .001	–.57	< .05	–.37





Figures 12. As obvious from the above figures, pupils were far more affected by the difficulty of the Ancient Greek text. They made 61% more reading errors in total, 73% more accuracy and 54% more timing errors in Ancient than in Modern Greek as compared to teachers, who made 33% more errors in total, 51% more accuracy and 22% more timing errors in Ancient Greek. It is noteworthy that the reading errors of pupils increased more steeply from Modern to Ancient Greek.

2.3.4. Quality of Reading Errors: Frequent & Infrequent Reading Errors

The purpose was to find out the kind of reading errors made by 12th grade pupils and teachers of Ancient Greek and to detect the most and the least frequent ones made in both Ancient and Modern Greek texts. For this reason, the percentage (%) of each category of reading errors in relation to the total amount of errors was calculated and the resulting percents were then sorted in descending order, using the corresponding command of the Microsoft Excel program. Thus, the highest values corresponded to the most frequent reading errors, whereas the lowest to the least frequent ones.

The equation used for the calculation of the percentage of each category in the total amount of reading errors was the following:

$$\%\text{ errors of x category} = \frac{\text{number of errors of x category}}{\text{total errors}} \times 100.$$

The findings are presented per group for each reading material:

2.3.4.1. Ancient Greek

a) Teachers

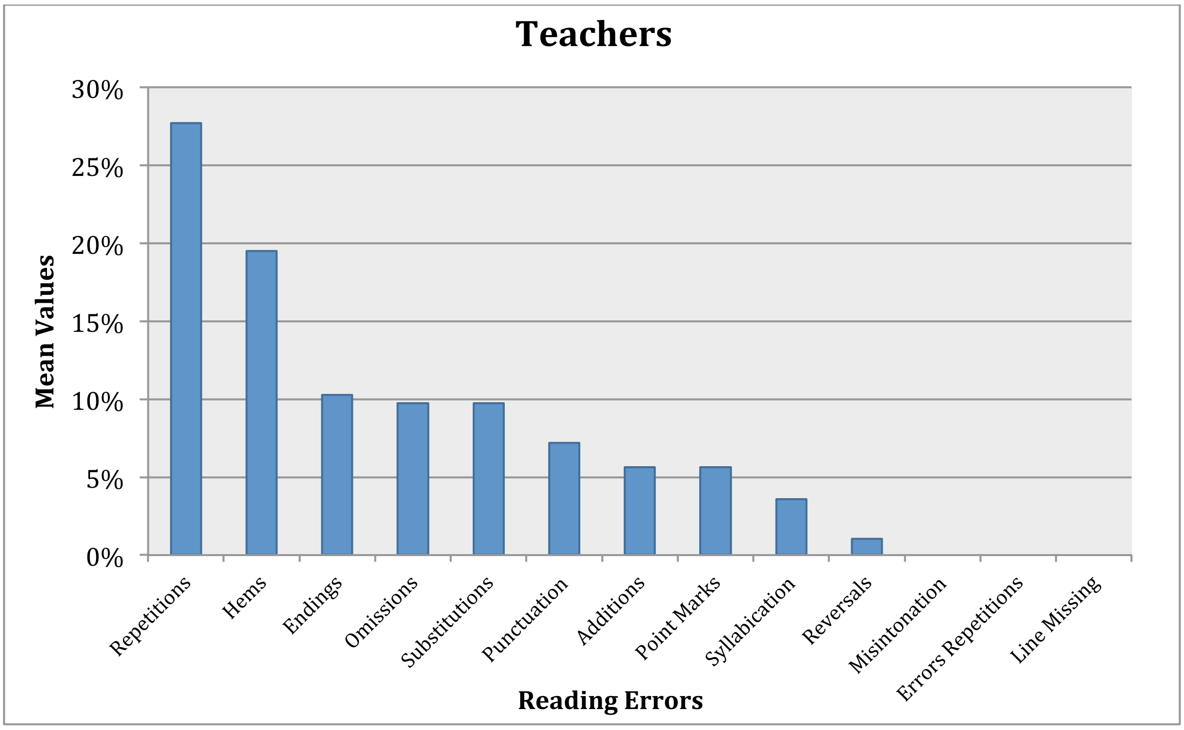


Figure 12(a). Mean values representing the most and least frequent errors of teachers made while reading Ancient Greek. Obviously, their most frequent errors were Repetitions and Hems, representing percents of 27.69% and 19.49% of the total errors, respectively, followed by Endings, Omissions, and Substitutions (10.26%, 9.74%, and 9.74%, respectively). Conversely, the least frequent ones were Line Missing, Errors Repetitions and Misintonation, all representing 0% of the total errors, followed by Reversals (1.03%).

b) Pupils

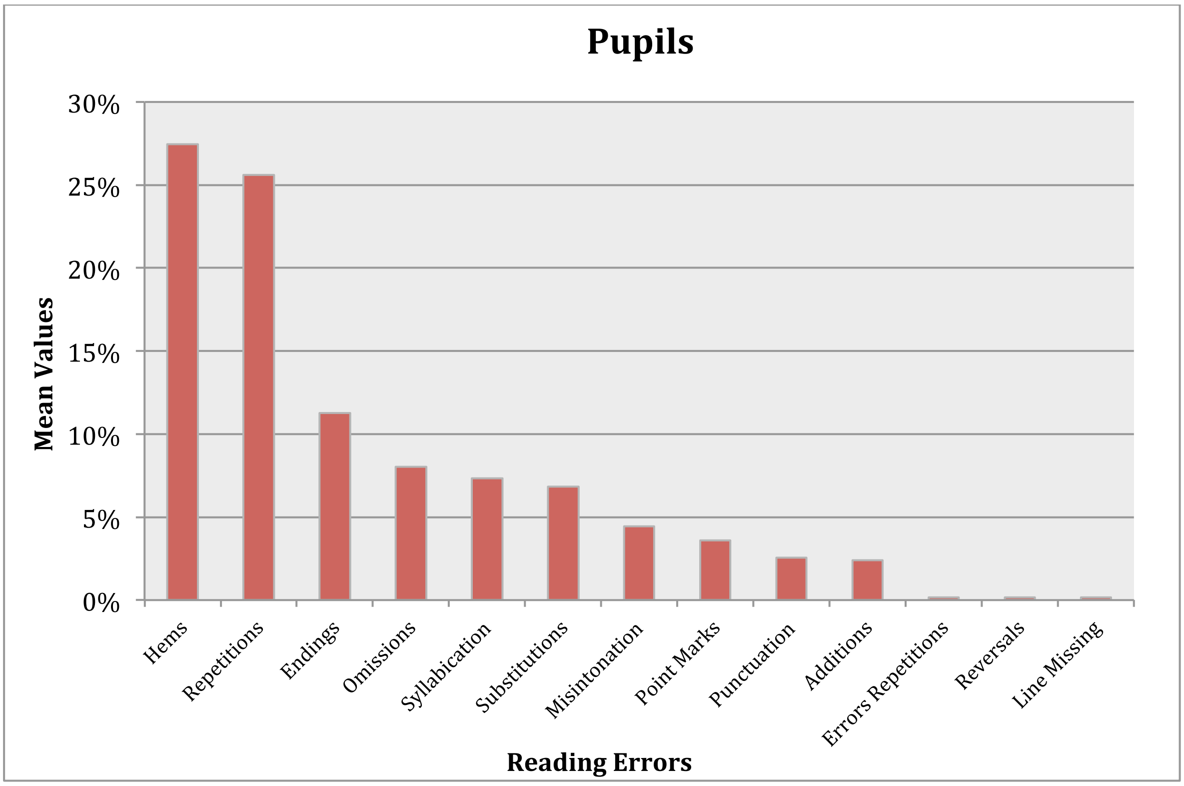


Figure 12(b). Mean values representing the most and least frequent errors made by pupils while reading Ancient Greek. As shown, their most frequent errors were Hems and Repetitions, which corresponded to 27.47% and 25.60% of the total errors, respectively, followed by far by Endings, Omissions and Syllabication (11.26%, 8.02%, and 7.34%, respectively). Conversely, the least frequent errors were Line Missing, Reversals, and Errors Repetitions, all representing 0.17% of the total reading errors.

Table 13. Ranking Order of the Reading Errors made by Teachers & Pupils in Ancient Greek

Teachers			Pupils		
Repetitions	1.5	27.69%	Hems	4.6	27.47%
Hems	1.1	19.49%	Repetitions	4.3	25.60%
Endings	0.6	10.26%	Endings	1.9	11.26%
Omissions	0.5	9.74%	Omissions	1.3	8.02%
Substitutions	0.5	9.74%	Syllabication	1.2	7.34%
Punctuation	0.4	7.18%	Substitutions	1.1	6.83%
Additions	0.3	5.64%	Misintonation	0.7	4.44%
Point Marks	0.3	5.64%	Point Marks	0.6	3.58%
Syllabication	0.2	3.59%	Punctuation	0.4	2.56%
Reversals	0.06	1.03%	Additions	0.4	2.39%
Misintonation	0	0%	Errors Repetitions	0.03	0.17%
Errors Repetitions	0	0%	Reversals	0.03	0.17%
Line Missing	0	0%	Line Missing	0.03	0.17%
Total	**5.6**	**100%**	**Total**	**16.7**	**100%**

Looking at the above table, it is very interesting to notice that the ranking order of the reading errors made while reading Ancient Greek is similar for both groups. In detail, Hems and Repetitions seem to be the most frequent errors made by both teachers of Ancient Greek and pupils of the 12th grade constituting half of their errors. Conversely, Line Missing, Errors Repetitions and Reversals are among the least frequent ones. However, a different pattern is noticed in Punctuation and Additions, which are located relatively higher for teachers, as well as in Syllabication and Misintonation errors, which seem to be more frequent in pupils.

2.3.4.2. Modern Greek

a) Teachers

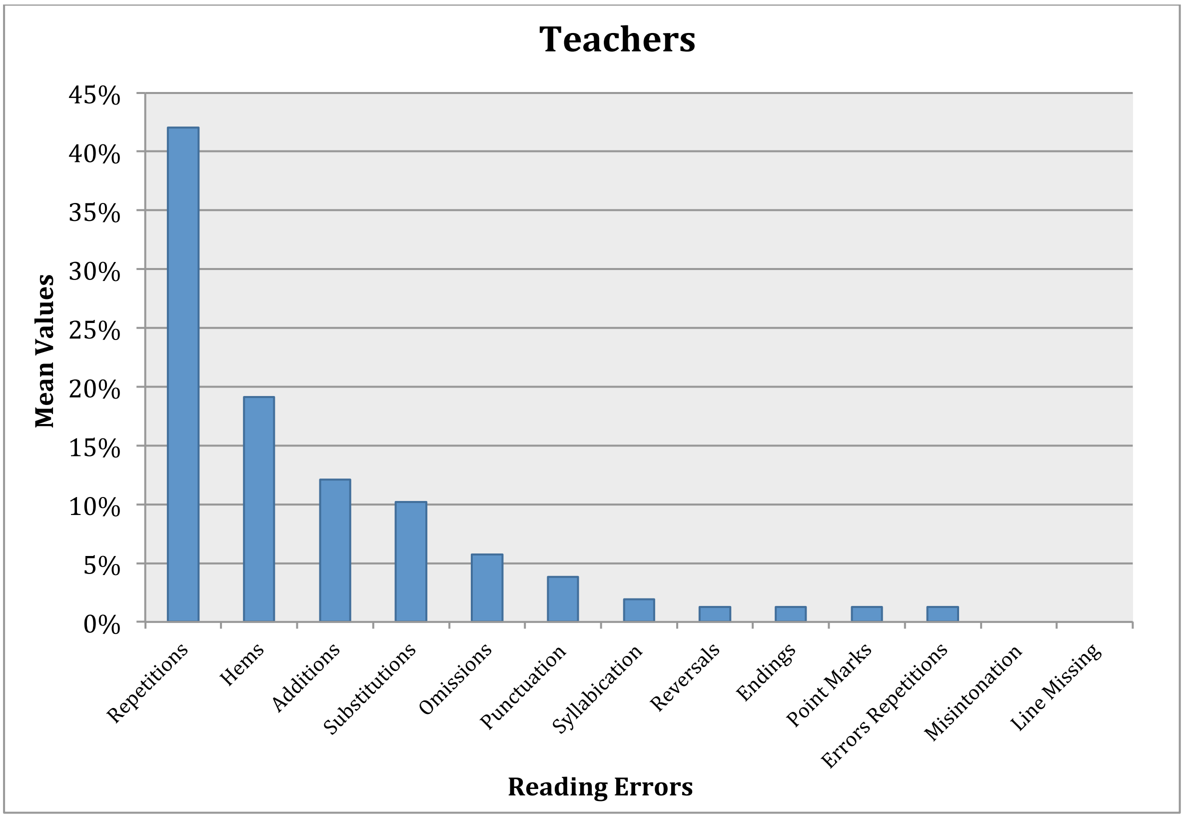


Figure 13(a). Mean values representing the most and least frequent reading errors of teachers made while reading Modern Greek. As obvious, their most frequent errors were Repetitions, which corresponded to 42.04% of the total errors, followed by far by Hems, Additions, and Substitutions (19.11%, 12.10%, and 10.19%, respectively). On the other hand, the least frequent ones were Line Missing and Misintonation (0% of the total errors), followed by Errors Repetitions, Point Marks, Endings, and Reversals, all representing a percentage as small as 1.27%.

b) Pupils

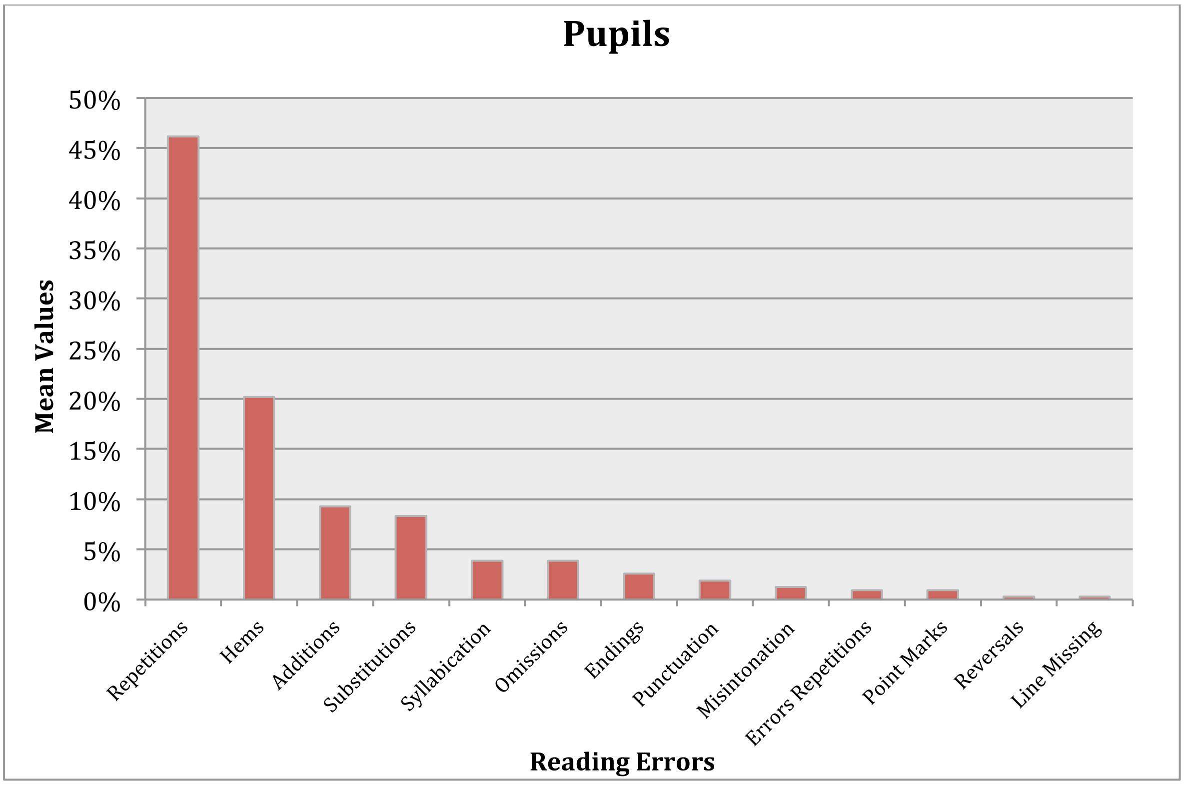


Figure 13(b). Mean values representing the most and least frequent errors made by 12th grade pupils, when reading Modern Greek. It is obvious that pupils' most frequent reading errors were Repetitions, which corresponded to almost half (46.15%) of their total errors, followed by far by Hems, Additions, and Substitutions, representing percents of 20.19%, 9.29% and 8.33%, respectively. Conversely, their least frequent reading errors were Line Missing and Reversals followed by Point Marks and Errors Repetitions, which represented percents as small as 0.32% for the former and 0.96% for the latter.

Table 14. Ranking Order of the Reading Errors made by Teachers & Pupils in Modern Greek

Teachers			**Pupils**		
Repetitions	1.9	42.04%	Repetitions	4.1	46.15%
Hems	0.9	19.11%	Hems	1.8	20.19%
Additions	0.5	12.10%	Additions	0.8	9.29%
Substitutions	0.5	10.19%	Substitutions	0.7	8.33%
Omissions	0.3	5.73%	Syllabication	0.3	3.85%
Punctuation	0.2	3.82%	Omissions	0.3	3.85%
Syllabication	0.1	1.91%	Endings	0.2	2.56%
Reversals	0.1	1.27%	Punctuation	0.2	1.92%
Endings	0.1	1.27%	Misintonation	0.1	1.28%
Point Marks	0.1	1.27%	Errors Repetitions	0.1	0.96%
Errors Repetitions	0.1	1.27%	Point Marks	0.1	0.96%
Misintonation	0	0%	Reversals	0.03	0.32%
Line Missing	0	0%	Line Missing	0.03	0.32%
Total	**4.5**	**100%**	**Total**	**8.9**	**100%**

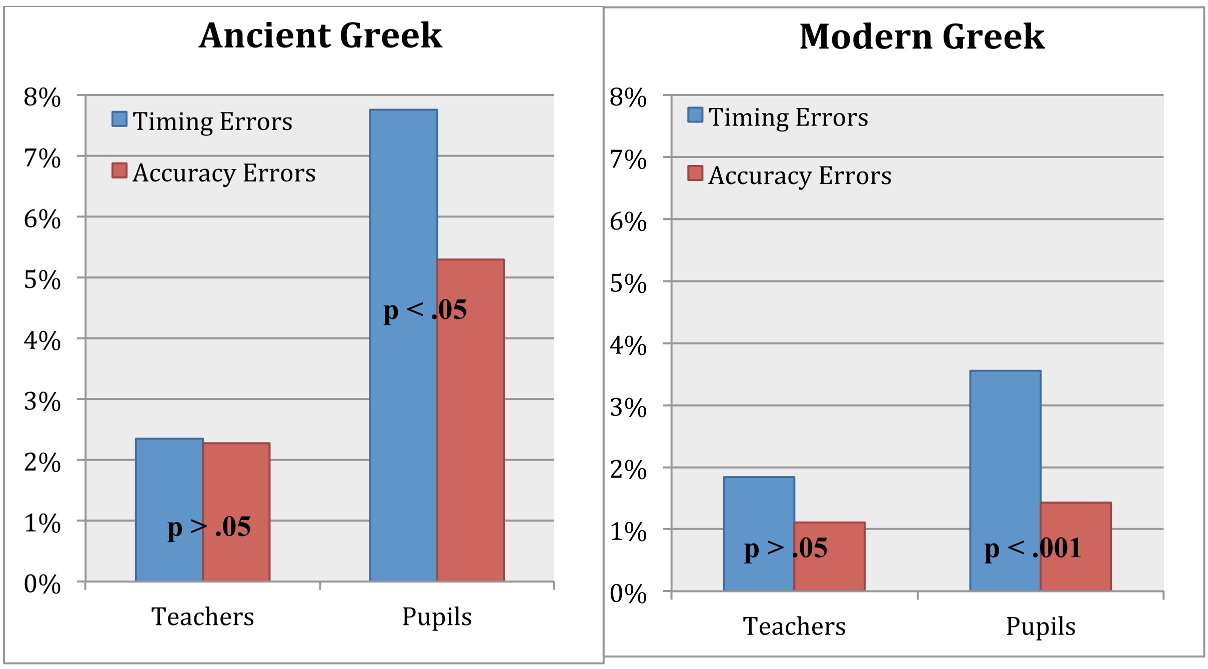
Looking at the table, it is really interesting that the ranking order of the reading errors made in Modern Greek is similar for both groups. Similarly to Ancient Greek, Repetitions and Hems were the most frequent errors made by both teachers and pupils, significantly exceeding half of their errors. Additions and Substitutions follow in the ranking order for either group. Conversely, Line Missing, Point Marks, Errors Repetitions, and Reversals are among the least frequent ones. However, like in Ancient Greek, it is remarkable that Syllabication and Misintonation errors seem to be more frequent for pupils, whereas Punctuation errors are more frequent for teachers.

Summary: Quality of Reading Errors

To sum up, it is concluded that both teachers of Ancient Greek and 12th grade pupils made similar reading errors in both Ancient and Modern Greek. The two most frequent categories were consistently Repetitions and Hems. Minimum deviations existed, such as Syllabication and Misintonation errors, which seemed to be more frequent for the group of pupils, whereas Punctuation errors occurred more frequently in the teachers' group, although the error rates of these latter categories were considerably low.

As obvious from the following figures, pupils made significantly more **timing errors** *(= errors that reduce their reading speed)*, than **accuracy errors** *(= errors that influence the accuracy of reading)* in either material ($p < .05$ and $p < .001$). On the other hand, teachers made comparable amount of timing and accuracy errors in both Ancient and Modern Greek ($p > .05$). Comparing Ancient to Modern Greek, it is remarkable that pupils' both timing and accuracy errors were significantly reduced in Modern Greek ($p < .001$), while for the groups of teachers, only accuracy errors were reduced to half ($p < .001$). This is probably due to the greater familiarity with Modern Greek that led to reduced accuracy errors.

Figure 14. Timing & Accuracy Errors of Teachers & Pupils



2.3.5. Reading Speed, Comprehension & Accuracy Correlations

In the current section, the relation among reading speed, comprehension and accuracy within each group was investigated. The Spearman's correlation coefficient was used for the analysis. The results are presented per reading material for each group separately.

2.3.5.1. Ancient Greek

Table 15. Correlations among reading components (N = 35, Spearman's correlation coefficients)

Teachers	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	$.332^{*}$	–
Reading Errors	.054	.200
Timing Errors	.000	.155
Accuracy Errors	.063	.108
Hems	–.150	
Repetitions	.176	
Syllabication	.013	
Substitutions	$.362^{*}$	
Omissions	–.126	
Misintonation	.000	
Punctuation	$–.363^{*}$	

$^{*}p < .05$

Looking at the above table, a significant positive correlation was found between teachers' reading speed and comprehension, $r_s = .332$, p (1-tailed) < .05. This positive correlation indicates that as reading speed increases, the reading comprehension increases as well. With regard to reading errors, significant correlations were found only between reading speed and

Substitutions (positive correlation, $r_s = .36$) and between reading speed and Punctuation (negative correlation, $r_s = –.36$). Reading comprehension did not significantly correlate with reading errors.

Table 16. Correlations among reading components (N = 35, Spearman's correlation coefficients)

Pupils	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	.005	–
Reading Errors	$–.336^{*}$	.078
Timing Errors	$–.287^{*}$	.086
Accuracy Errors	$–.393^{**}$	.063
Hems	–.128	
Repetitions	$–.337^{*}$	
Syllabication	.160	
Substitutions	$–.313^{*}$	
Omissions	–.242	
Misintonation	–.170	
Punctuation	–.282	

$^{**}p < .01$, $^{*}p < .05$

In the Ancient Greek text, the reading speed of pupils significantly correlated with the total amount of reading errors they made, $r_s = –.34$, p (1-tailed) < .05. The negative correlation indicates that as the reading errors increase, the speed of reading decreases. The subcategories of reading errors, timing and accuracy errors, were both negatively correlated with the reading speed, $r_s = –.29$, $p < .05$, and $r_s = –.39$, $p < .01$, respectively. Among timing errors only Repetitions significantly correlated with reading speed ($r_s = –.34$, $p < .05$), while from accuracy errors only Substitutions ($r_s = -.31$, $p < .05$). Reading comprehension did not significantly correlate with reading speed nor reading errors.

2.3.5.2. Modern Greek

Table 17. Correlations among reading components (N = 35, Spearman's correlation coefficients)

Teachers	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	.109	–
Reading Errors	$-.501^{**}$	.057
Timing Errors	$-.293^{*}$	.214
Accuracy Errors	$-.478^{**}$	–.001
Hems	$-.472^{**}$	
Repetitions	–.240	
Syllabication	.004	
Substitutions	$-.315^{*}$	
Omissions	–.093	
Misintonation	.000	
Punctuation	–.127	

$^{**}p < .01$, $^{*}p < .05$

As obvious from the above table, there was a significant negative correlation for the teachers between their reading speed and the reading errors they made in the Modern Greek text, $r_s = -.50$, p (1-tailed) < .01. The main subcategories of reading errors were both significantly correlated with the reading speed, $r_s = -.29$, p (1-tailed) < .05 for timing errors, and $r_s = -.48$, p (1-tailed) < .01 for accuracy errors. From the categories of timing errors, only Hems significantly correlated with the speed of reading ($r_s = -.47$, $p < .01$). Similarly, among accuracy errors only Substitutions did significantly correlate with reading speed ($r_s = -.32$, $p < .05$). Reading comprehension did not significantly correlate with reading speed nor with reading errors.

Table 18. Correlations among reading components (N = 35, Spearman's correlation coefficients)

Pupils	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	.410**	–
Reading Errors	–.037	–.003
Timing Errors	.011	–.027
Accuracy Errors	–.134	–.022
Hems	–.063	
Repetitions	.013	
Syllabication	–.117	
Substitutions	–.099	
Omissions	–.162	
Misintonation	–.321*	
Punctuation	–.318*	

**p < .01, *p < .05

As shown in the above table, in the Modern Greek text, there was a significant correlation between reading speed and level of reading comprehension attained by the pupils, $r_s = .41$, p (1-tailed) < .01. The positive correlation suggests that, as the reading speed increases, the reading comprehension increases as well. Regarding reading errors, only Misintonation and Substitutions significantly correlated with reading speed ($r_s = -.32$, $p < .05$). Reading comprehension did not significantly correlate with reading errors.

2.4. CONCLUSIONS

The main findings that came out of the statistical analysis are briefly reported here, whereas the conclusions will be thoroughly discussed at the last chapter of the thesis jointly for the reading studies, in order to provide a more comprehensive view of the findings, instead of a fragmented and unconnected one.

From the **between-groups** analyses, the following findings emerged:

In contrast to one's expectations that the far more experienced Greek language teachers would have been faster and more proficient readers, expectations that logically derive from research evidence establishing the relationship of reading skill with vocabulary size, exposure to print, domain knowledge and familiarity, etc. (Ouellette, 2006; Cunningham & Stanovich, 1990; Stanovich, 1996; Chateau & Jared, 2000), 12th grade pupils were significantly faster in reading both Ancient and Modern Greek texts. Although surprising, such a result is in line with the relevant literature, which shows that reading practice makes the reader faster, while the lack of practice has a negative effect on reading speed (Pavlidis, 2013). This is totally the case here taking into consideration that 12th grade pupils were preparing for University and, therefore, reading of large volume of written material was a daily reality for them. On the other hand, the fact that teachers continuously teach the same few subjects along with the unchanged for years curriculum results in less reading practice.

In terms of reading comprehension, no significant differences were found between groups, although pupils slightly exceeded the level of reading comprehension attained by teachers. Probably, the same advantage that made pupils faster readers was compensated for by the superior contextual knowledge and the richer vocabulary of the teachers, which are largely related with reading comprehension ability (Muter et al., 2004; Sénéchal et al., 2006; Braze et al., 2007; McBride-Chang et al., 1993; Payne et al., 2012). Finally, with regard to reading accuracy, as predicted, pupils of the 12th grade made significantly more reading errors than the more experienced teachers of Ancient Greek. The greater familiarity and experience, the larger vocabulary and the significant contextual knowledge of the teachers resulted in significantly reduced reading errors compared to pupils (Ouellette, 2006; Acheson et al., 2008; Payne et al., 2012).

From the **within-groups** analyses, the following findings emerged:

As predicted, both groups performed significantly better in Modern Greek, namely they read significantly faster, comprehended better and were considerably more accurate in Modern than in Ancient Greek. This is easily explained by the more complex structure of Ancient Greek *(more dense written word, larger sentences, more complex syntax, polytonic system, more grammatical features in quantity, etc.)* that influence the reading ability as well as by the fact that Modern Greek is far more familiar for both teachers and pupils, read and spoken in everyday life, in contrast to Ancient Greek that is read for educational purposes only and is, consequently, less familiar. Hence, undoubtedly, both teachers and pupils are less exposed to Ancient Greek and less familiarised with the structure of the language, have less contextual knowledge and poorer vocabulary.

A more detailed discussion of the results of the first research project conducted will follow at the last chapter of the current thesis.

CHAPTER 3

Research Project 2: Reading Performance of Adult Dyslexic University Students & Age-matched Normal Controls

3.1. INTRODUCTION

In the first research project, the review of the reading process was given in relation to normal achieving population, in order to investigate the effect of familiarity with language structure on reading performance. In the current research project, the reading process will be given in relation to reading disabled population, dyslexics in particular, as to investigate the effect of biological factors, such as the constitutional reading deficit of dyslexics, on reading ability.

Special Education has come to the forefront of the social interest over the last decades. It is a field considered not only very important but also quickly changeable, so as to attract the attention and interest of scientists, such as psychologists, educationalists, special educators, etc. It is a great challenge for them to work on a daily basis with children with disabilities or special educational needs. Learning Disabilities is the predominant category within Special Education. In the current chapter, before proceeding to the literature review of dyslexia, it seems appropriate to define the term “Learning Disabilities” as well as to briefly investigate its evolution from its beginnings until today. Such information constitutes the basis for understanding individuals with disabilities and the special instruction that they should benefit from.

3.1.1. Learning Disabilities

Learning Disabilities (LD) is a field that experienced rapid development, while enormous interest has been exhibited by physicians, psychologists, teachers and parents. No other area of Special Education went through such spectacular development and exceptional interest. The society's knowledge about Learning Disabilities has increased and public awareness has risen during the last four decades, since LD were first recognised offering an explanation for misunderstood children, who were encountering serious learning problems in school (Lerner & Johns, 2008; 2011).

Furthermore, the number of children identified as learning disabled has significantly increased since the passing of Individuals with Disabilities Education Act in 1975 (P.L. 94-142), making Learning Disabilities the greatest category within Special Education. Kavale & Forness (2000) mention that, since then, LD population has increased about 150% and now represents over 50% of all disabled students. Similarly, Hallahan, Kauffman and Pullen (2009) claim that the number of students identified as having Learning Disabilities has more than doubled since the 1970s, making up about half of the number of students identified as needing special education. Furthermore, according to Lerner and Johns (2008), a percentage of 48% among all students with disabilities encounter Learning Disabilities, followed by 20% with language impairment, 9% with mental retardation, 8% with emotional disturbance and 15% with any other disabilities. The high frequency of learning disabilities is also confirmed by Stichter and colleagues (2008), who included LD along with communication disorders, emotional disturbance and mild intellectual disabilities among those considered as high-incidence categories.

Hence, this increase has fueled *"an ongoing debate on the nature of the learning disability"* (Heward, 2009, p.173). Some believe that the increase in the number of children diagnosed as learning-disabled expresses the real extent of the handicapped condition and the society's growing awareness. Others consider that many low-achievers, who simply do not manage at school, have been wrongly diagnosed as learning-disabled, bringing to the forefront a severe strain on the limited resources, which are available to serve the real learning-disabled (Goula, 2001). According to Kavale and Forness (2000) this is due to the lack of an unequivocal LD definition that provides clear identification criteria resulting, therefore, in vague boundaries among conditions.

Nevertheless, the fact that Learning Disabilities are now in the focal point of public attention and interest is proved by much research conducted nowadays regarding the conceptualisation and treatment of LD, while many instructional methods and programmes have been developed to meet the unique needs of learning-disabled children. For a brief historical review of Learning Disabilities see Appendix 1.

3.1.1.1. LD Definitions – The Definitional Problem

MacMillan, Greshman & Bocian (1998) claimed that the category of Learning Disabilities emerged due to the acknowledgment of a practical issue. By the late 1950s, most schools had incorporated special education programmes, but there was still a group of students that encountered learning problems although they seemed physically intact. These students were excluded from any formal Special Education services, because their features did not fit into the existing categories of exceptionality (Heward, 2009).

Despite the unprecedented growth of the field of LD as well as the great resonance and immediate acceptance of the term, developing a definition, unique and universally accepted, has proved to be a tough challenge (Lerner & Johns, 2008). Several definitions have been proposed, but none has been widely accepted because of antagonisms and lack of consensus among professionals (Kavale & Forness, 2000). According to Hammil (1990) 11 LD definitions have enjoyed some degree of acceptance since the field's inception in the early 1960s. It would be pointless to review all the definitions of LD ever expressed, and, hence, an attempt is made to deal with the most influential of them.

Kirk, except for introducing the term "learning disability", also offered the first formal definition of LD. He namely defined learning disability as:

"a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, writing, arithmetic, or other school subjects resulting from a psychological handicap caused by a possible cerebral dysfunction and/or emotional or behavioral disturbances. It is not the result of mental retardation, sensory deprivation, or cultural and instructional factors" (as cited in Hallahan & Mock, 2003, p.22).

(Kirk, 1962)

Kirk's definition was *"the first to introduce the notion of psychological process disorders"* (Kavale & Forness, 2000, p.242). Furthermore, this definition introduced the exclusionary clause as a definitional criterion of LD, as it cannot primarily result from another condition. Several later proposed definitions followed his pattern, such as the definition suggested by the National Advisory Committee on Handicapped Children (NACHC, 1968), the definition included in the Education for All Handicapped Children Act (EAHCA, 1977) or Public Law (PL) 94-142, revised and renamed later as Individuals with Disabilities Education Act (IDEA, 1990). The IDEA Amendments of 1997 (P.L. 105-17) retained essentially the same definition found in EAHCA (1977).

The actual problem with Kirk's definition, however, was that LD was identified as either retardation, disorder or delayed development in one or more cognitive processes, but without the differences among them being further specified. And finally, exclusion is a negative criterion used to explain the characteristics of LD, a fact that conflicts with the need for a definition being positive (Kavale & Forness, 2000).

Currently, 2 definitions have major influence and enjoy the greatest support being the most commonly cited in the international literature at the same time: a) the federal definition found in the Individuals with Disabilities Education Act (IDEA), and b) the definition suggested by the National Joint Committee on Learning Disabilities (NJCLD). Kavale & Forness (2000) claimed that although similar in depicting LD neither of them has brought an end to the issue of definition.

a) Despite the various definitions expressed since 1975, the reauthorisation of the Individuals with Disabilities Education Act (IDEA, 1997) included substantially the same definition found in EAHCA (1977) significantly affected by Kirk. The IDEA last amendments of 2004 included exactly the same definition formalised almost 4 decades ago (in 1977) by the U.S. Office of Education, which reads as follows:

"In general – The term "specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations.
Disorders included – Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia.
Disorders not included – Such term does not include a learning problem that is primarily the result of visual, hearing or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage".

(IDEA Improvement of 2004, P.L. 108-446, 118 Stat. 2647)

As Hallahan & Mock (2003) mention, *"despite all the progress the field had made in those years, the federal regulations authorising special education for students with LD clung to an understanding that had in fact been proposed by Kirk as early as 1962"* (p.25-26).

The IDEA definition had continuous effect and has been the basis for policy in the majority of states (Mercer, Jordan, Allsopp & Mercer, 1996). Kavale & Forness (2000) claimed that *"rather than a description of the specific condition promised, a more generic concept is outlined"* (p.240). Hence, no explicit conceptualisation emerges beyond that of a generalised and unspecific learning problem. It is remarkable though that the IDEA definition likens LD to other conditions *(e.g. the term includes such conditions as…)* without, however, indicating which similarities or differences exist, while states what LD is not, and not what it actually is *(e.g. such term does not include…)*.

b) The National Joint Committee on Learning Disabilities (NJCLD), a group composed of representatives from professional organisations responsible for the rights, the education and the treatment of individuals with Learning Disabilities, claims that the federal definition of LD has several weaknesses (as cited in Heward, 2009, p.174, and Hallahan, Kauffman & Pullen, 2009, p.187-8):

1. Exclusion of adults; reference to school age children only.
2. Reference to "basic psychological processes".
3. Omission of the intrinsic nature of LD.
4. Inclusion of spelling; unnecessary, as it is included in "written expression".
5. Inclusion of difficult-to-define terms, such as dyslexia, minimal brain malfunction, perceptual impairments and developmental aphasia.
6. Wording of the exclusion clause.

Thus, the definition developed by the National Joint Committee on Learning Disabilities *(first developed in 1981 and modified twice since then, in 1988 and in 1990)* reads as follows:

"Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction, and may appear across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example, sensory impairment, mental retardation, serious emotional disturbance) or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences".

(NJCLD, 1994)

Unlike earlier definitions describing "specific" LD, the NJCLD definition describes LD as a general term that is possible to manifest a variety of symptoms. Similarly to previous definitions, the notion of discrepancy and underachievement is not explicit. Finally, the exclusion clause is modified, but even it is clearly stated that LD may co-occur with other conditions, it is difficult to determine what kind of relationships exist (Kavale & Forness, 2000).

Kavale and Forness (2000) stated that *"the similarity between the NJCLD and IDEA definitions was suggested as evidence for an emerging consensus about definition"*(p.245). Therefore, LD predominant definitions seem to have converged on the following characteristics (Lerner & Johns, 2011; Kavale & Forness, 2000):

- Heterogeneity of LD
- Result of neurological factors; Central Nervous System (CNS) dysfunction
- Psychological process disorders involved; inadequate functioning in one or more cognitive skills in the presence of intact intelligence.
- Association with underachievement; discrepancy between potential and achievement (IQ – achievement or chronological age – achievement discrepancy)
- Difficulties in academic and learning tasks
- Occurs across life span
- Exclusion of other causes; although LD may occur along with other conditions, it does not result from those conditions.

However, although consensus has been attained, seemingly in fact, the problem of definition did not come to an end. There are a variety of issues that still remain unsolved. It is unlikely that simple modifications of available definitions will resolve the difficulties, as many elements included in LD definitions are questionable (Kavale & Forness, 1985a).

Unlike other terms' definitions *(e.g. mental retardation)*, LD definitions appear to be subjected to often pervasive criticism leading to perceive LD as a dependent entity that does not include two vital scientific features: understanding *(clear and unhindered sense of LD)* and explanation *(reasoning why a student is learning-disabled)*. Besides, without a clear definition including unequivocal identification criteria, it is pointless and even risky to talk about prevalence of Learning Disabilities among other categories of Special Education (Kavale & Forness, 2000).

To sum up, although considerable agreement exists among definitions, none is completely satisfactory. None provides substantive insight into the nature of LD, offering only a generalised image. Having read the former definitions, it is doubtful whether someone could answer to the otherwise seemingly straightforward question "What is LD" with much exactitude.

However, as both these definitions come from America, it would be wiser to provide some definitions that come from Europe, in order to have a more global conceptualisation of this specific field.

A commonly used definition in the UK comes from Valuing People: the 2001 government White Paper for England about health and social care for people with learning disabilities. The **Department of Health in England** defined **learning disability** as:

- **"a significantly reduced ability to understand new or complex information, to learn new skills (impaired intelligence), with;**
- **a reduced ability to cope independently (impaired social functioning);**
- **which started before adulthood, with a lasting effect of development".**

(Department of Health, 2001)

This definition is consistent with the definition included in the International Classification of Disease (IDC-10) of the World Health Organisation

The **World Health Organisation** (WHO) has defined **learning disability** as:

- **A state of arrested or incomplete development of mind.**
- **Significant impairment of intellectual functioning.**
- **Significant impairment of adaptive and social functioning.**

(WHO, 1993)

The term “learning disability” was introduced in the UK in replacement of the term “mental retardation” or “intellectual disability”. The above definition given by the Department of Health includes intelligence and other functional aspects to make it distinct form the term “learning difficulties”, which has a wider application in education. In the context of health the two terms are interchangeably used. In terms of education, in the UK, the term **“learning difficulty”** is preferred to describe children, who experience generalised difficulties of varying degree of severity *(moderate, severe, profound, etc.)* in learning. Such a term also includes individuals with specific learning difficulties (i.e. dyslexia) despite their intact intelligence (Department for Education, 2012). Although the term “learning disability” could be alternatively used to describe the former, nevertheless, individuals with specific learning difficulties are not considered to have a disability. In the UK education services, the term “learning difficulties” is mainly used to describe individuals who have “specific learning difficulties”, but who do not have any impairment of intelligence. On the other hand, in other countries, and mainly in the USA, the term learning disability is used to refer to individuals with specific learning difficulties, as obvious from the previously mentioned definitions of LD (Emerson & Heslop, 2010).

3.1.1.2. Specific Learning Disabilities

It is of particular importance not to confuse Specific Learning Disabilities with generalised Learning Disabilities. General learning disability differs from specific, which means that the individual has difficulty in a specific area of learning, such as in reading, writing, or understanding, but has no problem with learning in other areas. General Learning

Disabilities are mainly due to environmental factors, such as socio-cultural disadvantage, limited opportunities to learn, inappropriate curriculum, inadequate teaching, or lack of positive family support for learning, without the possibility of low intelligence being excluded. The learning problems of these "low-achievers", as known in the past, are evident across almost all areas of the school curriculum (Pavlidis, 2013; Westwood, 2008). A child with generalised Learning Disabilities finds it more difficult to learn, understand and do things compared with children of the same chronological age.

On the other hand, a much smaller number of students experience Specific Learning Disabilities (SpLD). Despite having at least average intelligence, these students have problems in acquiring basic literacy and numeracy skills.

A detailed definition of SpLD was recently given by Karande and colleagues (2005):

"Specific learning disabilities (SpLD) is a generic term that refers to a heterogeneous group of disorders manifested by significant unexpected, specific and persistent difficulties in the acquisition and use of efficient reading (dyslexia), writing (dysgraphia) or mathematical (dyscalculia) abilities despite conventional instruction, intact senses, normal intelligence, proper motivation and adequate socio-cultural opportunity. The term does not include children who have learning problems, which are primarily the result of visual, hearing, or motor handicaps, of subnormal intelligence, of emotional disturbance, or of sociocultural disadvantage".

The above definition, even controversial, has been adopted by both the Diagnostic and Statistical Manual of Mental Disorders 4th edition – Text Revision (DSM-IV-TR, 2000) and the International Classification of Diseases 10th Revision (ICD-10, 2004).

The need to distinguish generalised from Specific Learning Disabilities is evident in both the DSM-IV and the ICD-10. According to the American Psychiatric Association (APA), **"Learning Disorders are diagnosed when the individual's achievement on individually administered, standardised tests in reading, mathematics or written**

expression is substantially below that expected for age, schooling, and level of intelligence. The learning problems significantly interfere with academic achievement or activities of daily living that require reading, mathematical, or writing skills" (DSM-IV-TR, 2000, p.49). According to the DSM-IV, Learning Disorders must be discriminated from normal variations in academic achievement and from difficulties, the so-called general LD, which are caused by *"lack of opportunity, poor teaching, or cultural factors"* (p.51). To be more precise, inadequate educational opportunities, different ethnic or cultural backgrounds, inefficient teaching, family environment, and absenteeism may result in poor performance.

Similarly, the World Health Organisation (ICD-10, 2004) defines **Specific Developmental Disorders of Scholastic Skills** "**as disorders in which the normal patterns of skill acquisition are disturbed from the early stages of development"** (p.351). As stated, such disorders are not simply due to lack of opportunity to learn, or to any form of acquired brain trauma or disease, while they do not solely result from mental retardation.

Thus, specific and general learning disabilities should not be confused. They have completely different etiology, and, despite the similar manifestations, they have different characteristics. Precisely, all the factors that are negative in general LD are positive in SpLD *(socio-cultural and educational opportunities, family environment, adequate teaching, intellectual ability, etc.)*. Finally, SpLD are manifested in specific literacy areas, while general LD are evident in all areas of the curriculum (Pavlidis, 2013). The following table presents the main differences between Specific and General LD:

Table 1. Differences between Specific & General Learning Disabilities

	Specific Learning Disabilities	General Learning Disabilities
Causes	Neurological-Biological etiology	Psychological or Environmental factors or low IQ
IQ	Average or Above average	Below Average
Lag	Poor performance in specific areas (e.g. reading, writing, etc.)	Poor performance in all areas
- Diagnosis	Gradual delay	Stable delay
+ Diagnosis	Rapid progress	Stable delay

At this point, it is noteworthy that in most LD definitions given in the previous section, with the term "Learning Disabilities" Specific Learning Disabilities are apparently meant. Most frequently in the literature the term "Learning Disabilities" appears, instead of the more precise "Specific Learning Disabilities". The component subcategories of Specific Learning Disabilities are described below.

3.1.1.3. Categories of Specific Learning Disabilities

Looking at the SpLD definition given by Karande and colleagues (2005), 3 subcategories arise: Specific Learning Disability in a) Reading, b) Writing, and c) Mathematics. However, both DSM-IV and ICD-10 include a fourth category, namely a mixed specific learning disability. Dyslexia is the most common among them and affects 80% of individuals identified as learning-disabled (Shaywitz, 1998). According to Karande et al. (2005), the incidence of dyslexia in children in the USA ranges between 5.3-11.8%. As dyslexia is the focus of the current research, it will be briefly presented here along with the other categories, but more extensive analysis will follow.

The following table includes the different categories of SpLD according to DSM-IV and ICD-10, which perfectly match with each other.

Table 2. SpLD according to DSM-IV & ICD-10

	DSM-IV	ICD-10	
Learning Disorders	Reading Disorder	Specific Reading Disorder	**Specific Developmental Disorders of Scholastic Skills**
	Mathematics Disorder	Specific Disorder of Arithmetical Skills	
	Disorder of Written Expression	Specific Spelling Disorder	
	Learning Disorder Not Otherwise Specified	Mixed Disorder of Scholastic Skills	

a) Specific Learning Disability in Reading

Specific Learning Disability in Reading or ***Reading Disorder*** or ***Specific Reading Disorder*** or ***Dyslexia***: The main feature of Reading Disorder is reading performance that is significantly below that expected based on the individual's age, intelligence, and appropriate education. The disorder in reading hinders academic achievement or other daily activities that require reading skills (DSM-IV-TR, 2000). Mathematics Disorder and Disorder of Written Expression are usually linked with Reading Disorder. According to DSM-IV-TR (2000), the prevalence of Reading Disorder is estimated at 4% of school age children. Reading Disorder, either alone or in combination with other disorders, *"accounts for approximately 4 out of every 5 cases"*, a percentage of 80% (p.52).

b) Specific Learning Disability in Writing

The main characteristic of ***Disorder of Written Expression*** is writing skills *"that fall substantially below those expected given the individual's chronological age, measured intelligence, and age-appropriate education"* (DSM-IV-TR, 2000, p.54-55). This disorder hinders academic achievement and other daily activities for which writing skills are required. Disorder of Written expression is commonly found along with Reading Disorder or Mathematics Disorder. It manifests with difficulties in composing written texts accompanied by grammatical or punctuation errors, poor paragraph organisation, spelling errors, and extremely poor handwriting. It is noteworthy that such diagnosis is not given if only spelling errors or poor handwriting exist without the co-occurrence of other impairment in written expression. Very little is known about Disorder of Written Expression, while standardised tests for the assessment of writing skills are less well developed. Furthermore, its prevalence is difficult to establish, as it is rarely found without other Learning Disorders. (DSM-IV-TR, 2000).

Handwriting difficulty or ***Dysgraphia***, as otherwise called, is defined as a specific learning disability in the production of written language related to the mechanisms of writing, which affects written expression making the act of writing difficult (Hamstra-Bletz & Blote, 1993; Brown, 1981, as cited in Rosenblum et al., 2004, p.433). Dysgraphia is manifested among children of at least average intelligence and who have not been identified as having any obvious neurological problems (Rosenblum et al., 2004).

Moreover, ***Dysorthographia*** or specific learning disability in spelling, even though not listed neither in the DSM-IV-TR nor the ICD-10, could also be included within the Disorders of Written Expression, as spelling could be subsumed under “written expression”. It is, however, listed in the recently published Educator’s Diagnostic Manual of Disabilities and Disorders (Pierangelo & Giuliani, 2007, p.31). Dysorthographia is a term referring to a specific learning disability associated with poor performance in spelling *(manifested with grammatical errors, arbitrary spelling, many spelling errors such as letters and/or syllables additions, omissions, substitutions, and reversals, etc.)* in contrast to dysgraphia, which is related with the overall performance in writing *(difficulties with spelling, poor handwriting and trouble putting thoughts on paper)*.

c) Specific Learning Disability in Maths

According to DSM-IV-TR (2000), the main feature of ***Mathematics Disorder*** is mathematical ability that is significantly worse than that anticipated for the individual’s age, intelligence and age-appropriate instruction. The disorder in mathematics significantly affects academic achievement or other daily activities requiring mathematical skills. Mathematics Disorder is usually found along with Reading Disorder or Disorder of Written Expression.

Developmental ***Dyscalculia***, as otherwise known, is a specific learning disability that affects the acquisition of arithmetic skills in otherwise normal children. Children who encounter difficulties in learning arithmetic and fail to achieve adequate proficiency in this area despite normal intelligence, educational opportunity, and necessary motivation have developmental dyscalculia. They have trouble, for instance, learning arithmetic tables, comprehending subtraction, multiplication, or division, understanding the concept of numbers or writing, reading and identifying numbers and symbols, etc. (Shalev & Gross-Tsur, 2001).

Albeit poor teaching, environment, and low intelligence have often been implied as causing developmental dyscalculia, present evidence suggests that it is a neurological disorder with hereditary nature (Shalev & Gross-Tsur, 2001). According to DSM-IV-TR (2000), Mathematics Disorder is a rare disability, with prevalence of 1% in school population. Shalev & Gross-Tsur (2001) suggest 5% as a more realistic estimate, a percent similar to Dyslexia and ADHD.

d) Other Specific Learning Disability

***Learning Disorder Not Otherwise Specified*,** according to DSM-IV-TR, or ***Mixed Disorder of Scholastic Skills*,** according to ICD-10: This ill-defined category refers to disorders that do not satisfy the criteria for any of the above categories; none predominates sufficiently to constitute the prime diagnosis. This disorder may include problems in all 3 areas mentioned above. These problems interfere with academic attainment, even though performance is not necessarily significantly below that expected based on the individual's age, intelligence and instruction (DSM-IV-TR, 2000).

3.1.2. Developmental Dyslexia

Dyslexia was a term quite misunderstood and controversial in the past, mainly because of ignorance and prejudice, while it has become the focus of many scientific fields, such as neurology, psychology, education, psychiatry even ophthalmology, in the last decades (Pavlidis, 1990). The cause of this misunderstanding is that there are many contradictory theories with regard to its etiology. Besides, the lack of objective and accurate diagnostic methods as well as the incomplete definition of dyslexia deteriorates its perception. Remarkably, Critchley refers to dyslexia as *"indefinable"* (Critchley, 1981).

The term "dyslexia" originates from the Greek language and is a compound word, which consists of the prefix "dys" *(= bad, abnormal, difficult)* and the word "lexis" *(= word),* derived from the verb "lego" *(= speak)*. Thus, dyslexia means "difficulty with words" (Pavlidis, 2013, 1981; MacDonald, 2009; Kulkarni et al., 2001). Furthermore, according to Critchley (1981), given that the etymology of dyslexia expresses a difficulty in the use of words, it is, therefore, implied that dyslexics have problems with identification, combination, pronouncement as well as spelling of words.

Dyslexia could be best described as a neurological disorder that is best explained by an unexpected severe retardation in reading, which, however, is not caused by any psychological *(e.g. existence of psychological problems)*, social *(e.g. low socio-economic background)*, educational *(e.g. high percentage of absenteeism)*, intellectual *(e.g. low IQ*), or any other environmental factors known to negatively affect the reading process (Pavlidis, 1990).

Dyslexia is considered to be the most common neurobiological disorder with prevalence rates that range from 5% up to 17.5% (ICLD, 1987; Shaywitz, 1998; Shaywitz & Shaywitz, 2005). It is a persistent, lifelong condition, while does not represent a transient "developmental lag", as often perceived. Namely, poor readers remain poor readers (Shaywitz, 1998; Shaywitz & Shaywitz, 2005).

Dyslexia is the common characteristic of many great inventors, leaders, artists and tycoons. Thomas Edison, Albert Einstein, Leonardo Da Vinci, Pablo Picasso, Antony Hopkins, John F. Kennedy, George Washington, Steve Jobs, Bill Gates and many other great personalities are among the most famous dyslexics. Besides, a recent research of BBC (2008) with 17,000 self-made millionaires participating found that the common characteristic of 40% among them was dyslexia (Pavlidis, 2013).

3.1.3. Historical Review

The concept of dyslexia has a brief history. It was not until the late 20th century that the term "dyslexia" came into general use, in order to describe individuals with high IQ but restricted literacy abilities (MacDonald, 2009), while it was not until the mid-20th century that dyslexia began to be accepted as an educational problem instead of a medical condition, as it was considered before. In the current section, an attempt is made to trace the milestones of the history of dyslexia from its beginnings to present.

Historically, the first reported case of dyslexia goes back to the Hellenistic period (3rd century B.C). This became known, when, in 1891, in the British Museum, a papyrus including 8 *"mimes"* of the Greek poet Herondas was discovered. The *"mimes"* were brief theatrical dialogues with satirical character, which depicted the daily life, the behaviours and morals of that period. In his 3rd mime, titled *"Didaskalos"(= Teacher)*, the beating of a little pupil named Kottalos, who had learning difficulties in reading and writing, is described (Pavlidis, 2013). Kottalos is later mentioned as dyslexic (Hock, 2005), as he had many symptoms of the syndrome (see Appendix 2).

Kottalos may constituted the earliest case of dyslexia, but the first reference to diagnosis of developmental dyslexia ever reported appeared in an article published in the British Medical Journal in 1896 by William Pringle Morgan titled *"A Case of Congenital Word Blindness"* (MacDonald, 2009). It was about a 14-years-old boy, named Percy, who was diagnosed with "congenital word blindness", as despite his intelligence and the continuous and laborious training, he barely managed to read and spell even words consisted of only one syllable. His teacher, who was teaching him for several years, described him as a bright, skilled boy and used to say that he would undoubtedly be the smartest student in the whole school *"if the instruction was entirely oral"* (BDA, The Dyslexia Handbook, 1996, p.11-14). It was obvious since then that dyslexics perform better in oral than in written (Pavlidis, 2013; Critchley, 1981), and, as Critchley (1981) mentions, *"even the dyslexic may have his head full of ideas, committing them to paper is too much for him"* (p.4).

Prior to 1900, a plethora of terms was used to describe dyslexia, such as word blindness, or strephosymbolia, words that originated from medicine, as during that time learning disabilities were considered medical conditions (MacDonald, 2009; Lawrence, 2009). In 1878, Adolph Kussmaul, a German neurologist introduced the term "word blindness" to describe the reading problems of his patients (Lawrence, 2009). According to Kussmaul, they exhibited unfamiliar symptoms, as they could see the text, but they could not understand it; patients had lost the ability to understand written words, while their hearing, eyesight and context knowledge was totally unaffected (MacDonald, 2009). The term "word blindness" began to be widely used until the 1940s (MacDonald, 2009) by the eye surgeon James Hinshelwood, Alfred Tredgold and others (Winzer, 1993).

It was in 1887 that the German ophthalmologist Rudolf Berlin introduced the term "dyslexia" instead of "word blindness", for which he believed it was misleading indicating a visual impairment as the basis of the problem, rather than a neurological origin (MacDonald, 2009). However, it was not until the following century that the term enjoyed general acceptance and common usage (Lawrence, 2009).

The term "strephosymbolia" was introduced in 1925 by an American psychiatrist, Samuel T. Orton. He was the first to recognise that children with reading difficulties tended to reverse letters during reading and writing, a phenomenon he named strephosymbolia (Lawrence, 2009). Orton attributed their difficulties to a functional malfunction of the nervous system. As cited in Winzer (1993), Orton invented this term to designate individuals who see “mixed symbols” in their attempt to read. In 1937, Orton published research, which developed the foundation of the current term referring to “congenital word-blindness” as “developmental dyslexia”. Given his contribution, dyslexia passed from medical to educational jurisdiction (MacDonald, 2009).

Since the mid-20th century, therefore, dyslexic children began to be considered under the jurisdiction of education and psychology, as both educational and psychological research started to broaden understanding and increase knowledge about the specific condition. The first teaching method devised to help children with reading disabilities were published by Anna Gillingham and Bessie Stillman in 1936, which is still in use known as the Gillingham-Stillman method (Lawrence, 2009).

Another significant event in the history of dyslexia occurred in 1963, when the Invalid Children’s Aid Association (ICAA) established the Word Blind Centre for Dyslexic Children in London, whose main focus was the teaching of dyslexic children. In 1967, the Orton Dyslexia Society was established in the USA, renamed in 1997 as International Dyslexia Association, as it is still known. Its main responsibility was to increase the society’s attention towards the needs of dyslexic children. Finally, another institution that is worth to be mentioned is the British Dyslexia Association concerned with promoting the needs of dyslexic children as well as training teachers (Lawrence, 2009).

Today, dyslexia is officially recognised as a category of learning disabilities and has become the focus of research of both medicine and education, with most of the research volume being conducted within the frameworks of education and psychology, however. Medicine, education and psychology are now collaborating in researching the origins as well as developing diagnostic and treatment methods for dyslexia. Medicine may continue to play a prominent role indicating that dyslexia causes lie within biology and neurology, but its diagnosis and treatment is and will continue to be within the field of education.

3.1.4. Defining Dyslexia

Dyslexia is probably the most widely known among specific learning disabilities. But, what is dyslexia? It is doubtful whether someone could answer to that seemingly straightforward question quite accurately. The lack of a complete definition hinders the conceptualisation of the syndrome and its characteristics. Hence, an attempt is made to review the most influential dyslexia definitions that have historically been expressed.

As dyslexia is a specific learning disability in reading, the perception of unexpected reading failure is evident in the majority of definitions. Its neurological basis is also reflected in most of them.

The World Federation of Neurology defined dyslexia as **"a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and social-cultural opportunity"** (as cited in Critchley 1970).

(World Federation of Neurology, 1968)

Other definitions have tended to be more specific listing, in addition to reading, other characteristics associated with dyslexia:

"Developmental dyslexia is a learning disability, which initially shows itself by difficulty in learning to read, and later by erratic spelling and by lack of facility in manipulating written as opposed to spoken words. The condition is cognitive in essence, and usually genetically determined. It is not due to intellectual inadequacy or to lack of socio-cultural opportunity, or to emotional factors, or to any known structural brain-defect. It probably represents a specific maturational defect, which tends to lessen, as the child grows older, and is capable of considerable improvement, especially, when appropriate remedial help is afforded at the earliest opportunity".

(Critchley & Critchley, 1978)

"Dyslexia could be described as the syndrome that is best exemplified by the unexpected severe reading retardation, which is not caused by any known medical, intelligence, psycho-educational or environmental factors". It affects the lives of millions of people worldwide often with devastating psychological, social as well as educational consequences. At least 1%-3% of the total population suffers from dyslexia of varying degree of severity, while most of those are classified as learning disabled.

(Pavlidis, 1990)

According to the International Dyslexia Association's Research Committee, the following definition was accepted (as cited in Lyon, 1995, p.9; Kirk, Gallagher, Coleman & Anastasiow, 2009, p.114):

"Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterized by difficulties in single word decoding, usually reflecting insufficient phonological processing abilities. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalized developmental disability or sensory impairment. Dyslexia is manifested by variable difficulty with different forms of language, often including, in addition to reading problems, a conspicuous problem with acquiring proficiency in writing and spelling".

(IDA, 1994)

The Committee on Dyslexia of the Heath Council of the Netherlands claimed that a working definition of dyslexia should fulfill certain conditions and it should be:

- descriptive, specific enough to identify dyslexia within the whole of reading and spelling problems
- general enough to allow for various scientific explanatory models and developments
- flexible for the purposes of research

- directive for statements concerning the need for intervention
- recognisable for the various groupings involved.

Therefore, the following working definition was developed:

"Dyslexia is present when the automatisation of word identification (reading) and/or word spelling does not develop or does so very incompletely or with great difficulty".

(Committee on Dyslexia, Health Council of the Netherlands, 1995)

The definition expressed by British Dyslexia Association gave a more positive view of dyslexia, focusing not only to disabilities but to dyslexics' abilities as well (as cited in Montgomery, 2007, p.66-67):

"Dyslexia is best described as a combination of abilities and difficulties which affect the learning process in one or more of reading, spelling and writing. Accompanying weaknesses may be identified in areas of speed of processing, short-term memory, sequencing, auditory and/or visual perception, spoken language and motor skills. It is particularly related to mastering and using written language, which may include alphabetic, numeric and musical notation. Some children have outstanding creative skills, others have strong oral skills. Dyslexia occurs despite normal teaching, and is independent of socio-economic background or intelligence. It is, however, more easily detected in those with average or above average intelligence".

(BDA, 1999)

Lyon, Shaywitz and Shaywitz (2003), members of the working group of the International Dyslexia Association, revised, updated and expanded the working definition proposed in 1994. They concluded in the following definition:

"Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor

spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge".

(Lyon, Shaywitz & Shaywitz, 2003, p.2)

The following table includes several definitions of dyslexia outlining the main features included in each of them.

Table3. Dyslexia Definitions

Definition	Date	Reading difficulty	Spelling difficulty	Written word difficulty	Number work difficulty	Oral language difficulties	Other difficulty	Normal IQ	Neurobiological origin	Not due to educational factors	Not due to psychological-emotional factors	Not due to mental or other medical factors	Not due to environmental-socio-cultural factors	Maturational defect	Improvement	Phonological deficit
World Federation of Neurology	1968	√						√		√			√			
Critchley	1978	√	√	√				√	√	√	√	√	√	√	√	
BPS	1989	√	√	√	√	√			√							
Pavlidis	1990	√						√	√	√	√	√	√			
IDA	1994	√	√	√				√	√			√				√
Committee on Dyslexia, Health Council of the Netherlands	1995	√	√													
BDA	1999	√	√	√	√	√	√	√	√	√		√	√			
Lyon, Shaywitz & Shaywitz	2003	√	√					√	√	√		√				√

Table 3 provides a global and comprehensive image of most definitions that have historically been expressed. As obvious, the notion of reading failure is evident in all definitions, whereas the neurological etiology is manifested in the majority of them. Although considerable agreement exists among definitions, none of them has brought an end to the definitional issue. The existing confusion could account for the lack of convergence surrounding the etiology, prognosis and diagnosis of dyslexia. One could argue that a different number and kind of children are identified as dyslexic by applying different definitions. Only a positive definition would help to overcome such problems.

3.1.5. Diagnosis of Dyslexia

Dyslexia is one of the most misunderstood syndromes in the fields of neurology, psychiatry, psychology, and education. The misunderstandings and misconceptions arise from the lack of a complete definition, from the contradictory theories surrounding its etiology as well as from the lack of accurate and unequivocal diagnostic criteria (Pavlidis, 1981, 1985a, 1990).

Lack of knowledge regarding the exact causes of dyslexia has compelled the adoption of definitions mainly based on exclusionary criteria. The diagnosis of dyslexia and LD is still based on 2 criteria:

1. <u>The criterion of exclusion</u>, which indicates that all other potential causes for learning difficulties should be excluded.
2. <u>The criterion of discrepancy</u>, which indicates that there should be a discrepancy between the individual's potential and his actual achievement.

Both criteria are evident in DSM-IV-TR (2000). Reading Disorder is diagnosed, when reading attainment is significantly below that expected based on the individual's intelligence, chronological age and age-appropriate education, while it is necessary to discriminate dyslexia from other learning difficulties, which are mostly due to lack of opportunity, poor instruction and other environmental factors.

Similarly, Shaywitz (1998) argued that, as with any medical condition, the diagnosis of dyslexia must reflect a careful synthesis of all available data, including history, observations, and testing. Tests of reading, spelling, and other cognitive abilities compose a diagnostic battery. The professional is seeking to determine whether there are unexpected difficulties in reading, as indicated by a discrepancy between the individual's reading performance and his intellectual abilities, chronological age, or level of education. Finally, dyslexia is distinguished from other disorders featuring reading difficulties due to other factors *(exclusion clause)*.

Finally, Hallahan, Kauffman and Pullen (2009) refer to the reliance on IQ – achievement discrepancy as the only solution, in order to determine whether a student achieves well below his potential.

However, the use of solely intelligence tests in the diagnosis of dyslexia seems to be a controversial issue shedding light on the need for more objective diagnostic criteria. The reliance on an IQ – achievement discrepancy criterion may be essential for the identification of very bright individuals who have dyslexia, but excludes individuals with average intelligence and severe reading problems. In that case, dyslexia could be identified only on the basis of low reading achievement for chronological age. According to Shaywitz (1998), that is why consensus is emerging that the criterion of unexpected reading difficulties may be met by children of at least average intelligence, who meet discrepancy criteria relative either to IQ or chronological age *(IQ – achievement or CA – achievement discrepancy)*.

Some educators have pointed out that the idea of discrepancy is useless in the first grades, as, until then, a child is not expected to have achieved very much, and, hence, it is difficult to find a discrepancy (Hallahan, Kauffman & Pullen, 2009). The use of such identification criteria creates severe problems, as dyslexia cannot be diagnosed until the child has been failing at school for at least one year and a half, meaning that reading disability cannot be diagnosed until the 2nd grade. And, by then, the continuous failure may result in aversion for school, low self-esteem and self-confidence, and psychological problems (Pavlidis, 1990). That is why this IQ – achievement discrepancy approach has properly been called a *"wait to fail"* model (Hallahan, Kauffman & Pullen, 2009, p.189).

Early indicators and risk factors for dyslexia, such as history of language delay, problems with the sounds of words *(trouble playing rhyming games, confusing words that sound alike)*, oral language and other difficulties, along with a family history of reading disabilities, even though very helpful for the prognosis of dyslexia and the identification of at-risk children (Shaywitz, 1998), they are not objective enough to make an unbiased diagnosis before children start to fail in reading.

Pavlidis (1981b, 1985a) argued that if the causes of dyslexia are neurological, then the syndrome should occur in all psychological, socio-economic, and intelligence levels, as all other neurological conditions do. Hence, his argument defends the view that it is risky to rely on exclusionary and discrepancy criteria for the diagnosis of dyslexia, because individuals a) psychologically maladjusted prior to beginning school, b) from disadvantaged socio-economic background, c) educationally deprived, or d) with lower IQ could not be unequivocally diagnosed and, hence, would be deprived of treatment. They are usually classified as non-dyslexic retarded readers, while in fact they are more likely to be undiagnosed dyslexics (Pavlidis, 1990). Besides, the delayed diagnosis based on exclusionary criteria has negative effects, such as the limited effectiveness of treatment and the development of secondary psychological problems (Pavlidis, 1985a).

Thus, an objective diagnostic method and a definition that could identify dyslexics based on positive behavioural, psychological and/or neurophysiological criteria seem preferable (Pavlidis, 1985a, 1990). The main advantage would be the possibility to identify and diagnose even children socio-culturally and educationally disadvantaged, psychologically disturbed or of low intelligence (Pavlidis, 1990, 1985a). The subjective nature and the variability of the majority of diagnostic criteria are reflected upon the fact that only a small percentage of children are diagnosed as dyslexic from different sources. Hence, all factors known to adversely influence the reading process must be precisely defined and quantified, in order to differentiate dyslexics from other retarded readers in a meaningful way (Pavlidis, 1990).

Although research criteria are usually stricter and more quantifiable than the clinical, according to Pavlidis (1990), most dyslexia studies use different inclusion criteria and not comprehensive enough resulting in heterogeneous populations. Besides, it is impossible to compare data between similar studies, if different criteria were applied, rendering the results of such a comparison pointless. Thus, he created the following list of strict, comprehensive, and quantifiable research criteria for the objective diagnosis of dyslexia, aiming to exclude any environmental and psychological factors that could account for the reading problem:

1. **Normal Intelligence:** Full-Scale, Performance or Verbal IQ equal or greater than normal range (minimum 1 SD below mean, plus 2 SE; i.e. WISC-R 92 verbal or 94 performance); and neither score less than 85.
2. **Reading retardation relative to CA (chronological age):** At least 2 years retarded if >10 or $1^{1/2}$ years retarded if <10 years old. Reading scores should derive from the standardised word recognition tests although reading speed and comprehension may worth be taken into consideration.
3. **Normal or corrected vision (greater than 20/40).** Excluded: amblyopia, nystagmus or oculomotor disturbance caused by known neurological disease.
4. **Normal or corrected hearing:** able to detect pure tones less than or equal to 15db for frequencies 500-4000 Hz.
5. **English is the language spoken at home** (which will vary from country to country).

6. **Average or above average socio-economic background, defined as at least one of the following:** (a) one or both parents/guardians have finished at least 1 year of college; (b) minimum income at average or above average for the state of residence; (c) one or both parents/guardians hold a professional occupation.
7. **Not on any psychoactive medication or within its washout period.**
8. **Adequate educational opportunity defined as:** (a) No more than two school changes during the first three years of school and/or not more than one change within a 12-month period (excluding normal transfer from nursery to primary to secondary school). (b) Absent not more than 10% of the school days during any of the first three years of schooling.
9. **No overt physical handicaps that could account for reading problems** (e.g. brain injury, malformation, tumor, seizures).
10. **No overt emotional problems defined as:** referral for psychological problems prior to beginning reading.

The early and objective diagnosis of dyslexia is of major importance, because, when undiagnosed, it can cause a lot of frustration and anxiety. Dyslexia is a "hidden problem", as there are no external signs to be recognised. That is why confusion surrounds the reasons of dyslexics' school failure and characterisations like "stupid", "dumb", and "lazy" are often used by parents and teachers, who are unaware of the problem. Besides, secondary psychological problems and low self-esteem can have long-term effects to dyslexics, even when reaching adulthood (Pavlidis, 2013).

3.1.5.1. Is IQ relevant to the Diagnosis of Dyslexia?

As aforementioned, IQ-achievement discrepancy is the main criterion used for the diagnosis of dyslexia. This discrepancy criterion was widely incorporated in most dyslexia definitions. Most intelligence tests, however, contain tasks that depend on the acquisition of knowledge and skills that are partially acquired through reading. Thus, intelligence in dyslexic children may be underestimated (Vellutino et al., 2004).

Support for the use of the IQ-achievement discrepancy criterion was initially derived from the study of Rutter and Yule (1975), while subsequent studies have questioned the reliability of their findings. In their study, Rutter and Yule identified two groups of poor readers, one having specific reading retardation and a second experiencing general reading backwardness. The first group's reading achievement was significantly below expected levels on the basis of IQ *(discrepancy)*; the reading skills of the second group were consistent with IQ *(low achievement)*. They claimed that these two groups existed and were distinct mainly based on finding a "hump" in the tail of the distribution of reading scores. This became the basis for exclusionary definitions having the IQ-achievement discrepancy as a critical component.

Currently, there is ample evidence supporting that IQ is irrelevant with learning disabilities. According to Vellutino and colleagues (2004), there is much evidence indicating that children with IQ discrepant and non-discrepant reading scores cannot be adequately differentiated (e.g. Vellutino et al., 2000; Vellutino et al., 1996; Fletcher et al., 1994, etc.). For instance, Vellutino and colleagues (1996), in an intervention study they conducted, found that intelligence tests did not manage to discriminate between poor and normal readers or between poor readers difficult to remediate and those readily remediated, contraindicating this way the use of IQ as a means for the identification of poor readers or the prediction of reading attainment in beginners, as they also failed to predict reading performance of normally achieving readers (as cited in Vellutino et al., 2004).

There is only little evidence in favour of the use of IQ-achievement discrepancy models supporting that a student might need little more than average or little below average intelligence to learn to decode, whereas other researchers claim that it is totally irrelevant (Vellutino et al., 2004). Siegel (1988, 1989), for instance, believes that IQ is totally irrelevant to the definition of learning disabilities and the use of discrepancy scores for the identification of learning-disabled individuals is highly questionable. She supported her argument with evidence indicating no difference among poor readers at a variety of IQ levels on measures of single word and pseudoword reading, phonological skills, spelling and memory. Besides, it was shown that some children with low IQ scores could be good readers, indicating that IQ cannot predict reading achievement.

Albeit this seems an extreme point of view and many researchers did not totally agree with Siegel, it remains that, in any alphabetic orthography, the ability to learn to decode is not determined by the level of intelligence (Vellutino et al., 2004). Indeed, how else the fact that research has shown that mentally retarded children often perform better in reading and spelling than dyslexics (Petrou, 2005; Goula, 2001; Pavlidis & Goula, 2004) could be explained?

If this is the case, then IQ-achievement discrepancy is proved invalid in defining dyslexia. Besides, if IQ were relevant to reading, it would be completely useless to assess someone's intelligence using IQ tests; it would be enough to test someone's reading performance to evaluate his intellectual ability. Consequently, as learning to decode print does not require higher intellectual skills, then intelligence tests have little utility for diagnosing dyslexia.

3.1.5.2. Eye-movements & Early Objective Diagnosis of Dyslexia

The eyes, the most sensitive and reliable sensory organs, are believed to be the mirror of the human soul, while their movements are considered among the most sensitive reflectors of the healthy function or malfunction of the brain. Eye-movements are the fastest and the most frequent movements made by the human body; they keep moving during sleep and even coma (Pavlidis, 2013).

There are at least 5 different types of eye-movements: *saccadic*, *pursuit*, *vergence*, *vestibular* and *micro-movements*. Each type is controlled by independent neurological mechanisms, which are among the best-designed neurological-biological control systems. The main type of eye-movements used during visual scanning and reading are the saccadic, which shift eyes from one fixation point to another (Pavlidis, 1985a).

Vision may depend on the efficiency of eye-movements, but it is erroneous to equate eye-movements with vision, as their function is extended beyond vision, reflecting higher brain processes and serving a variety of high-level cognitive functions. Their importance is proved by the fact that nature has devoted to eye-movements 3 out of the 12 cranial nerves. No other function receives so much neuro-anatomical hardware. This generosity can be further appreciated taking into account that vision, for instance, one of the most precious human senses, is given just 1 cranial nerve, while all other functions have been allocated less than one (Pavlidis, 2013, 1981b).

Given that the eye-movements reflect higher cognitive functions, it is not surprising that different patterns of eye-movements are found among the first signs and most sensitive indicators of many neurological conditions *(e.g. schizophrenia, Parkinson's disease, attentional disorders, etc.)*. Measuring eye-movements, therefore, is a powerful tool for uncovering and understanding mechanisms involved in processes like reading, as they form an integral part of the reading process. Recording eye-movements is now used to detect specific reading problems and, hence, treat them (Pavlidis, 2013).

There is consensus among researchers that dyslexics display erratic eye-movements during reading compared to normal readers (Hawelka & Wimmer, 2005; Biscaldi et al., 1994; Rayner, 1985; Pavlidis, 1985, 1981, etc.). Pavlidis (1985a) suggested that it is worth considering eye-movements recording as a means for the diagnosis of dyslexia. He assumed that the importance of using eye-movements as a diagnostic tool is enhanced by the fact that their function is beyond conscious control, and, thus, objective.

Pavlidis (1981) hypothesised that it is inconceivable for the same parts of the brain to perform inadequately during reading, but adequately in all other tasks, which require processing similar to reading. Therefore, dyslexia should also manifest itself in tasks other than reading, which simulate important components of the reading process *(e.g. sequencing, attention, oculomotor control)* and are controlled by the same or associated parts of the brain (Pavlidis, 1990).

Research has shown that eye-movements patterns during non-reading sequential tasks can clearly differentiate dyslexics from advanced, normal and retarded readers making dyslexia a clearly identifiable category (Pavlidis, 1985a). Tests based on non-reading tasks, which are free from any environmental or psychological influence involved in reading, serve as objective diagnostic tests of dyslexia. Given that such tests do not depend on reading, the diagnosis becomes possible at much younger ages and across all socio-economic backgrounds, cultures and languages, irrespective of intelligence and educational problems. Besides, the fully automated eye-movements recording and analysis system developed by Prof. Pavlidis makes measurements much easier to accomplish (Pavlidis, 2013, 1981a, 1981b).

The major advantage of Pavlidis objective diagnostic method is that it makes it possible to biologically identify dyslexia. Children, who otherwise would be classified as retarded readers, can be unequivocally diagnosed as dyslexic based on their eye-movements. Furthermore, non-reading tasks take only minimum time and, hence, the screening even of large populations becomes feasible, objectively assessing the prevalence of dyslexia. Finally, such a diagnostic method, independent of reading skills, may be internationally used irrespective of language and even before reading instruction begins. Hence, children do not have to wait to fail at school as to be diagnosed, eliminating this way any subsequent negative effects (Pavlidis, 2013). Besides, the earlier the diagnosis, the greater the possibility for remediation and the more effective the treatment.

Therefore, once the causes of erratic eye-movements and their relationship to dyslexia are clearly understood, it is more than likely that new and more effective treatment methods could be developed. Recently, this initial hypothesis was confirmed, as Pavlidis multimedia method for the treatment of dyslexia significantly improved dyslexics' performance in spelling (Katana, 2001; Katana & Pavlidis, 2004, 2005).

3.1.6. Dyslexia & General Learning Disabilities

All children struggling at school do not have dyslexia. Dyslexia should not be confused with other categories of learning disabilities *(e.g. general reading retardation)*. It is important to differentiate between dyslexia and general learning retardation, because they have different causes, different prognosis and different evolution although they can share some manifestations. Besides, the term "specific" that characterise dyslexia is used, in order to emphasise that it is not due to intellectual inadequacy or lack of educational opportunities, but is *specific* to reading (Pavlidis, 1981, p.103).

Although both dyslexics and learning-disabled children suffer from similar learning problems, dyslexia affects approximately 5% of the population, while, in contrast, general learning retardation 15-20%. Furthermore, dyslexia affects primarily males (5:1), unlike general learning disabilities, which equally affect males and females (Pavlidis & Katana, 2012). Another major difference is that general learning retardation can be predicted based on neurological, intellectual *(low I.Q.)*, sensory *(e.g. vision or hearing problems, etc.)*, socio-economic *(e.g. disadvantaged family environment, etc.)*, educational *(e.g. lack of equal opportunity, absenteeism, etc.*), and psychological *(psychological problems)* factors widely known to adversely influence the process of reading. The severity and the number of negative factors involved determine the extent and the severity of the retardation. (Pavlidis & Katana, 2012; Pavlidis, 1990).

Conversely, dyslexic children could have all the above factors favourable and still have severe reading problems that cannot be explained differently. Whilst other kinds of reading retardation can be caused by adverse psycho-environmental factors, dyslexia is caused by a brain malfunction (Pavlidis, 1990). Besides, in order to exist as a distinct category of LD, dyslexia must have a completely different etiology and evolution (Pavlidis & Katana, 2012). The brain malfunction is, therefore, the only remaining cause; its neurological basis is now universally accepted (Critchley, 1981; Geschwind, 1986). In summary, dyslexia is due to biological, usually hereditary factors and is often characterised by high IQ. Negative environmental factors cannot cause dyslexia, but they contribute to its deterioration or amelioration (Pavlidis, 2013; Pavlidis & Katana, 2012).

Dyslexics' performance is inferior in literary subjects, while they do not have problems with practical and maths. On the contrary, children with general learning disabilities exhibit poor performance in all areas, equally lagging in both language and practical subjects, written and oral word (Pavlidis, 2013; Pavlidis & Katana, 2012). The major difference among them is the great potential of dyslexics to improve, if early diagnosed and appropriately treated. Conversely, non-dyslexic learning-disabled individuals do not have great possibilities for progress especially in case of disability due to low intelligence (Pavlidis & Katana, 2012).

MacDonald (2009) claims that often no distinction can be made between dyslexia and general reading difficulties, especially when dyslexics come from lower socio-economic background. Pavlidis (1990) agrees that dyslexia and general reading retardation are commonly indistinguishable based on reading or other educational symptoms, as they usually have similar psychoeducational profiles. He argues that about 20%-30% of cases classified as having "general reading retardation" are probably undiagnosed dyslexics. He, therefore, suggested that eye-movements recorded during reading and non-reading tasks clearly differentiate the two groups (Pavlidis, 1981a, 1985b). The following table presents the differences between dyslexia and general learning disabilities:

Table 4. Differences between dyslexia & general learning disabilities (Pavlidis, 2013)

	Dyslexia	**General Learning Disabilities**
Prevalence	5%	15-20%
Affected population	4 males - 1 female	1 male - 1 female
Etiology	Neurological-Biological	Psychological, neurological, intellectual, environmental factors
IQ	Above average	Below Average
Learning problems	In literary subjects	In all subjects
Low performance	In written	In both oral and written
High performance	In oral	Nowhere
Special Abilities	Visual thinkers	Verbal thinkers
	Inventive-creative minds	Nothing special
Evolution - Diagnosis	Gradual delay	Stable delay
Evolution + Diagnosis	Rapid, impressive progress	Stable delay

3.1.7. Subtypes & Theories of Dyslexia

Even though dyslexia is the most common and most carefully studied among learning disabilities, the biological and cognitive mechanisms underlying the syndrome are still a matter of debate. Despite the huge amount of research conducted during the last decades – *a period during which dyslexia was viewed as a unitary syndrome with a single cause* – the most recent evidence is in favour of the existence of varieties of developmental dyslexia with the assumption of multiple cognitive causes.

Numerous theoretical approaches have identified different potential causes of dyslexia (Heim et al., 2008; Ramus et al., 2003). Besides, dyslexia is a syndrome and as such it manifests itself in a number of different ways (Rourke, 1989, as cited in Pavlidis, 1990). It may not represent a single disorder, but it may consist of a number of subtypes each possibly having different etiology. Research conducted by Heim and colleagues (2008) revealed that dyslexia might result from distinct cognitive deficits and that dyslexic children could be classified into different subgroups with different cognitive patterns.

Different cognitive theories conceptualise dyslexia as either phonological, attentional, auditory, magnocellular, or automatisation deficit. This heterogeneity indicates the existence of unrecognised types of dyslexics who suffer from distinct deficits (Heim et al., 2008). Not all dyslexics have deficits in all cognitive domains or equally benefit from every remediation technique (Ramus, 2003). Most of them belong to one or more of the many subgroups, for instance, those who have problems primarily with visual modality, auditory information, visual and auditory, attentional concentration, or sequential processing (Pavlidis, 1990).

However, even though there is consensus among researchers concerning the variability of dyslexic population, the extent to which they can be neatly partitioned into discrete subgroups still remains dubious. Consequently, it seems that dyslexia is more or less comprised of several subtypes, each possibly displaying different deficits. Hence, several theories of developmental dyslexia have been proposed based either on the language or the visual system, or other factors like temporal processing of stimuli within the aforementioned systems (Shaywitz, 1998). Distinguishing the different subtypes of dyslexia is a vital prerequisite for developing and applying more efficient treatment strategies, suitable for each subgroup (Rüsseler, 2006, as cited in Heim et al., 2008; Pavlidis, 1990).

The most influential among dyslexia theories is the phonological theory (e.g. Liberman, 1973; Liberman et al., 1977; Snowling, 2000; Stanovich, 1988; Shankweiler & Liberman, 1972; Shankweiler et al., 1979; Ramus, 2003; Ramus et al., 2003, etc.), which relates dyslexia to a deficit in phonological awareness, namely the ability to segregate and manipulate the speech sounds that form a word (Heim et al., 2008; Ramus et al., 2003). The critical difficulty of dyslexia consists a deficiency in the phonological module, the lower component of the language system, which is responsible for the processing of the speech sounds (Shaywitz, 1998). According to this theory, dyslexics have difficulty in developing awareness that words can be broken into smaller units of sound, and that letters of the printed word represent the sounds of the spoken word (Shaywitz, 1998).

Despite the different views of theorists about the nature of the phonological problem, they agree on the central and causal role of phonology in dyslexia (Ramus et al., 2003). In their research, Ramus and colleagues found that a phonological deficit may not be necessary, but it is a sufficient cause of dyslexia. The phonological deficit can arise independently, even though a significant number of dyslexics could suffer from additional deficits, which worsen the phonological deficit. The main difference of the phonological from other theories of dyslexia is that the cognitive deficit is considered to be specific to phonology. Conversely, opponents of the phonological theory, while they do not question the existence of a phonological deficit, they believe that the phonological problems are just secondary of a more basic disorder in sensory, motor or learning processes (Ramus et al., 2003).

Table 5 below summarises the main dyslexia theories along with a brief description of the main deficits and advocates.

Table 5. Dyslexia Theories

Theory	Deficit	Main advocates
Phonological theory	Deficit in phonological awareness	Liberman, Snowling, Stanovich
Double-Deficit theory	Double-deficit: Phonological awareness & RAN	Wolf
Auditory theory	Deficit in auditory processing	Tallal
Visual theory	Deficit in visual processing	Stein & Walsh
Attentional theory	Attentional deficit	Facoeti, Hari & Renvall
Cerebellar theory	Automatisation deficit	Nicolson & Fawcett
Magnocellular theory	General magnocellular deficit	Stein

In summary, many theories of dyslexia have been developed regarding its underlying biological and cognitive causes. However, all have weaknesses in their ability to explain the occurrence of certain deficits in dyslexics. For instance, Ramus et al. (2003) argued that the phonological theory, even though thought to give the most sufficient cause of dyslexia, suffers from an inability to explain the sensory and motor disorders that co-occur with phonological deficits in a significant number of dyslexics. This data is in favour of the notion of heterogeneity of dyslexia: different subtypes of dyslexia, more or less frequent, are manifested in different dyslexic individuals.

3.1.7.1. Is Dyslexia caused by Erratic Eye-Movements?

As discussed earlier, there is consensus among researchers that dyslexics show erratic eye-movements during reading. However, they disagree on the nature of the relationship between eye-movements and dyslexia. Are erratic eye-movements the cause of dyslexia or the consequence of reading failure? This problem has led to a number of contradictory hypotheses in an attempt to explain dyslexics' eye-movements. Several researchers have adopted the consequence position supporting that erratic eye-movements are just another reflection of dyslexics' difficulty with the reading material (Goldberg & Arnott, 1970; Rayner, 1978; Ellis & Miles, 1981). Conversely, others believe that dyslexics' erratic eye-movements may cause dyslexia (Leserve, 1968; Goldrich & Sedgwick, 1982; Zangwill & Blakemore, 1972).

Pavlidis' (1981b, 1985a) research findings have challenged the former statements. He claimed that erratic eye-movements and dyslexia could be seen as the symptoms of either commonly shared or independent but parallel central deficits. Such a theory would explain dyslexics' erratic eye-movements found during reading, non-reading tasks and also in their language, attentional, synchronisation and sequential problems (Pavlidis, 1986).

Pavlidis (1981b) recorded the eye-movements of dyslexics, other retarded, normal and advanced readers while reading texts of varying difficulty. He found that dyslexics made significantly more forward and regressive eye-movements than all other groups, even the group of retarded readers, who were matched with dyslexics for both chronological and reading age. Yet, dyslexics were found not only to make significantly more eye-movements, but also different kinds of eye-movements irrespective of text difficulty.

Based on the significant differences found between retarded readers and dyslexics, the hypothesis that reading failure causes dyslexics' erratic eye-movements should be rejected. If this assumption was true, as far as dyslexics and retarded readers were equally retarded, they should exhibit similar eye-movements. Besides, if dyslexics' erratic eye-movements were a manifestation of their difficulty with text, then, when reading a very easy material, their eye-movements should tend to be regular, something that has not been confirmed, though (Pavlidis, 1981b, 1985a). Thus, it was not dyslexics' reading difficulty, which caused erratic eye-movements, but vice versa, their abnormal eye-movements, which reflect a brain malfunction, may have caused their reading problem.

Pavlidis went a step beyond trying to confirm whether these eye-movements differences found in reading are still evident during non-reading tasks, which simulate the sequential process of reading. Based on the fact that dyslexia is a neurological condition *(brain malfunction)*, he hypothesised that it should also manifest itself in non-reading tasks, which, however, depend on skills also fundamental for the reading process, such as oculomotor control, automated sequencing, and others (Pavlidis, 1990, 1985a). The most vital skill involved in almost all stages of the reading process is sequential order (Pavlidis, 1981b). The former hypothesis predicts that dyslexics would perform worse than normal readers in both reading and non-reading tasks, which are processed and controlled by the same brain parts.

Indeed, Pavlidis (1981a) in a study of dyslexics and matched normal controls found significant differences in the eye-movements patterns between the 2 groups during a non-reading task, which simulated the sequential process of reading replacing words with lights. These findings were replicated in a second study comparing dyslexics to advanced, normal and retarded readers (Pavlidis, 1985a). Like during reading, there were significant differences in eye-movements between dyslexics and retarded readers, whereas the performance of the latter was similar to that of normal and advanced readers. These results excluded the possibility of similar causes of the reading problems of dyslexics and matched retarded readers. Dyslexics have central problems independent of reading, while retarded readers' problems are due to environmental factors (Pavlidis, 1985b).

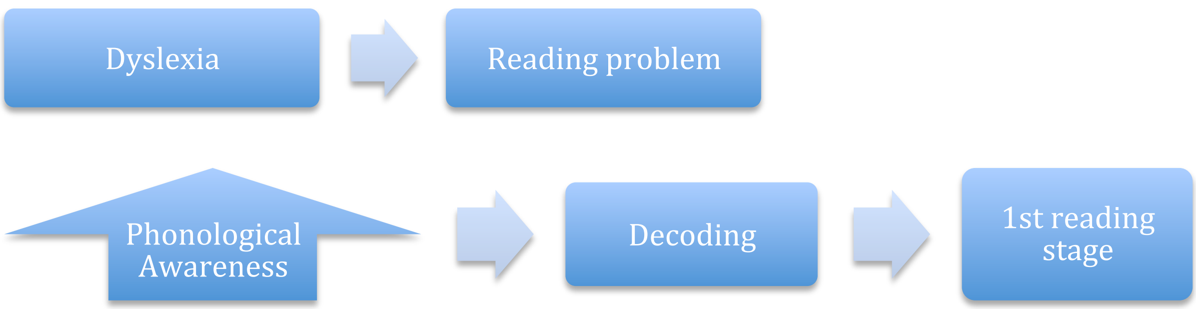
Summing up, eye-movements recorded during both reading and non-reading tasks highly differentiated between dyslexics and retarded readers. Thus, dyslexics' erratic eye-movements cannot be caused by their reading problems. However, even though it is not clear whether erratic eye-movements are the cause of dyslexia, it is possible to assume that abnormal eye-movements and dyslexia share a common or independent but parallel central cause (Pavlidis, 1985a). Indisputably, though, erratic eye-movements are linked to dyslexia.

3.1.7.2. Phonological Theory: Tautology or not?

It has been sometimes argued that the phonological theory is a tautology rather than a causal explanation of dyslexia (Pavlidis, 2013; Pavlidis & Katana, 2012). The advocates of this argument are based on the fact that phonology and reading are two sides of the same coin, in the sense that phonological awareness is enhanced by reading skill and vice versa (Ramus, 2003). According to Pavlidis (2013), the Phonological theory should be rejected, because it incorrectly tries to explain reading difficulties with reading, as phonological awareness coincides with the first reading stage, namely decoding (tautology). The following figure summarises Pavlidis' viewpoint:

Figure 1. The tautological character of the phonological theory according to Pavlidis

According to the phonological theory, the cause of **dyslexia** is a deficit in **phonological awareness**.



Thus, the cause of the **reading problem** *(dyslexia)* is a deficit in **reading** *(decoding)*, something that is in contrast to the prohibitive scientific rule of *tautology*.

On the other hand, the challengers of the tautological character of the phonological theory claim that this view would be valid only if the phonological deficit could be limited to just a problem of phoneme awareness. However, they impugn that this is not the case, as beyond phonological awareness, dyslexics exhibit two more phonological problems, in rapid naming and verbal short-term memory, neither of which can be said to rely on reading (Ramus, 2003). Nevertheless, whether these deficits are independent or different manifestations of a single underlying deficit is still a matter of debate. Besides, according to Ramus (2003), *"many aspects of dyslexics' phonology remain to be investigated"* (p.215).

3.1.8. Symptoms of Dyslexia

Dyslexia, as being a syndrome, expresses itself in a number of different ways manifesting various symptoms. The main characteristics of dyslexia are the unexpected reading failure, the bizarre spelling and sometimes the illegible handwriting (Pavlidis, 1990). However, symptoms are not limited in reading and spelling, but in every task controlled by the same or associated brain parts, which also control reading, such as attention, eye-movements, coordination, sequencing, and others. Besides, as dyslexia is biologically determined and exists since birth, neurophysiological *(e.g. abnormal eye-movements)*, behavioural and early developmental signs, like delayed spoken language, problems with sequential tasks *(e.g. putting on clothes or remembering the correct order of the days of the week, etc.)*, precede the manifestation of the reading problem (Pavlidis & Katana, 2012; Pavlidis, 1990).

The main symptoms of dyslexia are evident in the definition given by the former president of the World Federation of Neurology. According to Critchley (1981), "specific developmental dyslexia is a learning difficulty that is primarily manifested with ***difficulties in learning to read*** and later with ***strong misspellings*** and ***lack of fluency in handling the written word*** as opposed to spoken. The cause is actually cognitive and usually genetic. Dyslexia is not caused by a mental deficiency, lack of socio-cultural opportunities, unsuccessful teaching, emotional factors, or brain injury. Dyslexia may represent a specific lack of maturity, which tends to decrease as the child grows up and is open to significant improvement, especially if the appropriate therapeutic help is offered on time". The main characteristics and symptoms of dyslexia are described in detail in the following table:

Table 8. Dyslexia symptoms

DYSLEXIA SYMPTOMS
Runs in families; strong genetic component (Pavlidis, 1990).
Congenital neurological abnormality (Stein & Walsh, 1997).
Affects primarily males; 3-5 males to 1 female (Pavlidis, 1990).
Unexpected significant discrepancy between potential for achievement and actual school performance (Pavlidis, 1990).
Better in practical than in language subjects (Pavlidis, 2013).
Perform better in oral than in written (Pavlidis, 2013; Critchley, 1981).
Inconsistent school performance, *e.g. good in sciences and fail in English* (Pavlidis, 1990).
Trouble learning a foreign language (NCLD, n.d.).
Basic Abilities – Areas of strength
Bright, highly intelligent and alert (BDA, n.d.).
Inventive and creative (Pavlidis, 2013).
Frequently visual thinker (Pavlidis, 2013; 1990).
Frequently have superior spatial abilities (Pavlidis, 1990).
Highly intuitive and insightful (IDA, n.d.; Davis & Braun, 1997).
Instinctive understanding of how things work (BDA, n.d.).
Problem solving and lateral thinking abilities (BDA, n.d.).
Aptitude for constructional or technical toys, *e.g. bricks, puzzles, blocks, etc.* (BDA, n.d.).
Great perseverance and determination (BDA, n.d.).
Talented in art, drama, music, sports, mechanics, sales, business, designing, medicine, maths, physics, building or engineering; many dyslexics are often entrepreneurs (IDA, n.d.; Pavlidis, 2013).
Vivid imagination (Davis & Braun, 1997).

Vision
Complains of non-existent movement during reading, writing, or copying (BDA, n.d.).
Text may appear distorted, words or letters appear to move around, blur, or merge with each other (BDA, n.d.; Stein & Walsh, 1997).
Unstable binocular fixation; Poor binocular control; Tends to make visual reading errors (Stein & Walsh, 1997).
Reading
Lateness in acquiring reading skills (BDA, n.d.).
Unwillingness to read (Critchley, 1981); trying to avoid reading whenever possible.
Trying to conceal reading difficulties from others (NHS, 2012).
Embarrassed if asked to read in public (Lawrence, 2009).
Aversion to the printed page (Critchley, 1981).
Repetitions, additions, transpositions, omissions, substitutions and reversals in letters, numbers and/or words (Pavlidis, 1990; Critchley, 1981; DSM-IV-TR, 2000, BDA, n.d.).
Misses or repeats a line; Loses his place or uses a finger or marker to keep the place (BDA, n.d.).
Trouble understanding non-literal language, such as idioms, jokes or proverbs (NCLD, n.d.).
Extremely slow reading (Pavlidis, 1990); cannot be hurried, because if pressurised he falters and loses accuracy (Critchley, 1981).
Both oral and silent reading are characterised by slowness and errors in comprehension (DSM-IV-TR, 2000).
Monotonous reading: lack of voice colouring (Pavlidis, 1990).
Difficulties in letters, words or subjects naming (Pavlidis & Katana, 2012).
Finds difficulty with dictionaries, directories, or encyclopedias (BDA, n.d.; Pavlidis, 2013).
Fails to recognise familiar words (BDA, n.d.).

Hesitant and laboured, especially when reading aloud (BDA, n.d.).
Hesitancies when unfamiliar or polysyllabic words are encountered (Critchley, 1981).
Difficulty in reading handwritings (Pavlidis, 1981), even his own (Pavlidis, 1990).
Word abbreviations, *e.g. reading – read* (Pavlidis, 1990).
Word substitutions by smaller and more usual words, *e.g. physician – doctor* (Pavlidis, 1990).
Omissions of filler words, *e.g. a, the, etc.* (Pavlidis, 1990).
Grammatical errors, *e.g. I are dyslexic* (Pavlidis, 1990).
Erroneous pronunciation (Pavlidis, 1990; Critchley, 1981).
Does not read for pleasure (Pavlidis, 1990).
Relying on memory and verbal skills, rather than reading (NHS, 2012).
Trouble summarising a story (NCLD, n.d.); Difficulty in picking out the most important points from a text (BDA, n.d.).
Fatigues or becomes bored quickly while reading (Pavlidis, 2013).
Spelling - Writing
Lateness in acquiring writing skills (BDA, n.d.).
Repetitions, additions, omissions, substitutions, and reversals in letters, numbers, and/or words (Pavlidis, 2013).
Avoidance of writing whenever possible; confident with oral communication (Critchley, 1981).
Trying to conceal writing difficulties from other people (NHS, 2012).
Relies on others to correct spelling (IDA, n.d.).
Poorly organised written work; problems putting knowledge in written (Pavlidis, 2013; NHS, 2012).
Painfully slow spelling, even for words he/she is capable to spell (Critchley, 1981).
Bizarre spelling (Pavlidis, 1990; Stein & Walsh, 1997).

Handwriting varies or is illegible (Pavlidis, 1990).
Atrocious handwriting (Critchley, 1981).
Persisting reversals *(e.g. was – saw)* up to the age of 7 or 8 years (Pavlidis, 1990).
Erratic and inconsistent spelling of the same word even in the same sentence (Pavlidis, 1990; Critchley, 1981).
Difficulties in spelling long words (Pavlidis, 1990).
Confusion with letters, which look similar (BDA, n.d.).
Difficulties in taking down notes dictated or proclaimed (Critchley, 1981).
Intonation and punctuation omissions (Pavlidis, 1990).
Problems with grammar (Critchley, 1981); Difficulty mastering the rules of spelling (NCLD, n.d.).
Extremely slow handwriting (Pavlidis, 1990).
Inaccurate spelling, even when copying (Critchley, 1981); difficulties copying from a board (Lawrence, 2009).
Relies on memory or verbal skills, rather than writing (NHS, 2012).
Pencil grip is unusual (NCLD, 2012; Kulkarni et al., 2001).
Compensatory tricks to remember spelling (Pavlidis, 2013).
Hearing
Easily distracted by sounds. (Pavlidis, 1990).
Poor auditory discrimination (BDA, n.d.).
Oral language
Delayed speech development (Pavlidis & Katana, 2012; Pavlidis, 1990).
Similar errors during speech as during reading and writing (Pavlidis, 1990).
Approximately 50% of dyslexics exhibit problems with sequential oral language (Pavlidis, 1990).

Difficulty putting thoughts into words; Problems expressing themselves, *e.g. remember the right word to use* (Pavlidis & Katana, 2012; NHS, 2012).
Little understanding of non-literal word; misunderstandings and misinterpretations (Kulkarni et al., 2001).
Problems in learning and correctly using new vocabulary (NCLD, n.d.).
Lack of verbal fluency and precision in speech (BDA, n.d.).
Little understanding or appreciation of rhyming words (NHS, 2012; Pavlidis & Katana 2012).
Leaves sentences incomplete (Pavlidis, 2013).
Mispronunciation (Pavlidis & Katana, 2012).
Mispronounces long words or transposes phrases, words, and syllables (NHS, 2012); "Jumbling" up phrases, *e.g. "hecilopter" instead of "helicopter"* (NHS, 2012; NCLD, n.d.).
Information Processing
Difficulties with taking in information efficiently (BDA, n.d.).
Slow speed of information processing (Nicolson et al., 2001); delay between hearing something, understanding it, and responding to it (BDA, n.d.).
Difficulty processing complex language or series of instructions at speed (BDA, n.d.; Pavlidis, 2013).
Primary attention & concentration
Concentration difficulties; short attention span (Pavlidis, 1990).
Deficit in orienting attention (Facoetti et al., 2003); Sluggish attentional shifting (Hari & Renvall, 2001).
Forgetful (Stein & Walsh, 1997).
Easily distractible; gets lost easily (Pavlidis, 1990; Stein & Walsh, 1997).
Impatience, low tolerance (Pavlidis, 1990, 1981).
Hyperactive and energetic (Pavlidis, 1990).

Impulsive, *e.g. cannot wait for his turn* (Pavlidis, 1990).
Sensitivity to noise and visual stimuli (Pavlidis, 2013).
Does not seem to listen (Pavlidis, 2013).
Directional confusion
Poor spatial sequencing; Difficulty telling left from right (Stein & Wlash, 1997).
Often confuses left-right, over-under, etc. (Pavlidis, 1990).
Difficulties in following (oral) directions (Pavlidis, 1990).
Poor sense of direction (Pavlidis, 2013); Difficulty finding the way or navigating round an unfamiliar place (BDA, n.d.).
Difficulty reading maps (Stein & Walsh, 1997).
Secondary psycho-social problems
Psychological problems mainly resulting from frustration, continuous failure and lack of support (Pavlidis, 1990).
Hypersensitivity to criticism (Pavlidis, 1990).
Low self-esteem, depression, lack of self-confidence (Pavlidis, 1990).
Anxiety and stress due to academic problems (Pavlidis, 2013).
Emotionally immature; prefers to play with younger children (Pavlidis, 2013).
Sensitive, feels underprivileged (Pavlidis, 2013).
Does not take credit for success (Pavlidis, 1990).
Gives-up easily (Pavlidis, 1990).
Develops dislike for school and learning (Pavlidis, 1981).
Feels dumb and less capable than actually is (IDA, n.d.).
Word Sequences
Problems in remembering the normal and reverse sequence of: • Letters of the alphabet

- Days of the week
- Months of the year
- Number sequences
- Letters within syllables
- Syllables within words
- Words within sentences (Pavlidis, 1990)

Sequential tasks
Slower learning of automatic performing sequential tasks, e.*g. putting on clothes, tying shoelaces, etc.* (Pavlidis, 1990). Problems in serial thinking and recall, *e.g. cannot rapidly consult a dictionary or a telephone directory* (Critchley, 1981).
Memory & Cognition
Poor short-term memory (Pavlidis, 2013). Difficulty holding on several pieces of information while undertaking a task, *e.g. taking notes as you listen, etc.* (BDA, n.d.). Difficulty in remembering directions (Pavlidis, 1990); cannot easily remember verbal instructions (Lawrence, 2009). Difficulty in reciting poems and songs (Pavlidis, 1990). Problems in remembering math tables (Pavlidis, 1990). Rote memory problems (Pavlidis, 1990).
Maths
Finds mental arithmetic at speed very difficult (BDA, n.d.); use of finger counting and other tricks. Confused by symbols, such as + or *x* signs (Kulkarni et al., 2001). Difficulty memorising formulae and math tables (Pavlidis, 1990; BDA, n.d.).

Does not lack mathematical thinking, but needs a calculator even for simple calculations (Pavlidis, 2013; BDA, n.d.). Difficulty with the wording of problems (Pavlidis, 2013).
Coordination – Time management - Organisation
Problems in coordinated actions, *e.g. ball games* (Pavlidis, 1990). Problems in keeping a rhythm, *e.g. walking, dancing, hopping, etc.* (Pavlidis, 1990). Clumsy (Pavlidis, 1990). Poor balance (Stein & Walsh, 1997); Difficulties in motor control (Facoetti et al., 2003). Uncoordinated (Pavlidis, 1990). Difficulties with fine motor skills, *e.g. cutting, sticking, crayoning, etc.*, and/or gross motor skills, *e.g. catching, kicking, riding a bicycle, or throwing a ball, etc.* (BDA, n.d.; Stein & Walsh, 1997). Prone to accidents (Pavlidis, 1981); tripping, bumping into things and falling over (BDA, n.d.). Temporal sequencing problems; has difficulty telling the time (Stein & Walsh, 1997). Poor time management; losing track of time; difficulties in estimating the passage of time or being on time (Pavlidis, 2013; NHS, 2012). Finds tasks difficult to complete on time (BDA, n.d.). Disorganised (Pavlidis, 1990); Poor organisational skills (Stein & Walsh, 1997); problems with general organisation, *e.g. tidying up bedroom* (Lawrence, 2009).
Eye-movements
Erratic, highly variable, inconsistent eye-movements during reading and non-reading tasks, which reflect a brain malfunction (Pavlidis, 2013, 1990; Critchley, 1981).
Behaviour, Health, Development & Personality
Behaviour problems (Pavlidis, 2013).

Failure to realise the consequences of his speech or actions (BDA, n.d.).

May become unmotivated and develop dislike for school (Pavlidis, 1981).

Work avoidance tactics, *e.g. sharpening pencils or looking for books, etc.* (Pavlidis, 2013).

Sociable and outgoing (Pavlidis, 1990).

Aggressive and temperamental (Pavlidis, 1990).

Does not make nor keeps friends easily (Pavlidis, 2013).

Forgetful and immature (Pavlidis, 2013).

Unusually early or late developmental stages, *e.g. talking, crawling, walking, etc.* (Pavlidis, 1981).

Health-medical problems *(e.g. allergies, asthma, headaches etc.)* mainly due to stress caused by the humiliating school failure (Pavlidis & Katana, 2012; Pavlidis, 2013);

Unusually high or low tolerance for pain (Pavlidis, 1981).

Emotionally sensitive (Pavlidis, 2013).

Easily tired due to amount of concentration and effort required (Pavlidis, 2013).

Symptoms increase dramatically with confusion, anxiety, time pressure, or emotional stress (Pavlidis, 1990).

It is noteworthy that most of the symptoms get worse with stress. Of course, not all characteristics are present in a dyslexic individual. The dyslexic may exhibit a few or most of them and in varying degree of severity. Furthermore, he can have one or more symptoms and still not be dyslexic, as any of these characteristics could be indicative of other learning disabilities as well. It should be emphasised that the more symptoms exhibited, the greater the likelihood for dyslexia. And, if someone has all the above symptoms, he is likely to be dyslexic. Finally, the worse the symptoms are, the more severe the disability is likely to be (Pavlidis, 1990).

3.1.9. The Neurobiological Basis of Dyslexia

As discussed earlier, since dyslexia cannot be caused by psychological, sensory, intellectual or environmental factors, a brain malfunction is the only remaining cause (Geschwind, 1986; Pavlidis, 1981b; Critchley, 1981; Masland, 1981). This means that dyslexia is neurologically determined. The neurological nature of the syndrome is widely accepted nowadays (Szenkovits & Ramus, 2005; Ramus, 2003; Brunswick et al., 2001; Pavlidis, 1990; Geschwind, 1986; Critchley, 1981). According to Ramus (2003), dyslexia is directly caused by a cognitive deficit, which arises from a congenital dysfunction of certain areas of the brain involved in reading.

The notion that dyslexia may be of neurological origin was initially suggested in the end of the 19th century by the Scottish ophthalmologist James Hinshelwood and the British physician Pringle Morgan both emphasising on the similarity of certain symptoms in individuals with the neurological syndrome "word blindness" (Habib, 2000). According to Lyon, Shaywitz and Shaywitz (2003), the neurobiological origins of dyslexia were suspected as early as 1891, when the French neurologist Dejerine proposed that a part of the left posterior region of the brain is vital for the reading process. Another neurological theory dates back to the American neurologist Samuel Orton, who proposed that *"the lateralisation of language functions in the left hemisphere was delayed in dyslexics"* resulting in abnormal development of learning to read (Habib, 2000, p.2374). More recently, in the second half of the 20th century, Geschwind with his colleague Gallaburda made brain asymmetry a key issue of Neurology (Geschwind & Galaburda, 1985; 1987). They suggested a special vulnerability of the left hemisphere, which subserve various language-related abilities, as an etiological factor for dyslexia (Geschwind & Galaburda, 1985).

Vellutino and colleagues (2004) attempted to summarise the main findings of the last decades and mention that plenty of research until today confirm the neurological basis of dyslexia, namely a different structure and function of some neural networks in the brain related with the reading process. According to Kavale and Forness (2000), central nervous system impairments would represent the most prominent etiology of specific learning disabilities, including dyslexia. Shaywitz (1998) mentions that a range of neurobiological investigations suggests that differences exist in the temporo-parieto-occipital brain regions between dyslexic and non-dyslexic readers.

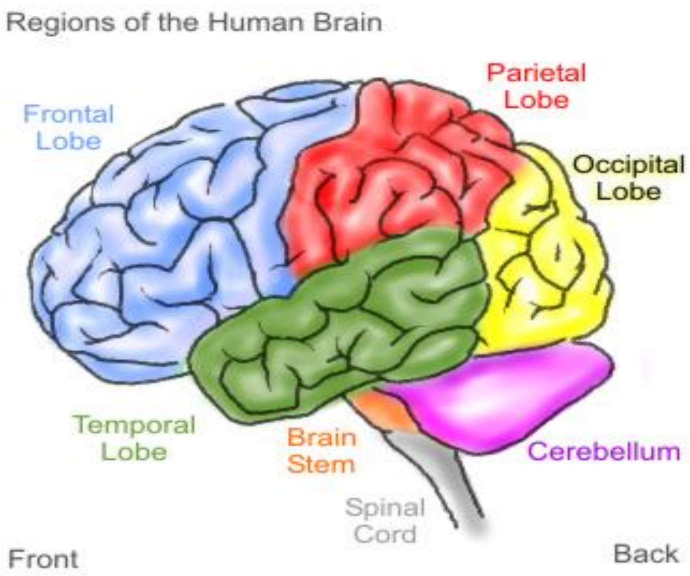
However, the neurological basis of dyslexia was just an assumption at first based on indirect information. It was usually assumed that, if dyslexia is not due to external, it must be due to constitutional factors (Vellutino et al., 2004). The constitutional nature of dyslexia was, therefore, based on what dyslexia is not rather than on evidence from the central nervous system (Rutter, 1978). Only in the last two decades, it became possible to directly evaluate its neurological basis (Vellutino et al, 2004). Brain structure, brain functioning and genetic studies supported this assumption.

Finally, a recently published review is enhancing the neurological basis of developmental dyslexia. Hence, according to Habib (2000), much research evidence to date encourages the view of dysfunction of some neural systems in the dyslexic brain, known to participate in the normal acquisition of reading skills and other relative cognitive functions, whereas differences in brain anatomy of dyslexics compared to controls have totally been confirmed.

3.1.9.1. The Normal Brain

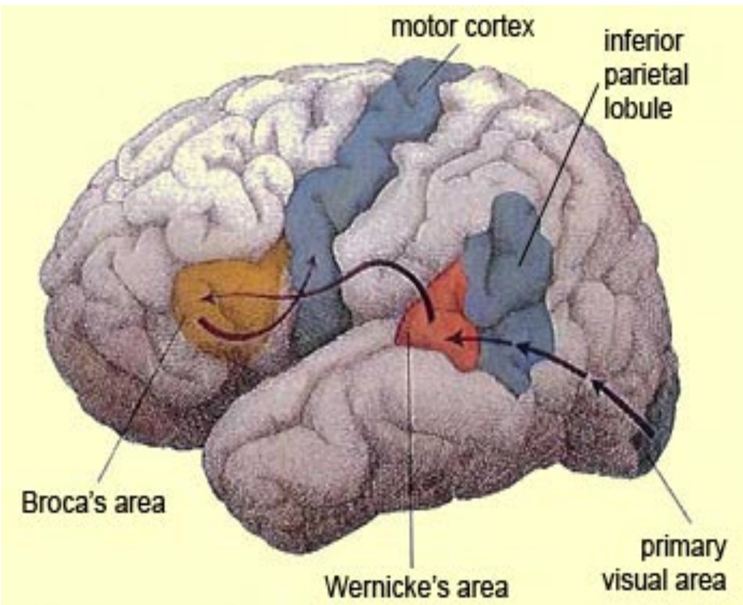
The human brain is divided into 2 hemispheres connected by the corpus callosum. Within each hemisphere, there are 4 regions *(lobes)* with different roles, while it has been established that regions in the temporal lobe of the left hemisphere are involved in language processing. Human brain is thought to be asymmetric, namely the left hemisphere is larger than the right (Snowling, 2000).

Figure 2. The 4 lobes of the brain



The following figure indicates the language areas of the brain and depicts the pathway for aloud reading. Printed word is processed through the eyes via the visual area at the backside. From there, activation passes in the temporal lobe to meet the language processing resources necessary for decoding and reading comprehension. Wernicke’s area is involved in language comprehension and Broca in speech production. (Snowling, 2000).

Figure 3. Brain areas involved in reading



3.1.9.2. The Dyslexic Brain

Although there is not a single neurobiological model of dyslexia, most data agree that focal cortical abnormalities in specific areas of the left hemisphere involved in phonological representations and processing are the primary cause of dyslexia. Data from anatomical studies have documented differences between dyslexic and control brains, located in different regions, albeit their functional significance has not been clarified. Functional brain imaging studies have indicated that the areas that show abnormal activation in dyslexics are those involved in phonological processing (Ramus, 2004).

Undoubtedly, the most significant contribution to the neurology of dyslexia was the studies of Galaburda and colleagues, who described the brains of 4 male dyslexics. All brains studied differed from controls', as they showed developmental anomalies of the cerebral cortex affecting mainly the left hemisphere. All brains exhibited a deviation from the normal left-right cerebral asymmetry, unexpectedly characterised by symmetry (Galaburda et al., 1985). Rather than finding the left planum temporale larger than the right in dyslexics, they were equal in size, with the right being larger than normal (Snowling, 2000). As the specific area of the left brain hemisphere is responsible for language functions, the symmetry was considered as the cause of language deficits leading to reading problems (Vellutino et al., 2004). Such findings were the results of other studies as well with larger dyslexic populations participating. Larsen and colleagues (1990) found a high frequency of symmetry in 70% of dyslexics with the right planum being larger than normal, but only in 30% of controls *(70% of controls showed asymmetry in favour of the left hemisphere)*.

Even though this symmetry in dyslexic brains compared to controls has not been totally confirmed by more recent studies (e.g. Rumsey et al., 1997a; Habib & Robichon, 1996; Leonard et al., 1993; Jernigan et al., 1991; Hynd et al., 1990) – *some of them finding a reversed asymmetry in dyslexics, others revealing symmetry but in different cerebral regions, some resulting in higher degrees of asymmetry favouring the left hemisphere, or others* *finding no differences in size or symmetry of the planum temporale between dyslexics and controls* – all findings, even conflicting, converge to developmental malformations, even subtle, of specific cerebral regions and to different anatomy of the dyslexic brain confirming the wide acceptance of the neurological basis of dyslexia.

Recent advances in technology made it possible not only to perceive the brain structure, but also to record its function during cognitive processing (Snowling, 2000). The most recent studies use functional neuroimaging to evaluate the reaction of the brain to cognitive stimuli (Vellutino et al., 2004). Research has shown that tasks demanding reading and phonological processing are linked with an increase of activation in several brain regions of the right hemisphere instead of the corresponding of the left normally activated in controls. For instance, Simos and colleagues (2002b) found that dyslexic children showed increased activation in certain areas of the right hemisphere rather than in the homologous areas of the left, which tend to be activated in good readers.

Brunswick and colleagues (1999) investigated which brain regions are activated in adult dyslexics during explicit and implicit words and pseudowords processing. Dyslexics, even though they activated the same regions of the left hemisphere known to be associated with reading, showed less activation than controls during both explicit and implicit processing in the left posterior temporal cortex, while during aloud reading they showed increased activation in a region of Broca's area, a fact attributed to an effortful compensatory strategy. Results confirmed that the abnormal functioning of left hemisphere regions involved in reading is responsible for dyslexics' atypical processing of written stimuli.

Similar findings are reported by Shaywitz and colleagues (1998) from dyslexic adults during performing a series of phonological tasks. Left posterior regions of the cortex showed less activation, while left frontal and right posterior regions appeared over-activated suggesting anomalous brain function in dyslexics. The following figures depict the brain regions that are activated during reading (figure 4) and how the brain reads (figure 5) in dyslexic and non-dyslexic individuals.

Figure 4. Brain activation during reading in non-dyslexic and dyslexic readers

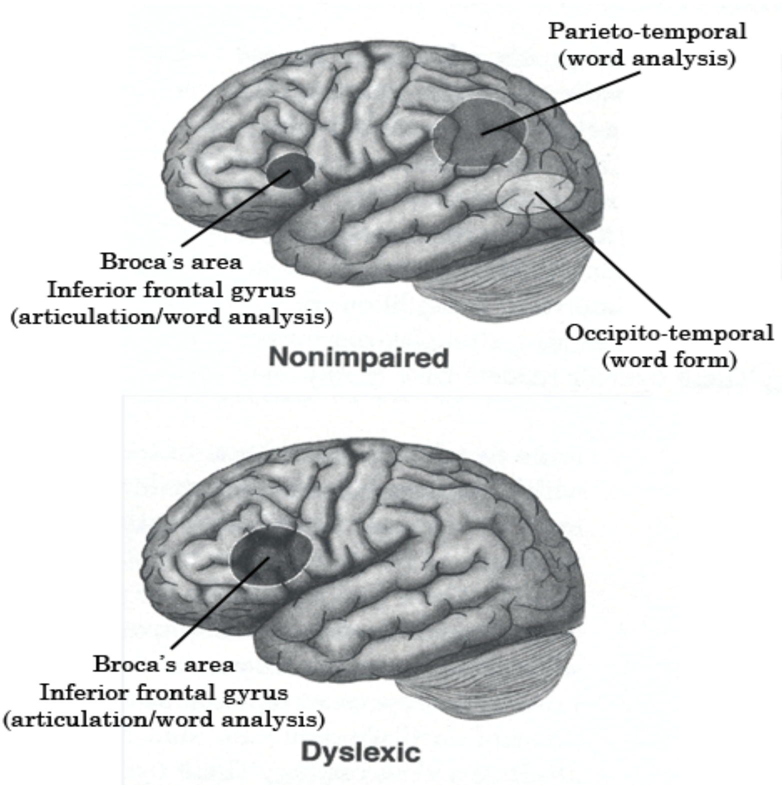
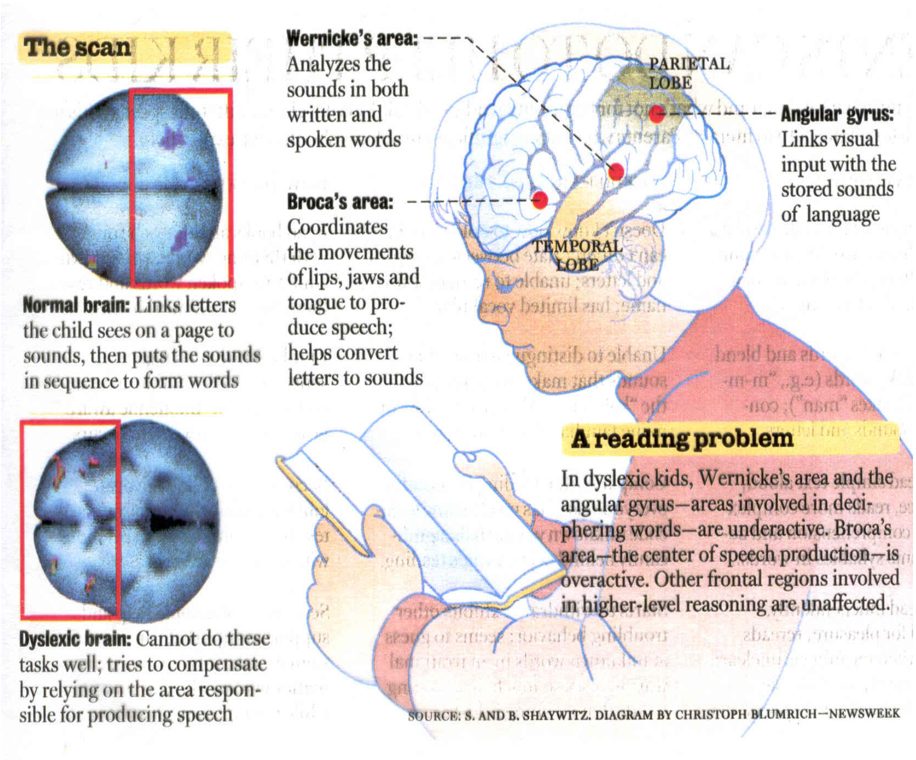


Figure 5. How the brain reads in normal and dyslexic readers



Regarding the neurobiological basis of dyslexia, it is undeniable that there are still questions that remain to be answered. However, there is little doubt that the cognitive deficits characterising dyslexics stem from differences in the language processing mechanisms located in the left hemisphere of the brain.

3.1.10. The Hereditary Nature of Dyslexia

Except for the neurobiological basis of dyslexia, significant evidence also proves its heritability. Ramus (2001) mentions that dyslexia is nowadays known as a hereditary neurological disorder that influences almost 5% of the population. DeFries and colleagues (1997), Brunswick and colleagues (1999) and Szenkovits and Ramus (2005) refer to a strong genetic origin of dyslexia. According to DSM-IV-TR (2000), Reading Disorder is more prevalent among first-degree biological relatives. Similarly, Habib (2000) claims that dyslexia is probably of genetic origin, since it occurs most often in families.

3.1.10.1. Family Studies

It is well documented that the risk of reading failure is greatly increased among children of dyslexic parents. In family studies, the risk of dyslexia is estimated to be 8 times greater in children with a family history of reading difficulties (Vellutino et al., 2004). Familial history is one of the most essential risk factors, with 23% up to 65% of children with a dyslexic parent reported to have the disorder too. A rate of dyslexics of approximately 40% among siblings and from 27% up to 49% among parents could contribute to the early identification of affected siblings and often to the delayed, but helpful, identification of affected adults (Shaywitz & Shaywitz, 2005; Shaywitz, 1998).

The increase in risk is significantly elevated, when a parent is affected, and, due to ample evidence from dyslexic families, it is possible to estimate the risk of a child being dyslexic (Snowling, 2000). Precisely, the risk for a son to be dyslexic, if he has a dyslexic father, is approximately 40%, while it is 36%, if he has a dyslexic mother. The risk for a daughter is reduced (20%) regardless of the parent affected (Gilger, Pennington & DeFries, 1991). Similarly, according to Elbro et al. (1998), many children of dyslexic families are expected to develop severe difficulties in reading and writing acquisition.

Research results have also confirmed dyslexia's hereditary basis. The first prospective study of children at familial risk of dyslexia was conducted by Scarborough (1990). She observed the progress of a group of 2-year-old toddlers from families with a history of reading disabilities in comparison to a group of children matched for age and socioeconomic background from families without any history of dyslexia. When children reached their 8^{th} year of age, 65% of the group at high risk were classified as reading-disabled, a result confirming the hereditary nature of dyslexia.

Pennington & Lefly (2001) followed the progress of 67 pre-school children at high family risk of dyslexia and 57 controls from kindergarten through 2^{nd} grade. Consistent with the hypothesis that dyslexia runs in families, 34% of the at-risk group was diagnosed as having reading disability in the 2^{nd} grade in contrast to only 6% of the control group. Similar evidence was reported earlier by Elbro, Borstrom & Petersen (1998) who followed a group of Danish children of dyslexic parents from kindergarten until the 2^{nd} grade. They found that children of dyslexic families had increased risk of dyslexia relative to controls.

According to Snowling, Gallagher & Frith (2003), the family risk of dyslexia seems to be continuous. To reach this conclusion, they followed the progress of a group of children at high-risk to manifest dyslexia because of their family environment from 3 to 8 years old. Indeed, 66% of these children were diagnosed with learning difficulties at the age of 8 compared to barely 13% of controls matched for socio-educational background. Moreover, among the children at family risk, but who were classified as normal readers, there were significant weaknesses in reading and spelling compared to controls.

However, these data, even tempting, are not sufficient to conclude that dyslexia is hereditary. According to Snowling (2000), families share not only heredity but also environment, and thus, these data do not necessarily imply that genetic factors are involved. The strongest evidence for the hereditary nature of dyslexia comes from studies in twins.

3.1.10.2. Twin Studies

There are two types of twins: identical *(monozygotic)* and fraternal *(dizygotic)*. Because monozygotic twins are genetically identical, they share 100% of their genes, while fraternal share on average 50% of theirs. It was assumed that, if dyslexia were totally heritable, then both twins in a monozygotic pair would always be affected. Although reported evidence varies, it is undeniable that there is a greater probability of both twins being dyslexic if they are identical than fraternal, a fact implying that genetic factors should be involved (Snowling, 2000).

Vellutino and colleagues (2004) point out that in twin studies, the percent of correlation is almost always over 80% for identical and usually less than 50% for fraternal twins. And, as identical and fraternal twins share the same environment, obviously the differences are related to heredity.

Zerbin-Rüdin (1967) investigated 17 pairs of identical and 34 pairs of fraternal twins and found a concordance rate of 100% for the former *(if a twin was affected, the co-twin was affected too)*, whereas 52% for the latter *(in 52% of the cases, if a twin was affected, the co-twin was affected as well)*, although DeFries and Alarcon (1996) argue that these rates may be somewhat inflated. Similarly, Bakwin (1973) included in his research 31 pairs of monozygotic and 31 of dizygotic twins from which at least one member of each pair was affected. He resulted in concordance rates of 91% and 45% for identical and fraternal twins, respectively, rates slightly lower than those of Zerbin-Rüdin.

Convincing evidence also resulted from Hermann's study of identical and fraternal twins as early as in 1959. He found that 12 out of 12 (100%) pairs of identical twins had dyslexia, while only 11 out of 33 of fraternal twins were both dyslexic.

The Colorado Twin Study of Reading Disability initiated in 1982 was an influential work and provided evidence for the heritability of dyslexia (Decker & Vandenberg, 1985; DeFries, 1985; DeFries et al., 1991). Compared to previous studies, a much larger number of twins, namely 186 pairs of identical and 138 pairs of fraternal twins, were recruited to participate, giving considerable reliability in its results. The concordance rates found were 68% for identical, while 38% for fraternal twin pairs suggesting that dyslexia could be considered to some extent as a result of heritable influences (DeFries & Alarcon, 1996).

DeFries and Alarcon (1996) performed multiple regression analyses on reading data obtained from the twin pairs participated in the Colorado Twin Study, aiming to estimate the influence of heredity and environment on the reading behaviour of twins. They found that, although the average scores of affected identical and fraternal twins were similar, the reading scores of the fraternal co-twins tended to the average level expected for children of this age in contrast to monozygotic co-twins. Their results indicated that more than half of the reading deficits of twins are a consequence of heritable influences.

Finally, other studies managed to provide estimates for genetic and environmental contribution to a child's reading profile indicating the amount of variance that is under the control of the former or the latter. For instance, DeFries and Alarcon (1996) found that individual differences of twins were highly heritable, while shared environmental influences did not significantly contribute to twin resemblance. In general, as cited in Vellutino and colleagues (2004), family and twin studies produced evidence that about 50%-60% of the variance in reading performance and associated abilities can be attributed to genetic factors. These studies also showed that, although environmental factors could account for significant variance in reading achievement, genetic factors contribute consistently more (Olson et al., 1999; Grigorenko, 2001).

3.1.10.3. Genetics of Dyslexia

According to Snowling (2000), since the predisposition to be dyslexic is heritable, it is reasonable to wonder what accounts for its transmission from a generation to another. Some genes are likely to be involved, although genetists are still at an early stage of understanding. DeFries and Alarcon (1996) and Vellutino and colleagues (2004) claim that linkage studies of families with dyslexic members may reveal the chromosomal locations of the genes that cause dyslexia. Linkage analyses implicate loci on chromosomes 6 and 15 for reading disability (Shaywitz, 1998). The first gene markers of dyslexia were found on chromosome 15 (Grigorenko et al., 1997), while more recently gene markers have also been identified on chromosome 6 (Grigorenko, 2001; Grigorenko et al., 2000). Furthermore, potential markers have been identified on chromosomes 1 and 2, but have not been replicated (Grigorenko, 2001). Finally, replicated linkage studies implicate loci on chromosomes 2, 3, 6, 15, and 18 (Fisher & DeFries, 2002).

To sum up, it would be impossible to review all research evidence regarding the hereditary basis of dyslexia, and, thus, an attempt was made to deal with the most representative among them. Of course, other recent (e.g. Cardon et al., 1994; Fisher et al., 1999; Olson & Gayan, 2001, etc.) as well as earlier research (e.g. Ingram et al., 1970; Zahalkova et al., 1972; Finucci et al., 1976; DeFries et al., 1978, etc.) also confirms the hereditary nature of dyslexia.

3.1.11. Decoding & Comprehension Skills in Developmental Dyslexia

As discussed earlier, reading is a complex function, which comprises of two component processes: *decoding* & *comprehension*. The purpose of reading is to extract and construct meaning from written text, namely comprehension (Vellutino et al., 2004). There is growing consensus that the language system, which is dedicated in processing the sounds of the speech, is central to understanding both reading and dyslexia. In dyslexics, a deficit impairs rapid word identification and, hence, learning to read; the reader has difficulty in decoding the word and identifying it. However, it is independent of other non-phonological abilities. Particularly, higher-level cognitive and linguistic functions *(such as intelligence, semantic, syntax, reasoning, vocabulary, etc.)* involved in comprehension are not affected. These intact cognitive abilities explain the paradox of intelligent people, who experience great reading difficulties, or why some extremely bright dyslexics can achieve high literacy levels (Shaywitz & Shaywitz, 2005; Giannouli, 2001; Shaywitz, 1998). Similarly, Vellutino and colleagues (2004) in their review of specific reading disability concluded that dyslexia is a deficit in learning to decode print. Dyslexia is primarily manifested in inability in word decoding, but without being necessarily accompanied by deficits in comprehension.

The reading performance of dyslexics is assessed by measuring their decoding and comprehension skills. Initially, decoding skills are evaluated by how accurately and rapidly they decode words. However, this refers to reading single words, because reading texts allows bright dyslexics to use context and help word recognition. Thus, it is noteworthy that dyslexic individuals often perform worse on single word decoding tasks than in context reading (Shaywitz, 1998). Conversely, for skilled readers there is evidence that decoding skill is automatic; words can be read nearly as well in list form as in context (Nicholson, 1991, as cited in Shankweiler et al., 1999). According to Shaywitz (1998), this automatisation never comes for dyslexics, who mainly suffer from less automatic and slow reading instead of less accurate.

In order to comprehend what someone reads, he must have the ability to recognise the words in the text. Accuracy and fluency of word identification allow *"computation of the meanings embodied in the text within the limits of working memory"* (Vellutino et al., 2004, p.5-6). A lower level deficit hinders access to higher level processing and, therefore, to the ability to construct meaning from written material. Namely, if decoding skills are weak, then working memory devotes extra effort for word recognition, drawing resources away from higher-level processing, such as comprehension (Ransby & Swanson, 2003). This means that the dyslexic individual cannot use his intact higher-level skills to comprehend until the written word has at first been decoded and identified (Shaywitz, 1998); when decoding is weak, the meaning of the word is not available to the reader to assimilate with other words, limiting, therefore, reading comprehension (Fidler & Everatt, 2012). It does not matter whether someone knows the exact meaning of a word if he is unable to decode and identify it on the paper; if this is the case, he is unable to use his knowledge and seems as if he does not know the meaning of the word. It is conceivable, therefore, that dyslexics have no actual comprehension problem, but the fact that they cannot access meaning, unless they have decoded the words first, makes them seem as comprehension-impaired.

This is further supported by the definition of dyslexia given by Lyon, Shaywitz & Shaywitz (2003), according to which *"secondary consequences may include problems in reading comprehension"* (p.2), suggesting that the existent decoding problem may lead to reading comprehension deficits as well. However, as aforementioned, in context reading, bright dyslexics can use context to guess the following words compensating for their decoding deficit and, hence, comprehend. That is why dyslexics are often found to perform well in reading comprehension, but not in single word decoding tasks. According to Fidler and Everatt (2012), adult dyslexics do not usually perform below normal readers in comprehension, when ease of reading is not exceeded and when there is no time pressure.

At this point, it is noteworthy that either individuals with high reading comprehension relative to decoding skill or others with high decoding relative to comprehension are considered poor readers, even though they have strengths that distinguish them from numerous other poor readers, who perform uniformly low on both decoding and comprehension (Shankweiler et al., 1999).

There is ample research evidence suggesting that dyslexia is mainly a deficit in learning to decode print, while reading comprehension may or may not be affected. Studies investigating the relationship between word identification and comprehension support that reading comprehension is impaired in individuals characterised by inadequate word identification *(accuracy and fluency),* even if they have intact language comprehension skills, while, individuals with impaired reading comprehension are found to have inadequate word decoding skills (Catts et al., 2003; Vellutino et al., 1996; Vellutino et al., 1994; Vellutino et al., 1991; Gough & Tunmer, 1986; Shankweiler et al., 1999).

Catts, Hogan and Fey (2003), trying to subgroup poor readers based on individuals differences in reading-related abilities, found that more than 70% of the children belonging to the dyslexics' subgroup, who encountered problems with reading comprehension in 2nd grade, also had a word recognition deficit.

Shankweiler and colleagues (1999) tried to reveal which factors limit comprehension. They found that differences in reading comprehension in a sample of children were closely associated with differences in decoding skills suggesting that decoding is critical in distinguishing readers at different levels of comprehension ability. The majority of their participants showed similar patterns in both decoding and reading comprehension. Only a small number of children diverged from this dominant pattern. Precisely, 32 out of 361 showed better reading comprehension than that expected from their decoding skills, while the opposite accounted for as few as 17 out of 361.

Studies evaluating the skills and abilities underlying reading ability (e.g. Curtis 1980; Stanovich, Cunningham & Feeman, 1984, etc.) have shown that decoding determines reading comprehension at the early stages of reading development, while, on the other hand, language comprehension is what defines reading comprehension at the later stages of development (as cited in Vellutino et al., 2004). This is keeping with the idea that reading comprehension may or may not be affected by dyslexics' decoding deficit and explains the fact that there are dyslexics unable to decode, but able to understand.

The fact that decoding accounts for less of the variance in reading comprehension in skilled readers does not mean that it is expected to lose its predictive value in such readers (Shankweiler et al., 1999). Bruck (1990, 1992), Perfetti (1985), and Shankweiler et al. (1996) found that the level of attainment in basic phonological skills accounted for the variance in reading comprehension in secondary school and college, especially for students with a history of reading disabilities.

Case reports of compensation in well-educated dyslexic adults that have appeared from time to time, even few, provide more evidence that decoding deficits can be successfully surpassed by some readers. Campbell & Butterworth (1985), for instance, presented detailed findings on a bright university student who decoded nonwords poorly, yet he managed to build up a large sight word vocabulary and was able to comprehend written material well (as cited in Shankweiler et al., 1999).

Concluding, research suggest that adequate facility in word identification and decoding is necessary, but not sufficient condition for reading comprehension and indicate that dyslexia is basically an impairment in decoding print, which may or may not be accompanied by deficits in reading comprehension.

3.1.12. Dyslexia in Higher Education

The vast majority of dyslexia research focuses on primary school pupils and adolescents. Quite recently, dyslexia began to be researched within higher education, as a result of the steady increase of the number of dyslexic students who enter higher education institutions, while gradually society becomes aware of the problem (Pope et al., 2006). Throughout the 1990s, several reports identified the need for improved opportunities for dyslexic students (Stampoltzis & Polychronopoulou, 2008). Recently, in the UK, the report of the Working Party on Dyslexia in Higher Education *"brought together extant knowledge regarding the provision that dyslexic students need to be able to perform optimally at University"* (Singleton, 1999, as cited in Hatcher et al., 2002, p.120), whereas in 2001, legislation impelled the review of the policy and provision for dyslexic students in higher education (Mortimore & Crozier, 2006). Knowledge and provision are essential for providing recourses and establishing strategies to deal with dyslexia, in order for dyslexic students to be treated fairly and effectively as well as to improve in their academic, social, professional and psychological life. Internationally, the provision for dyslexic students, although not ideal, is gaining ground.

The incidence of dyslexia in higher education varies because of the different criteria used for its definition and evaluation. In the UK, 2% of students that entered higher education institutions in the academic year 2001-2002 were dyslexics (Singleton & Aisbitt, 2001) compared to 1.35% in the academic year 1996-1997 (Singleton, 1999), whereas this percent is likely to increase over the years. However, Singleton (1999) found that 43% of the dyslexic students were not diagnosed before entering higher education (as cited in Bell, 2010). Pope et al. (2006) found that 12.1% of their sample (1182 university students) was "at-risk" of dyslexia. In Greek universities, the overall incidence of dyslexia is estimated at 0.16%, a percent significantly lower from other countries (Stampoltzis & Polychronopoulou, 2008). The fact that many dyslexic students decide not to disclose dyslexia upon admission to higher education (Kirby et al., 2008) could probably explain such low prevalence rates. Besides, it is undoubted that many dyslexics finish high school without ever been diagnosed (Pavlidis, 2013), while there is no provision for them (Pope et al., 2006). As a result, the actual incidence of dyslexia in higher education is difficult to be estimated (Mortimore & Crozier, 2006). It is comforting, though, that the number of dyslexics entering Greek institutions seems to grow over the years following the gradual increase in the number of dyslexic students in higher education reported in other countries (Stampoltzis & Poluchronopoulou, 2008).

However, in Greece, the situation for dyslexic students in Higher education is adverse, because the Greek educational system is still relatively unsupportive. The only formal reference made about dyslexia in higher education is a circular acknowledging the right of dyslexics to be orally examined in all subjects. All other existing decrees exclusively refer to pupils attending primary and secondary education. Therefore, it is obvious that there is limited interest for dyslexia in Greek higher education, while usually dyslexia is just hushed up, as if it is outgrown with the end of schooling. Besides, there are no sensitive diagnostic tests for the evaluation of dyslexic students' reading and reading-related difficulties, so that appropriate support programmes could be established in higher education institutions. It is noteworthy that often institutions are informed about the existence of dyslexia by dyslexic students themselves during or even after registration (Stampoltzis & Polychronopoulou, 2008).

The situation in Greece seems to be inconsistent with the international literature, which has proved that dyslexia is a lifelong condition, which persists from childhood throughout adult life. Historically, dyslexia in adults was first noted in the latter half of the 19th century (Shaywitz & Shaywitz, 2005). Since then, many reports in the literature support the existence-continuity of dyslexia in adults. Elbro, Bostrom and Petersen (1998), Hatcher and colleagues (2002) and Ransby and Swanson (2003) claimed that many studies have shown that dyslexia diagnosed in the early school years persists into adulthood in almost every case. Similarly, according to Miles (1986), adolescent and adult dyslexics do not simply surpass their problems despite the fact that they can make progress, while Ramus and colleagues (2003) describe dyslexia as a disorder with lifelong persistence.

Hellendoorn and Ruijssenaars (2000), in their recent research in adult dyslexic population investigating the way they deal with their disability in their social, educational and professional life, indicate that as children grow up, their dyslexia does not disappear. Thus, 3% to 5% of adults daily deal with dyslexia, a fact that prevents them from fully participating in the society. Wilson and Lesaux (2001) suggested that university students with dyslexia experience persistent difficulties irrespective of age and reading level. According to Shaywitz

(1998), dyslexia is a persistent chronic condition; it does not go away, it is not a transient lag. Practically, this means that once someone is diagnosed as dyslexic, there is no need for reexamination. Residua of deficits persist, so that reading remains effortful, even for the brightest dyslexics.

Besides, given the neurobiological etiology of the syndrome, which suggests that someone is born dyslexic, whereas he cannot acquire dyslexia due to environmental factors, it is easily conceivable that, it should follow him in adulthood.

The vast majority of research evidence comes from studies of adults with childhood diagnoses of dyslexia confirming that dyslexics do not experience problems only throughout school but also in adult life. Reading difficulties and related deficits persist across development, even in compensated dyslexics.

According to the developmental lag theory, which enjoyed great support, the reading acquisition of dyslexics follows a slow but normal course, and, therefore, their skills would develop continuously throughout childhood and should catch up their peers in reading proficiency by adulthood (Scarborough, 1984). If this was the case, then dyslexia should not exist in adult population. However, there is only minor evidence of catch-up, despite the substantial acceleration of achievement that has been occasionally observed (e.g. Muehl & Forell, 1973; Rutter & Yule, 1975), whereas, conversely, there is much research evidence proving the continuity of dyslexia in adult population.

Scarborough (1984) compared the reading skills of an adult group with reading disabilities during childhood to a group of adults, who did not report any reading problems. In contrast to the developmental lag hypothesis, results showed that nearly all adults, who experienced reading difficulties as children, continued to have similar problems in adulthood remaining poor readers reading in many cases more than 2 standard deviations below the mean levels predicted. Self-reported reading problems in childhood were reliably associated with continuous reading problems in adulthood. Precisely, 86% of the no-report group but only 20% of the self-report group were reading average or above average, while only 13% of the no-report group, but 80% of the self-report group were reading below the mean level expected.

Felton, Naylor & Wood (1990) compared groups of individuals with childhood diagnoses of reading disabilities, borderline reading disabilities and average reading skills on a battery of tests. Their performances on most measures significantly differentiated between the 2 groups of reading disabled adults and the control group. It is remarkable that differences were evident despite the long-term intensive instruction that many dyslexic individuals had received. Elbro, Nielsen and Petersen (1994) found that adults with history of reading disability still encounter such difficulties. They indicated that 9 out of 10 adults with a history of difficulties in learning to read and write in school read nonwords below the level of adults without such a history.

More recently, Wilson & Lesaux (2001) compared a group of dyslexic students *(recently diagnosed but with a history of persistent reading problems during childhood)* to a group of normal controls in terms of their reading and spelling skills. Results indicated that dyslexics' performance in both reading and spelling tasks was significantly worse than that of their non-dyslexic peers. Dyslexia seemed to persist and their deficits were still evident in adulthood. Additionally, Rack's (1997) findings of similar inefficiencies in children and adults with dyslexia provide further support for the notion of a lifelong condition.

Bruck (1990, 1992, 1993) also investigated whether the disabilities that characterise children diagnosed as dyslexics continue to influence them during adulthood. She compared adults with childhood diagnosis of dyslexia to age-matched and reading level-matched students on word recognition, spelling and reading comprehension. In line with the previous studies, results revealed that dyslexic students' reading and spelling performance was still characterised by inaccuracy, inconsistency and slowness. They performed significantly below both age-matched and level-matched controls on all measures and were found to have persistent difficulties in both reading and spelling, irrespective of age or reading level.

Pennington and colleagues (1990), comparing 2 groups of adult dyslexics *(clinic-identified and familial-genetic)* with 2 groups of controls, matched on chronological and reading age, respectively, found that dyslexics performed significantly worse than both control groups, a finding that confirms as well the continuity of dyslexia in adulthood. A little earlier, Muehl & Forell (1973), after observing a group of 43 children diagnosed as reading disabled for several years, concluded that children characterised as poor readers in primary and junior high school also remained poor readers in the last grades of high school, five years after their diagnosis and despite the potential better reading performance they exhibited at follow-up examination.

Shaywitz et al. (1999), comparing a group of adolescents monitored from school entry, who met the criteria for reading disability in the grades 2-6, to 2 groups of non-disabled readers *(average and superior)*, confirmed the continuity of the deficits that characterise dyslexics even in adolescence. The reading-disabled group was impaired on all measures compared to both average and superior readers, proving that dyslexics never catch up their non-disabled peers, even average readers, in the development of reading skills.

Concluding, it is clear that dyslexia is intrinsically linked to human life and the majority of difficulties that characterise dyslexia persist into adulthood.

3.1.13. The Symptoms of Dyslexia in Adults

As discussed earlier, given the neurobiological nature of dyslexia, it is easily assumed that the symptoms of the syndrome remain the same, although several problems may be compensated to varying degrees (Hatcher et al., 2002). Entering higher education dyslexics still encounter difficulties coping with reading, spelling and writing. Other weaknesses, such as in short-term memory, sequencing, speed of processing, attention, organisation and time management skills are associated symptoms (Stampoltzis & Polychronopoulou, 2008).

Secondary effects, like low self-esteem and self-confidence, as well as increased levels of frustration, might affect their performance (Hatcher et al., 2002). All studies conducted until today comparing dyslexic and non-dyslexic adults mention that the former group lags behind the latter in terms of reading and spelling accuracy, reading speed, identification of polysyllabic words (Hatcher et al., 2002; Szenkovits & Ramus, 2010; Wilson & Lesaux, 2001; Brunswick et al., 1999; Bruck, 1992, 1990; Lefly & Pennington, 1991, etc.), as well as attention, rapid naming and short-term memory (Szenkovits & Ramus, 2010). Fidler and Everatt (2012) claimed that the main manifestations of dyslexia in adulthood may differ from that found in children.

It is true, however, that the literature in terms of similarities or differences of the symptoms of dyslexia as manifested in children and adults is little to lacking – *none research has ever compared dyslexic children and adults in terms of their symptomatology* – and could perhaps become the basis for further investigation.

The following table describes the symptoms of dyslexia in adult population, especially university students, who are the focus of the current study.

Table 9. Dyslexia Symptoms in Adults

SYMPTOMS OF DYSLEXIA IN ADULTS
Reading Difficulties
Slow reading (Brunswick, 2012); cannot be hurried, because if pressurised he hesitates and loses accuracy (Critchley, 1981).
Difficulty reading at the same rate as others (Reid, 2011).
Monotonous reading; he fails to hoist in the connotation (Critchley, 1981).
Aversion to the printed page (Critchley, 1981).
Unwillingness to read (Critchley, 1981); hides reading problems (Kulkarni et al., 2001).
Antipathy towards the disclosure of his problems (Hatcher et al., 2002).
Avoids aloud reading (Pavlidis, 2013).

Hesitancies when unfamiliar or polysyllabic words are encountered (Critchley, 1981).
Mispronunciation; puts the accent on the wrong syllable (Critchley, 1981).
Word omissions; Substitutions; Grammatical errors (Critchley, 1981).
Difficulties understanding large quantities of complex texts (Simmons & Singleton, 2000).
Lack of fluency when required to read university texts (Mortimore & Crozier, 2006).
Difficulty extracting the sense from written material, summarising a story (Hatcher et al., 2002), synthesising course material for examinations (Kirby et al., 2008).
Comprehension difficulties under time pressure or when difficult reading materials are encountered (Fidler & Everatt, 2012).
Spelling & Writing Difficulties
Painfully slow spelling even for familiar words (Critchley, 1981; Reid, 2011).
Spells phonetically (Hatcher et al., 2002).
Erratic and inconsistent spelling, even when copying (Critchley, 1981; Brunswick, 2012).
Relies on others for spelling (Kulkarni et al., 2001).
Poor written expression (Hatcher et al., 2002).
Avoidance of writing, however, often competent with oral communication (Critchley, 1981).
Atrocious handwriting (Critchley, 1981).
Problems with punctuation and grammar (Critchley, 1981).
Difficulties in taking down notes dictated or proclaimed (Critchley, 1981).
Difficulty taking down messages, especially if these involve strings of numbers, *e.g. telephone numbers* (Brunswick, 2012).
Coping strategies to deal with spelling (Bell, 2009).
Difficulties writing essays (Kirby et al., 2008).
Difficulty proofreading and self-correcting work (Hatcher et al., 2002).
Oral Language Difficulties
Speech difficulties (MacDonald, 2009).

Lack of verbal fluency (Hatcher et al., 2002); word finding problems (Rack, 1997). Problems expressing ideas clearly, in a logical way (NCLD, n.d.).
Information Processing
Slow speed of processing (Hatcher et al., 2002) Delay between hearing something, understanding and responding to it (BDA, n.d.).
Attentional – Concentration problems
Difficulty sustaining attention (Hatcher et al., 2002) Difficulty concentrating in a noisy environment (Brunswick, 2012); easily distracted by visual stimuli (BDA, n.d.).
Directional Problems
Directional confusion, *e.g. left-right, north-south, etc.* (Pavlidis, 2013). Difficulty finding the way to places or navigating the way round an unfamiliar place (BDA, n.d.).
Short-term memory & Sequencing problems
Poor short-term memory (Hatcher et al., 2002). Difficulties remembering verbal instructions or directions (Pavlidis, 2013). Problems in serial thinking and recall, *e.g. cannot rapidly consult a dictionary or a telephone directory* (Critchley, 1981; Brunswick, 2012). Incorrect sequencing of number and letter strings (BDA, n.d.). Difficulty in sequencing tasks, *e.g. filling information in an alphabetised list or directory* (Brunswick, 2012).
Time – Organisation – Coordination problems
Poor time management (Hatcher et al., 2002); often arrive late for appointments or miss them completely (Brunswick, 2012; Reid, 2011). Poor organisational skills – disorganised (Hatcher et al., 2002); difficulty remembering and organising timetable, planning study time, or essays (Reid, 2011). Coordination problems (Pavlidis, 2013).

Eye Movements Problems
Abnormal eye-movements, *e.g. pauses, regression, backward movements* (Critchley, 1981; Pavlidis, 2013).
Career
Employed in positions that will be able to hide difficulties or not require dealing with reading and writing (Stampoltzis & Polychronopoulou, 2008).
Limited career opportunities (Bell, 2010).
Thrives in careers, where visual-spatial talents can be realised, *e.g. entrepreneurs, engineers, architects, artisans, actors, trades, business executives, etc.* (Pavlidis, 2013; IDA, n.d.).
In jobs often work well below capacity (Bell, 2010).
Conceal difficulties from co-workers (MacDonald, 2009).
Disadvantaged when functioning in the workplace; fear of embarrassment (Bell, 2010).
Secondary psycho-social problems
Increased levels of frustration and annoyance (Hatcher et al., 2002).
Easily stressed and overwhelmed (Pavlidis, 2013).
Low self-esteem and self-confidence (Riddick et al., 1999; Hatcher et al., 2002).
Feels less competent than others (Riddick et al., 1999).
Recalls negative memories from school (Hellendoorm & Ruijessennaars, 2000).
Does not feel motivated and confident (Rack, 1997).
Emotional and social problems (Bell, 2010).
Behaviour, Health & Personality
Highly intuitive, reading people (IDA, n.d.).
Failure to realise the consequences of their speech or actions (BDA, n.d.).
Confusion, stress, health problems, time pressure and fatigue significantly increase symptoms (Pavlidis, 2013).
Areas of strength

Bright, inventive, creative.
Problem solving, lateral thinking abilities.
Originality, great perseverance and determination (Pavlidis, 2013).
Exceptional visual-spatial talents (Kulkarni et al., 2001).

Generally, as dyslexia is a lifelong condition, there are difficulties that are still evident even after the end of schooling, while some symptoms may be limited as the child grows up. According to Shaywitz (1998), the reading skills of dyslexic readers become more accurate over the passage of time, but they never become automatic, as occurs in skilled readers. As children reach adolescence, a slow reading speed is the main manifestation of dyslexia. Young adults may read accurately, but not fluently or automatically. That is why sometimes they are wrongfully thought to have outgrown their dyslexia (Shaywitz et al., 1999). Therefore, Shaywitz (1998) suggests that tests measuring reading accuracy alone are not adequate for the diagnosis of dyslexia in dyslexic students, whereas measurements of reading speed should be used as a measure of reading automaticity.

Similarly, according to Simmons and Singleton (2000), in higher education, dyslexics may have acquired reading abilities or develop strategies to compensate for word recognition difficulties, but they usually exhibit significant difficulties in other areas, such as taking lecture notes, writing essays, comprehending large volume of complex text. Besides, such strategies were probably necessary for them, in order to meet the admission criteria for university (Mortimore & Crozier, 2006). Bell (2009) argues that adult dyslexics may have learnt to read with varying degrees of efficiency, but spelling will be always arduous for them.

Mortimore and Crozier (2006) found that the most frequently cited difficulties of dyslexic students in higher education were taking notes, organising essays and expressing their ideas in written, with more that 70% of their dyslexic participants reporting that they suffer from such difficulties. Furthermore, 64% of the dyslexic group indicated that they still experienced difficulties with the speed of reading, while only 24% reported problems with expressing their ideas orally and 40% with listening. Comparing the self-reported symptoms of dyslexics across all educational levels, Mortimore and Crozier concluded that although some of their difficulties decrease with age, they still remain problems for most university students with dyslexia.

Rack (1997) highlights the development of “secondary symptoms” over the years in adult dyslexics, which could complicate or hide the primary symptoms. Such secondary consequences could be the lack of reading and writing experience and practice, poor study habits, as well as socio-emotional consequences like low self-esteem, low achievement motivation or depression. Riddick et al. (1999) found significantly lower levels of self-esteem in a group of adult dyslexic students compared to controls, whereas the former were feeling less competent in their written work and their general academic performance.

Pope and colleagues (2006) were interested, among others, in the reluctance of dyslexic students to seek for help to accommodate their difficulties, even though support services were available in most institutions. Investigating the reason of such an attitude they came across the following answers: dyslexic students did not want to be labeled or judged, they were embarrassed, they did not know where to seek for help, they felt that they could not be helped, or they thought that nobody was interested in providing support.

According to Stampoltzis (2007), year-after-year dyslexics’ difficulties may be limited. By adulthood, many dyslexics develop compensatory strategies through assistive technology and reliance on others for reading and spelling, in order to respond to the challenges of adult life and workplace. Dyslexic adults may succeed in their professional life, especially if their job does not require high written language skills. Besides, their positive features, such as intelligence, problem-solving abilities, creativity, critical thinking, reasoning skills, etc., help them fight against their weaknesses (Shaywitz & Shaywitz, 2005). For instance, the use of context is a strategy used by most dyslexics to compensate for their decoding deficit.

Kirby and colleagues (2008) compared a group of dyslexic university students to a group of normal achieving readers in terms of the learning strategies and study approaches they use. They suggested that the greater use of study aids and time management strategies reported by dyslexics as well as the adoption of a deep learning approach compared to controls could be considered as compensatory strategies, in order to deal with the difficulties they encounter.

The potential for reduction of the symptoms of dyslexia in adults also underlies the definition given by Critchley (1981), who argues that dyslexia is a lack of maturity, which tends to reduce over the years and is open to significant improvement, especially if appropriate support is offered. Besides, if the severity of the symptoms could not be limited, there would be no reason for any dyslexic to seek for expert help. And, undoubtedly, the earlier the diagnosis, the more effective the treatment will be.

Furthermore, there is much research evidence suggesting that dyslexics can compensate for their difficulties. According to Lefly and Pennington (1991), although someone diagnosed as dyslexic in childhood remains dyslexic throughout his entire life, he occasionally compensates for his difficulties in some way and as an adult he is no longer a diagnosable dyslexic. However, they will probably never catch up their peers in terms of literacy skills. Comparing a group of non-diagnosable dyslexics to a group of dyslexics and a group of normal population, Lefly and Pennington concluded that the former significantly differed in their reading and spelling performance from both the dyslexic and the control group, although their skills tended more to those of non-dyslexics.

More recently, Ransby and Swanson (2003) compared the reading comprehension skills of a group of adults with childhood diagnosis of dyslexia to 2 groups of normal population *(chronological age and reading age-matched)*. Results indicated that dyslexics scored lower than the normal readers matched for chronological age, but higher compared to the reading age-matched normal controls. Such a finding indicates that dyslexics, even in certain skills, develop and tend to be improved over the years.

Finally, Snowling, Goulandris and Defty (1996), in their longitudinal study, observed the development of dyslexic children in reading and spelling from $7^{1/2}$ to $12^{1/2}$ years old. During that time, dyslexic children made some progress, although insignificant in comparison to non-dyslexics. However, even that little progress during 5 years of observation allows the assumption that the weaknesses of dyslexics could be improved even minimally over the time.

In conclusion, effective remediation or compensation could account for reduced intensity of symptoms in some dyslexic adults at least. However, this is not the case for all dyslexics and, undoubtedly, it depends on the early diagnosis and the appropriate treatment methods. It is noteworthy though that, despite the potential decrease in the severity of the symptoms of dyslexia manifested, the parameter that remains unchanged over time is the extremely slow reading speed, irrespective of age and spoken language (Pavlidis, 2013).

3.1.14. Reading Performance of Adult Dyslexic Students & Normal Controls

Few studies until now have compared the reading performance of adult dyslexic university students and normal controls in English (Hatcher et al., 2002; Hanley, 1997; Bruck, 1990; Snowling et al., 1997; Ramus et al., 2003; Simmons & Singleton, 2000, etc.), which is a phonologically inconsistent language, even fewer in other languages (Leinonen et al., 2001; Miller-Shaul, 2005; Lehto & Lehtola, 2000; Laasonen et al., 2012, etc.), while none in Greek, a phonologically consistent language, which is the focus of the current research. Much evidence, however, generally concerns adult population *(not university students necessarily)* with childhood diagnoses of dyslexia and whose native language was English (Felton et al., 1990; Ransby & Swanson, 2003, etc.).

Most studies suggest that, similarly to children, phonological processing difficulties underlie adult developmental dyslexia (e.g. Felton et al., 1990; Bruck, 1993; Hanley, 1997; Snowling et al., 1997, etc.) affecting, except for the reading speed, the accuracy of reading to a significant extent. The regularity of the orthography seems to have an impact on the manifestation of dyslexia in different languages (Lehtola & Lehto, 2000; Laasonen et al., 2012). In regular languages, the consistency of grapheme-to-phoneme correspondence enables relatively accurate decoding (Leinonen et al., 2001), but at the expense of reading speed. For instance, Wimmer (1993) concluded that German-speaking children acquire word-decoding skills with minor difficulty, unlike children who read in English, which is a phonologically inconsistent language. German dyslexics make less reading errors than English (Wimmer, 1993; Landerl et al., 1997). For German dyslexics the extremely slow reading speed seems to be the main persisting deficit, while they can acquire high accuracy levels. Conversely, English dyslexics except for low reading rates – *their reading speed was twice as slow compared to Germans* – they also showed a much more impaired reading accuracy, with error rates reaching even 70% (Landerl et al., 1997). These findings are probably attributed to the different level of consistency that characterise the 2 languages. Similar findings were also reported by Ziegler and colleagues (2003). They found similar reading speed impairments in both German and English-speaking dyslexics, whereas, with regard to reading accuracy, English dyslexics made significantly more reading errors than German *(due to the nature of the English orthography, which permits more reading errors)* and they concluded that there are far more similarities than differences between orthographies. It is noteworthy that the speed deficit of dyslexics, irrespective of language, persists even compared to reading level-matched controls, as opposed to reading accuracy, which did not differ between dyslexics and reading level-matched normal readers (Ziegler et al., 2003). It is undoubted, therefore, that the slow speed of reading is the fundamental manifestation of dyslexia that remains evident irrespective of spoken language and age (Pavlidis, 2013).

Inaccuracy in word and nonword reading tasks is considered a main manifestation of dyslexia among English-speaking children (Lyon, 1995). With regard to adult population, deficits in phonological awareness and inaccuracy in phonological decoding have also been found to characterise adult dyslexics. Most research conducted in the English language reached such conclusions.

Felton and colleagues (1990), aiming to investigate the neuropsychological profile of adult dyslexics, compared a group of reading-disabled adults to a borderline and a non-disabled group. Reading-disabled adults significantly differed on both oral and single word reading measures compared to the borderline and the control group ($p < .05$) as well as on rapid naming and phonological awareness. They also performed significantly poorer on a nonword-reading test ($p < .05$), which was among the tasks *(along with phonological awareness and rapid naming)* that clearly differentiated the reading-disabled from the non-disabled group. Hence, they suggested that the accuracy of nonword reading could have diagnostic value as a predictor of reading disability.

Similarly, Snowling and her colleagues (1997) compared a group of 14 English dyslexic university students (M = 25.5 years old) to a group of 19 non-disabled readers (M = 22.7 years old) on a battery of phonological tests. Statistically significant differences between groups were found on word and nonword reading ($p < .001$) and on most phonological measures, but not on rhyming and repetition tasks, where both dyslexics and controls performed similarly. They concluded that residual phonological deficits remain in adult dyslexics, even those who acquired relatively age-appropriate reading accuracy. Finally, they also suggested that nonword reading should be among the best tests for identifying dyslexia in adult population, as it was associated with one of the largest effect sizes.

Ramus and his colleagues (2003) tested 16 dyslexic university students from UCL in comparison to an equal number of controls on a battery of psychometric, phonological, auditory, visual and cerebellar tests. On all literacy measures dyslexics performed significantly poorer than controls: single word reading accuracy and spelling ($p < .001$), reading speed ($p < .01$), nonword reading speed and accuracy ($p < .001$). Additionally, significant differences between groups were reported on most phonological tasks suggesting that all dyslexics suffered from a phonological deficit.

Hanley (1997) compared the performance of a group of undergraduate dyslexic students at Liverpool University ($N = 33$) in reading, spelling and other measures to a group of normal achieving undergraduates. Dyslexics performed significantly worse on both single word reading and spelling ($p < .01$), whereas the 2 groups did not significantly differ on a picture naming test ($p > .05$). Further significant differences between groups were found in lexical decision *(distinguish between written words and nonwords)*, nonword reading, and homophone definition tests ($p < .01$). Dyslexics were also impaired on a short-term memory task ($p < .05$), while from phonological measures only on a rhyming test significant differences were found ($p < .05$).

Despite the excessive attention given to phonological awareness and inaccuracy of decoding, in several other studies, even in the English language, the most salient feature of adult dyslexia has been slowness in word recognition, whereas most of them concluded that inaccuracy in reading was not as evident as in children. Similarly, in more regular orthographies, slow reading is the main manifestation of adult dyslexia rather than accuracy, which is relatively easily achieved.

Bruck (1990) examined the reading skills of college students with childhood diagnosis of dyslexia ($M = 21$ years old) compared to age-matched ($M = 20$ years old) and reading level-matched normal controls ($M = 11$ years old), in order to identify the impairments associated with their reading disability. Data revealed that adult dyslexics encounter problems with slow word recognition compared to both chronological and reading age-matched controls. In all reading measures *(context reading, words, nonwords, regular or exception words, low and high frequency words, short and long words)*, their reading speed was significantly slower than both control groups'. Regarding the accuracy of reading, in most tasks their error rates were significantly higher compared to age-matched students, but comparable to reading age-matched younger controls. This probably means that, reaching adulthood, dyslexics can relatively accurately recognise a wide range of words. Furthermore, comparisons between single word and context reading indicated that dyslexic students, like less skilled readers, rely heavily on contextual information for successful word recognition. Indeed, dyslexics' word recognition speed and accuracy were highly affected by context *(greater speed and less errors)*, even though they were still slower and less accurate compared to the control groups in both reading conditions. Finally, Bruck concluded that different instruments should be used for the identification and diagnosis of dyslexia in adults. She argues that tests used for children measuring only the reading accuracy are not adequate for adults and suggests the time needed for word identification as a more valid criterion. Besides, as she mentions, reading speed of words and reading accuracy of nonwords are the measures that fully discriminate dyslexics from age-matched controls.

Ben-Dror, Pollatsek and Scarpati (1991) compared a group of dyslexic college students (M = 20.6 years old) to an age-matched (M = 20.9 years old) and a reading level-matched (M = 11.7 years old) control group on a battery of reading measures *(context reading, words, nonwords, regular and irregular words)*. Dyslexics were slower on all tasks. Similarly to the findings of Bruck (1990), dyslexics showed a regularity effect and were based on grapheme-to-phoneme conversion for word recognition. Finally, they were found to rely more on context for successful word identification, like less skilled readers also do.

Decker (1989) compared a group of young adult dyslexics to a matched control group on a battery of cognitive processing rates *(verbal fluency, rapid automatic naming, and* *perceptual speed)*. Their results revealed that dyslexics have persistent deficits in rapid automatic processing, mainly regarding stimuli that require phonetic coding, such as letters, suggesting that reading-disabled young adults show a slower developmental pattern in terms of coding speed. Finally, discriminant analysis showed that reading recognition, spelling, letter naming, and speed of non-words matching as predictors could best discriminate between groups, with the accuracy of classification reaching 94% *(90% of dyslexics and 98% of controls being correctly classified)*.

Hatcher and colleagues (2002) investigated the cognitive skills of 23 dyslexic students (M = 24.11 years old) compared to a group of 50 controls (M = 21.8). They evaluated their literacy skills *(reading, decoding ability, spelling, writing and arithmetic*), as well as their phonological skills, verbal fluency and speed of processing. They found statistically significant differences between groups in all measures indicating that adult dyslexics show impairments in reading and reading-related skills. As far as it concerns reading skills, dyslexic students performed significantly worse in single word reading, speed and accuracy of nonsense passage reading ($p < .001$). Furthermore, it took longer for dyslexics to silently read a passage administered to them ($p < .01$). Finally, using discriminant analysis, they tried to ascertain the tests that could best differentiate between dyslexics and controls. They resulted in nonword spelling, writing speed, nonword reading and short-term memory with the accuracy of classification reaching 95.9% *(95.7% dyslexics correctly classified and 96% controls)* and concluded that a short assessment using the above tests would be useful to "diagnose" dyslexia in adult population. However, based on literacy measures only *(reading, spelling and nonword reading)*, they ended up at classification accuracy of 91.8% *(96% of controls, but only 78% of dyslexics correctly classified)*.

Lehtola and Lehto (2000), in a pilot study aiming to contribute to the development of a dyslexia assessment test for older students, compared the reading and spelling performance of a group of dyslexics (N = 15) to a group of controls (N = 17) from 5 senior high schools in

Finland *(age range 16-20 years old)*. Evaluation procedure included text recoding, nonword recoding, text and nonword spelling. Statistically significant differences were found between dyslexics and controls in all measures *(text reading speed $p < .001$, text reading accuracy $p < .01$, pseudoword reading speed $p < .01$, pseudoword spelling $p < .001$)* except for the text spelling task, where both groups performed equally well. Precisely, dyslexics' reading speed was 20% and 26% slower than controls' in the text and nonword reading tasks, respectively. Correlations between text and nonword reading speed revealed that both were similarly time-limited ($r = -.73$, $p < .001$), whereas the faster readers made less reading errors as shown by the significant negative correlation between the number of errors and text reading speed ($r = -.46$, $p < .01$). They concluded that the slow reading speed was the most typical characteristic of Finnish dyslexics. Regarding reading accuracy, dyslexics made only 3% of reading errors in the text and 15.7% in the nonword reading task, whereas controls 0.9% and 6.3%, respectively with the difference between groups being significant only in text reading. The low rates of errors could be attributed to the regularity of the Finnish language.

Laasonen and colleagues (2012) investigated the existence of subgroups among adult dyslexics in the high transparent Finnish orthography. The clustering of dyslexics based on their reading performance *(speed and accuracy of oral reading)* resulted in 3 subgroups: slow but accurate, highly error-prone *(slow and erroneous decoding)*, and somewhat error-prone *(many self-corrections, which slow down the reading speed)*. 22 out of the 38 dyslexic participants (58%) fell into the first subgroup making "slow but accurate" dyslexics the largest category. Such a distribution indicates that most adult dyslexics are mainly impaired in reading speed and to a smaller extent in reading accuracy, in a shallow orthography at least, suggesting that reading accuracy is not necessarily impaired in adult dyslexics. Besides, all 3 subgroups were slower than controls on all reading measures, whereas with regard to reading accuracy the slow group was not less accurate compared to controls. It is also noteworthy that from the 3 subgroups that resulted, only the slow-but-accurate one had difficulties in reading comprehension, while the other 2 did not. They concluded that the distinction into slow and error-prone dyslexics is generalisable across age and languages, but that, in consistent languages at least, dyslexia is a unitary condition varying in severity.

Similar findings supporting the heterogeneity of adult dyslexia were also reported in a little earlier cluster analysis by Leinonen and colleagues (2001) based on reading speed and accuracy of 84 Finnish dyslexic readers. They also resulted in 3 subgroups: hasty *(many errors)*, hesitant *(slow & some errors)*, and mildly dyslexics *(few errors & relatively faster)*. However, compared to controls, all dyslexic subgroups performed significantly more slowly and less accurately in oral text reading. They suggested that differences in the accuracy of decoding could mainly discriminate between dyslexics and controls as well as among the different dyslexic subgroups, although, compared to English-speaking readers, Finnish dyslexics produced far less reading errors. Finally, investigating the reading habits of adult dyslexics, they concluded that the slower the reading speed, the more the aversion for reading in everyday life. Such a finding highlights the importance of reading speed.

Miller-Shaul (2005) investigated the characteristics of Hebrew-speaking 4^{th} grade children and adult dyslexics *(university students)* in terms of their reading and reading-related skills compared to normal readers. Adult dyslexic students were significantly slower in both text and single word reading ($p < .05$ and $p < .001$, respectively) as well as less accurate ($p < .05$) compared to the control group. Further significant differences between groups were found on most phonological measures, speed of processing and memory tasks. As shown by the effect sizes calculated for both young and adult dyslexics, the gap between dyslexics and controls that was maintained the most unchanged, despite the print exposure and remedial teaching, with a tendency to increase over the years was in the speed of single word reading *(effect size: 1.24 for children and 1.30 for adults)*. On the contrary, the gap between dyslexics and controls in terms of reading errors and reading speed in context decreased with age – *meaning that reading accuracy and speed in context increase over the years* – possibly suggesting dyslexics' reliance on compensatory strategies. Miller-Shaul concluded that dyslexia could be characterised as an inaccurate and slow reading process including difficulties in phonological processing *(slow processing)*.

Another research that came from Hebrew-speaking population was that of Meyler & Breznitz (2003), who compared 18 dyslexic college students to 19 normal readers. They found that adult dyslexics were significantly slower ($p < .001$) and less accurate ($p < .01$) on a word reading task, whereas in text reading, they were significantly slower compared to controls but only when reading silently ($p < .01$). Furthermore, dyslexics were not impaired in reading comprehension (neither aloud nor silently). They concluded that the primary deficit of adult dyslexics was slow speed of processing, while they were quite accurate on most measures.

Regarding reading comprehension of adult dyslexics, even less studies have been carried out, whereas there is no much consistent evidence on how well adult dyslexics comprehend written material, as outcomes from different studies do not always converge. As discussed earlier (p.168-169), most studies consider dyslexics' reading comprehension as a direct result of their decoding deficit. Other studies suggest that there is no strong association between word recognition skills and reading comprehension for dyslexic adults, as indicated by the comparable performance of dyslexics and controls on reading comprehension tasks, or that another deficit may impair their reading comprehension.

Miller-Shaul (2005), for instance, did not find significant differences between dyslexics and controls in the level of comprehension they attained. Reading comprehension was evaluated with multiple-choice questions on a text they have read aloud and it was calculated as the percentage of correct answers. Meyler & Breznitz (2003) did not find significant comprehension differences between dyslexics and controls *(neither in aloud nor silent reading)*. Similarly, Reid and colleagues (2007) did not find significant differences with regard to reading comprehension between their dyslexic sample of Polish university student and controls, after having read 2 passages silently. Lefly and Pennington (1991) noticed that some adult dyslexics of their adult sample with childhood diagnoses attained reading comprehension levels similar to those of age-matched normal controls and they estimated that almost 25% of reading-impaired children reach adulthood with no evident reading comprehension difficulties. Bruck (1990) concluded that several adults with childhood diagnosis of dyslexia achieved age-appropriate scores on reading comprehension tasks. Laasonen and colleagues (2012) found that, from their 3 subgroups of adult dyslexics, only the Slow-but-accurate group was significantly impaired in reading comprehension compared to the control group, while the other 2 answered in comparable number of questions as controls did.

Simmons and Singleton (2000) investigated the reading comprehension skills of dyslexic university students. They compared a group of adult dyslexic students (N = 10, M = 27.6 years old) to a group of controls (N = 10, M = 21.4 years old). Both groups, after having silently read a relatively complex text, had to answer to literal (multiple choice) and inferential questions. Results revealed that dyslexics performed comparably to controls on the literal questions ($p > .05$), whereas they performed significantly worse on the inferential questions ($p < .05$) indicating their difficulty to process complex reading material. These comprehension difficulties were not attributed, however, on the decoding deficit that characterise dyslexics – *if decoding inability was responsible, then dyslexics should perform worse on both literal and inferential questions* – but in poor decoding automaticity and working memory. This was further confirmed by the lack of significant correlation between decoding score and literal questions, meaning that even dyslexics who were unable to accurately decode could answer the questions, whereas a moderate positive correlation between decoding score and inferential questions was found, suggesting that individuals with poorer decoding skills have impaired comprehension. They concluded that poor decoding automaticity forces dyslexics to devote extra effort for decoding (slow down), which overstrains the already limited working memory, and, as a result it draws resources away from other tasks, such as reading comprehension. Their results are not consistent with most current views, as discussed earlier, that consider reading comprehension difficulties as a direct result of the decoding deficit of dyslexics.

Ransby and Swanson (2003) compared the reading comprehension performance of a group of young adults with childhood diagnoses of dyslexia to a group of age-matched and a group of reading level-matched controls. Results revealed that adult dyslexics attained significantly lower level of comprehension compared to age-matched normal readers in both standardised tests of reading comprehension accuracy *(the first followed silent reading of several passages and the second aloud reading of several passages of raising difficulty)*, but they showed comparable comprehension level to the younger reading level-matched control group. They concluded that the reading comprehension of reading-disabled adults is moderated not only by weak word recognition skills, but also by several other cognitive deficits, such as in vocabulary, working memory, and listening comprehension, which play just as important a role.

3.1.15. Focus of the present study

Looking at the existing literature, one could find out that few studies until now have compared the reading performance of adult dyslexic students and normal controls in English – *phonologically inconsistent language* – (Hatcher et al., 2002; Bruck, 1990, etc.; Hanley, 1997, Snowling et al., 1997, etc.) even fewer in other languages (Lehtola & Lehto, 2000;Miller-Shaul, 2005, etc.) and none in Greek – *phonologically consistent language*.

More specifically, most studies conducted in English focused on deficits in phonological awareness and inaccuracy in phonological decoding. However, they did not fully investigate the relationship between reading speed and adult dyslexia. On the other hand, in more regular orthographies, studies concentrated on the slow reading speed as the main manifestation of dyslexia without accuracy being necessarily affected (Wimmer, 1993;

Landerl et al., 1997; Ziegler et al., 2003). Nevertheless, these studies involved children population, while few were the studies that referred to adult population (Lehtola & Lehto, 2000; Laasonen et al., 2012). Interestingly, no studies have ever investigated the reading speed, accuracy and comprehension skills of adult dyslexic (university) students in Greek.

Greek language *(phonologically consistent and transparent language)* has a lot of differences compared to other languages like English *(phonologically inconsistent and less transparent)* (Pavlidis & Giannouli, 2003). These differences may affect the reading process and strategies that Greek students, and dyslexics, in particular, use. Thus, there may be differences compared to research in other languages regarding the reading speed as well as the amount and kind of reading errors that mainly dyslexics do.

It is crucially important to investigate the speed, accuracy and comprehension of dyslexic students because, unlike other dyslexic adults, the dyslexic undergraduate and postgraduate students keep spending a great amount of time reading. As reading is an essential duty of students, it is compulsory for them to read extensively in order to perform well. If dyslexia were not a biological condition and could be treated, dyslexic students, at least, should have overcome their constitutional reading deficit, due to greater familiarity with print and through daily practice.

This research project addresses exactly this problem, namely whether dyslexic students overcome their reading difficulties and reach a normal speed, accuracy and comprehension for their age or, irrespective of their extensive practice in reading, they still continue to read characteristically slowly with possible inaccuracies and/or difficulties of comprehension.

It is noteworthy and of particular interest and importance to study the reading performance of university students (undergraduate and postgraduate), especially in a phonologically consistent language like Greek, because any phonological barriers that could be negatively affecting the reading performance in inconsistent languages do not exist in consistent ones and, therefore, their reading performance should be similar to the one expected for normal readers. This exactly is the point of investigation of this study, namely to illuminate whether a phonologically consistent language coupled together with the multi-year consistent reading practice, that leads to increased familiarity with print, minimises or eliminates the reading problem that characterises dyslexia.

Based on the research evidence, one should expect that even adult dyslexic students would be less proficient readers in terms of speed, accuracy and comprehension compared to normal controls. Especially, the investigation of the reading speed was of major interest, in order to find out whether this study would provide further support for research findings that come mainly from consistent languages, indicating that reading speed is the main discriminating factor between dyslexic and non-dyslexic students and the main persisting deficit of dyslexics.

Additionally, dyslexics are expected to have superior reading performance in context reading compared to reading out of context (list of words). Besides, it is widely known that dyslexics rely largely on context for successful word identification (Shaywitz & Shaywitz, 2005; Shaywitz, 1998; Bruck, 1990). The presence of many unfamiliar words out of context is expected to negatively affect their reading performance.

Thus, the aim of the second research project designed was to find out in what aspect – parameters of reading adult dyslexic students performed worse than non-dyslexics and to what extent reading in context and out of context affects their reading performance. Gaps in the existing literature led to the formulation of the research hypotheses presented in the following chapter.

3.2. METHODOLOGY

3.2.1. Hypotheses

Comparing a group of Greek adult dyslexic students to a group of matched for age, sex and socio-educational level normal controls, the following series of hypotheses and null hypotheses were set up:

1) H_1: Dyslexics will make more reading errors (quantity) than controls, when reading Greek texts.

H_0: Dyslexics will not make more reading errors (quantity) than controls, when reading Greek texts.

2) H_1: Dyslexics will make different kind of reading errors (quality) than controls.

H_0: Dyslexics will not make different kind of reading errors (quality) than controls.

3) H_1: Dyslexics will read more slowly than controls in all reading materials.

H_0: Dyslexics will not read more slowly than controls in all reading materials.

4) H_1: Dyslexics will attain lower level of reading comprehension than controls.

H_0: Dyslexics will not attain lower level of reading comprehension than controls.

5) H_1: Within each group, there will be differences in reading speed, comprehension and accuracy among the different reading materials:

- Easy text
- Difficult text
- List of Words

H_0: Within each group, there will not be differences in reading speed, comprehension and accuracy among the different reading materials:

- Easy text
- Difficult text

- List of Words

6) H_1: Within each group, participants will read faster and comprehend better in the silent than in the aloud condition.

H_0: Within each group, participants will not read faster and comprehend better in the silent than in the aloud condition.

7) H_1: Dyslexics will be accurately discriminated on reading speed accuracy and comprehension from controls.

H_0: Dyslexics will not be discriminated on reading speed, accuracy and comprehension from controls.

3.2.2. Design

As discussed earlier, the present study is an "experimental" research, as far as the independent variable is controlled and manipulated by the researcher (for more details see p.50-51). In the current study, the independent variable was the different levels of the grouping variable (dyslexics & non-dyslexics), while the set of dependent variables were the categories and subcategories of reading errors, reading speed and comprehension.

Similarly to the first research project, the current experimental design is a "Between Groups" design, because data derived from different groups of participants. The aim was to test the differences between the levels of the grouping variable (independent variable) on each dependent variable. However, as it would be of major interest and importance to investigate how each group behaved under the different reading conditions, analyses at a "Repeated Measures" design *(same participants exposed in different experimental conditions)* were also carried out.

3.2.3. Participants

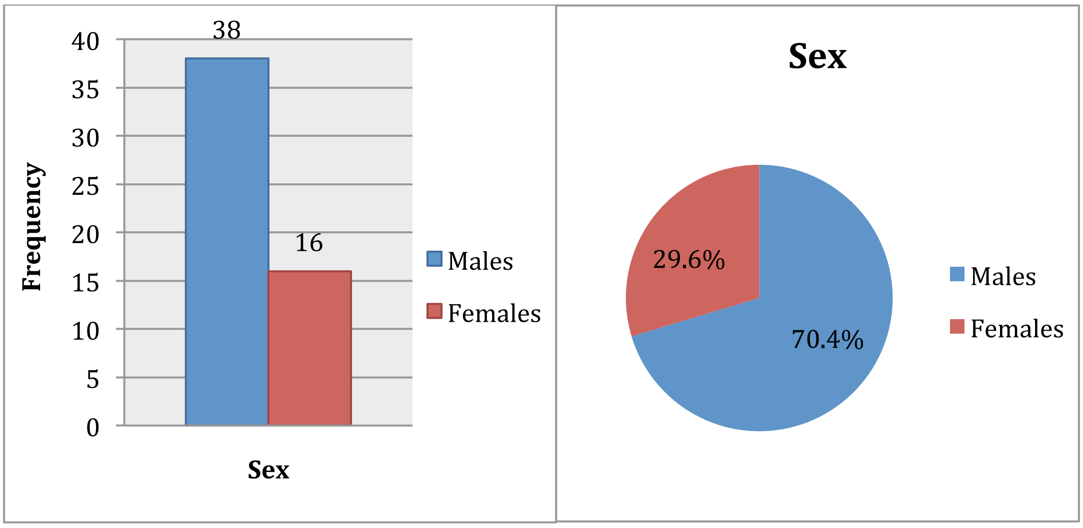
Fifty-four (54) Greek University students took part in the current research. All participants were either undergraduate or postgraduate students in Greek Universities, most of them studying in the broad urban area of Thessaloniki and Larissa, Greece. Thirty-eight (38) of them were males and sixteen (16) females, representing percents of 70.4% and 29.6%, respectively.

Table 1. Male & female participants

SEX	Frequency	Percent	Valid Percent	Cumulative Percent
Male	38	70.4	70.4	70.4
Female	16	29.6	29.6	100.0
Total	54	100.0	100.0	

Table 1 shows the frequency of male and female University students participating in the present study along with the percent represented by each sex. As obvious, the majority of the participants were males, namely 38 (70.4%) compared to 16 (29.6%) females (see also figure 1).

Figure 1. Number & percentage of male & female participants



For the needs of the research they were divided into 2 groups:

1. The first group consisted of twenty-six (26) University students with dyslexia, representing a percentage of 48.1% among all participants (see table & figure 2). Eighteen (18) of them were males, while the remaining eight (8) were females (see table & figure 3). Their age ranged from 17.9 up to 35.1, mean age 22.1 years old, SD 4.26 (see table & figure 4).
2. The second group consisted of twenty-eight (28) non-dyslexic University students matched for age, sex and socio-educational level, representing a percentage of 51.9% among participants (see table & figure 2). Twenty (20) of them were males and eight (8) females (see table & figure 3). Their age ranged from 18.2 up to 35.3 years old, mean age 22.0, SD 3.91 (see table & figure 4).

Table 2. Participants per group

GROUP	Frequency	Percent	Valid Percent	Cumulative Percent
Dyslexics	26	48.1	48.1	48.1
Controls	28	51.9	51.9	100.0
Total	54	100.0	100.0	

Table 2 shows the frequency of dyslexic and non-dyslexic students participating along with the percent represented by each group. Approximately the same number of dyslexics (N = 26) and non-dyslexics (N = 28) took part in the current research, representing percents of 48.1% and 51.9%, respectively.

Figure 2. Number & percentage of participants per group

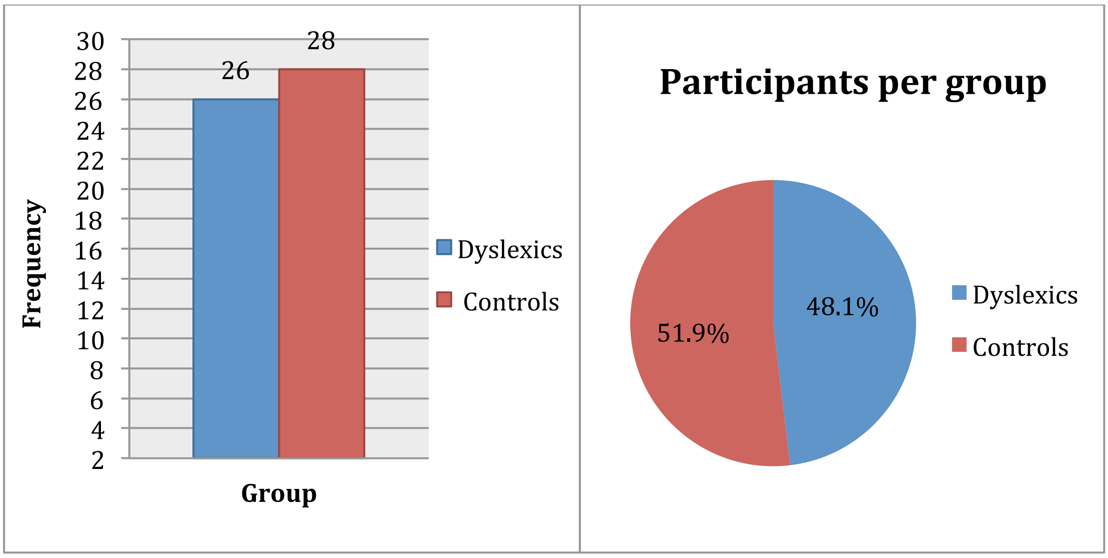
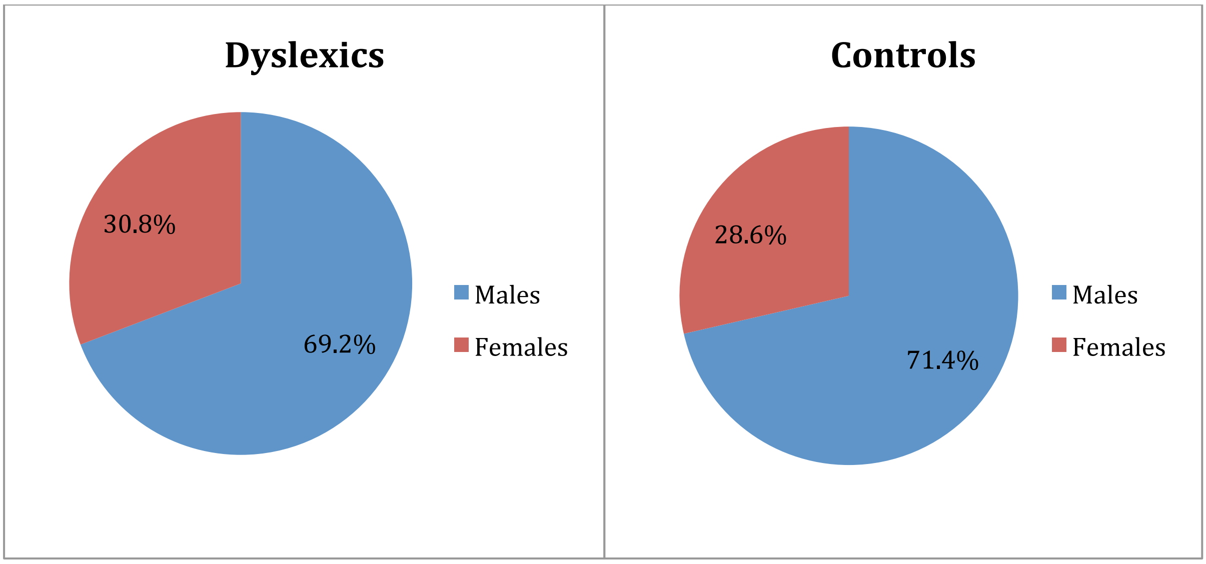


Table 3. Male & female participants per group

SEX / GROUP		Frequency	Percent	Valid Percent	Cumulative Percent
Dyslexics	Male	18	69.2	69.2	69.2
	Female	8	30.8	30.8	100.0
	Total	26	100.0	100.0	
Controls	Male	20	71.4	71.4	71.4
	Female	8	28.6	28.6	100.0
	Total	28	100.0	100.0	

Table 3 shows the frequency of male and female participants per group along with the percent represented by each sex in each single group. In both groups, the vast majority of participants were males, namely 18 (69.2%) and 20 (71.4%), respectively, compared to 8 females in both the former (30.8%) and the latter (28.6%) group (see also figure 3).

Figure 3. Number & percentage of male & female participants per group



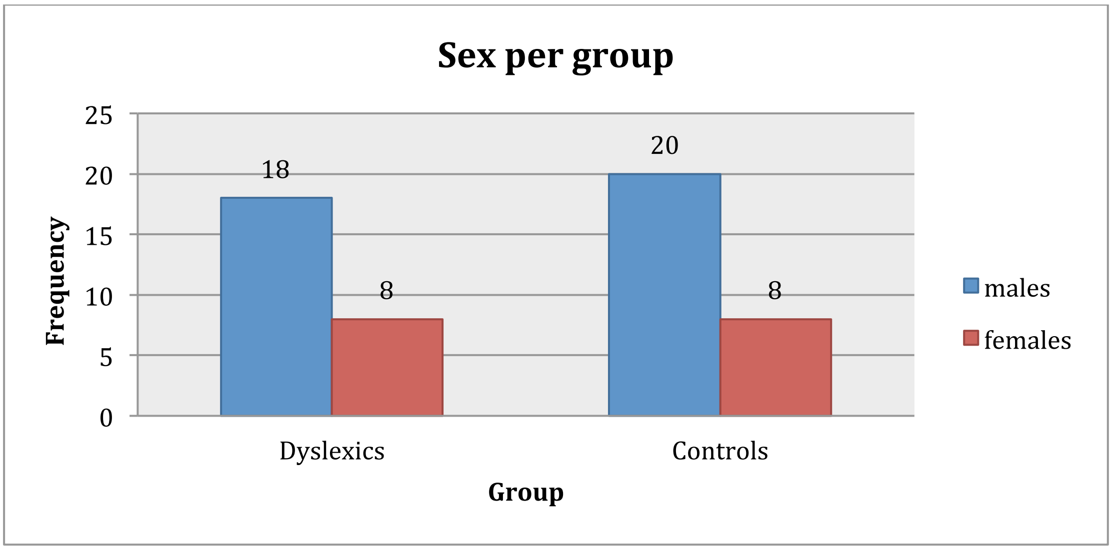


Table 4. Mean age per group

GROUP	N	Range	Minimum	Maximum	Mean	Std. Deviation
Dyslexics	26	17.2	17.9	35.1	22.1	4.26
Controls	28	17.1	18.2	35.3	22.0	3.91

Figure 4. Age range per group

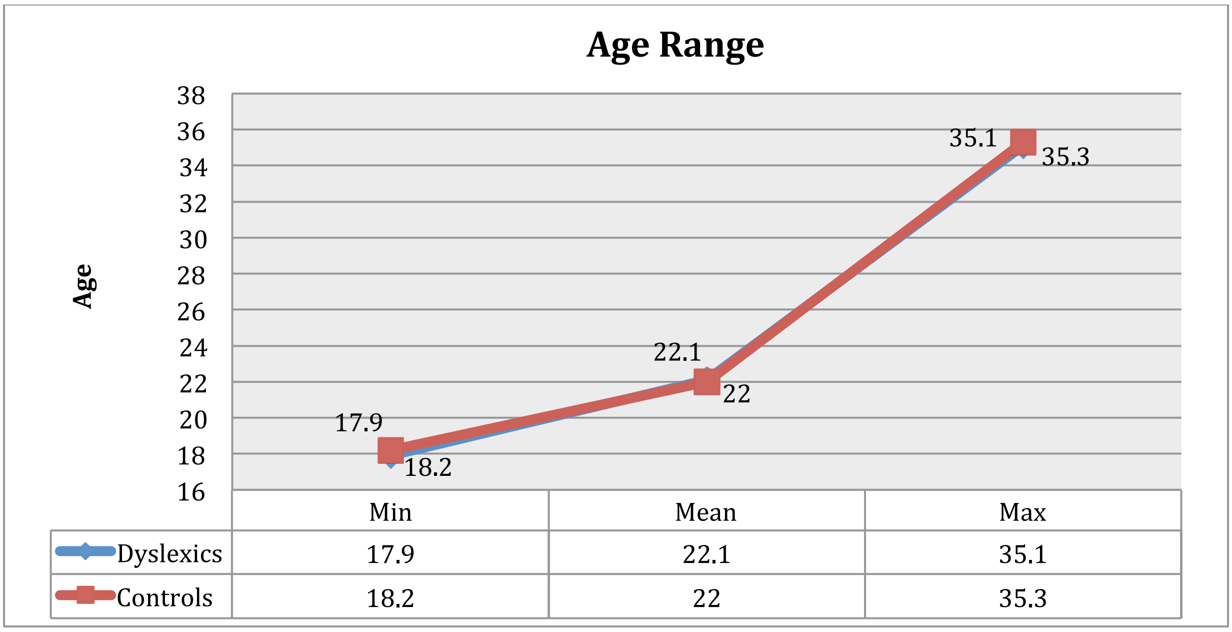


Table and figure 4 show the mean age of both groups along with the minimum and maximum age values defining the age range per group. As obvious, dyslexic university students and normal controls were roughly matched for age, mean age 22.1 and 22.0 with an age range of 17.2 and 17.1, respectively. The youngest dyslexic participant was 17.9, while the youngest non-dyslexic was 18.2 years old. Conversely, the oldest participant was 35.1 years old for the group of dyslexics and 35.3 for controls.

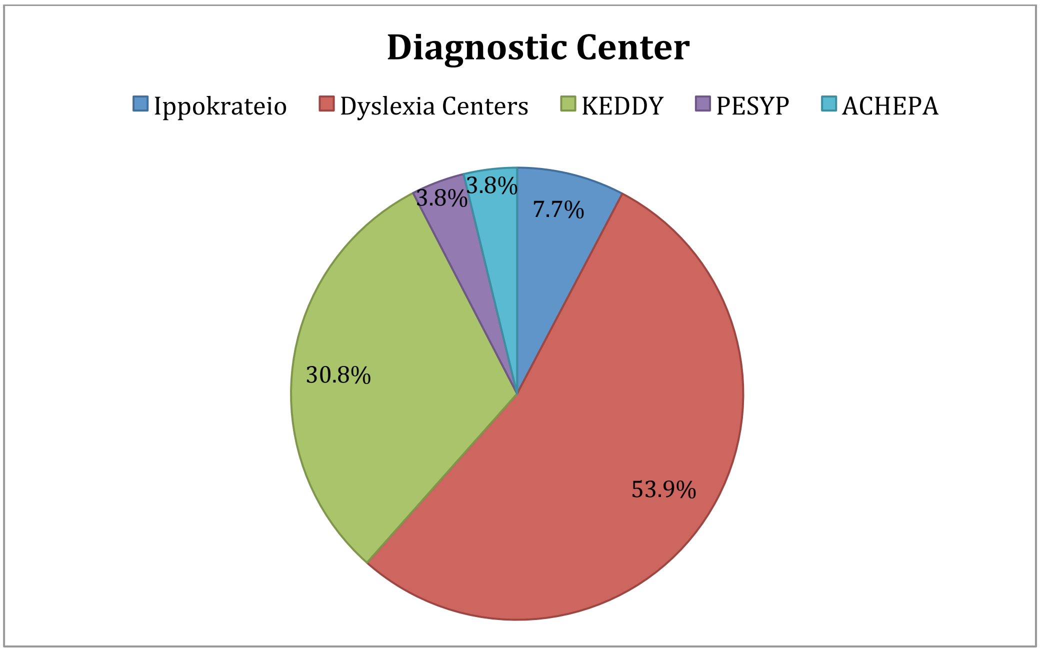
All dyslexic participants had a formal diagnosis from either public or private diagnostic centers of Greece. Having a formal diagnosis of dyslexia was prerequisite for their participation. The following table indicates the diagnostic centers from which dyslexics obtained their diagnosis.

Table 5. Diagnostic centers

DIAGNOSTIC CENTER	Frequency	Percent	Valid Percent	Cumulative Percent
Ippokrateio	2	7.7	7.7	7.7
Dyslexia Centers	14	53.8	53.8	61.5
KEDDY	8	30.8	30.8	92.3
PESYP	1	3.8	3.8	96.2
ACHEPA	1	3.8	3.8	100.0
Total	26	100.0	100.0	

Table 5 shows the frequency of dyslexic participants that were diagnosed by each of the five diagnostic centers given in the first column along with their corresponding percent. It is obvious, that more than half of dyslexic students participating, namely 14 out of 26 (53.8%), were diagnosed in Dyslexia Centers - Pavlidis Method, followed by 8 (30.8%) diagnosed by the public diagnostic centers KEDDY. Only 2 (7.7%) obtained their diagnosis from Ippokrateio Hospital, while the remaining 2 (3.8% each) were diagnosed by PESYP and ACHEPA (see also figure 5 below).

Figure 5. Percentage (%) of dyslexics diagnosed by each diagnostic center



3.2.4. Sampling Method & Participants' Selection Criteria

As mentioned before (p.55), carefully deciding on the sampling strategy to be used as well as on the sample size is crucial, as it is sometimes arduous to gain access to the whole target population (Cohen, Manion & Morisson, 2009).

All dyslexic participants were selected based on the "Quota" sampling method, in order to satisfy certain inclusion criteria (Pavlidis, 1990), which are in detail described below. A non-probability or purposive sampling method like "Quota" was used, as, in contrast to probability methods, where all members of the wider population have equal chances of being selected to participate, only some members had the chance of being included in the sample (Cohen, Manion & Morisson, 2009). To be more precise, "Quota" sampling method seeks to represent significant characteristics of the wider population, but in the proportions that these characteristics can be found in that population (Cohen, Manion & Morisson, 2009, p.114). Thus, all participants included in the present research had certain characteristics, in order to be representative of those found in the wider population of adult dyslexic University students and normal controls, described in detail below.

According to Cohen, Manion & Morisson (2009, p.114), *"a quota sample seeks to give proportional weighting to selected factors, which reflects their weighting in which they can be found in the wider population"*. Precisely, regarding the selection of the dyslexics' group, it is widely accepted that dyslexics display a ratio of approximately 3-4 males to 1 female (Pavlidis, 1990; Pennington, 1990; Miles et al., 1998; Beaton, 2004). Therefore, this ratio should be reflected in the sample of the target population. Thus, following the proportion 3-4:1, eighteen (18) out of the twenty-six (26) dyslexic participants were males and eight (8) were females.

Wondering whether twenty-six (26) dyslexic students were adequate so as the sample to be representative of certain characteristics of the wider population of University students with dyslexia, some simple calculations have been made to prove it. The minimum number of participants required in a “Quota” sampling can be determined as follows: It is necessary at first to calculate the total number of dyslexic students in Greek Universities. According to Stampoltzis and Polychronopoulou (2008), the percentage of dyslexics in higher education was estimated to be around 0.16%, much lower, however, than the incidence of dyslexia in the general population (3%-5%). Rotsika and colleagues (2007) also confirm this percentage, as they mention that, in 2006, from 66177 out of a total of 79155 candidates, who entered higher education *(numerical data obtained by the Greek Ministry of Education)*, only 167 were dyslexics *(from a sample of 420 dyslexics examined in 8 out of 28 marking centers in areas throughout Greece of different socio-economic background*), representing a percentage of 0.2%. This means that the number of dyslexics entering Universities every year does not exceed this extremely low percentage. According to the Greek Ministry of Education and Lifelong Learning, in 2010, the total number of students throughout all Greek Universities was about 600,000 (596,964). Hence, the number of dyslexic students is estimated at around 1000. From these 1000 dyslexic students, keeping with the gender ratio (3-4 males:1 female), there should be on average 775 males and 225 females. The proportions of males and females being 7.75:2.25, a minimum of 10 participants (7.75+2.25) would be required in the sample (Cohen, Manion & Morisson, 2009, p.114). However, recognising that this is just a minimum, a sample of twenty-six (26) dyslexic University students were selected to participate in the research. After the selection of the dyslexic group, twenty-eight (28) non-dyslexic students matched for age, sex and socio-educational level were selected as the control group.

The majority of adult dyslexic students were obtained from “Dyslexia Centers – Pavlidis Method” located all over Greece and Cyprus, which function under the direction and management of Prof. G. Th. Pavlidis. All dyslexics were evaluated by Prof. Pavlidis and his colleagues based on all the appropriate tests as well as his clinical experience of more than thirty years. All necessary information was provided from a database of thousands of pupils who attended the Centers. The rest were selected from Universities and Technological Educational Institutions of the broad urban area of Thessaloniki and Larissa, Greece.

Both groups consisted of individuals of similar IQ, socio-economic background and educational history. Moreover, they were matched based on ethnicity, nationality and mother tongue (Greek), while within each group they also had the same experience, so as to establish that the groups were different from each other only in the task under study (Pavlidis, 1990).

3.2.5. Inclusion Criteria

Both groups had to fulfill the following criteria, as stated in Pavlidis (1990):

i) Normal IQ *(average or above average)*

ii) Normal or corrected vision and hearing

iii) Greek being their native language

iv) Average or above average socio-economic background: Individuals from the lowest socio-economic status were excluded from the study, in order to minimise any potential social adversity. Thus, participants should have at least one employed parent or be employed themselves, while at least one of their parents should have graduated from high school.

Table 6(a). Dyslexics' socio-economic background

Dyslexics	Parents' employment history		Parents' education history	
	Both parents employed	One parent employed	Both parents high school graduates	One parent high school graduate
	62%	43%	54%	46%

Table 6(b). Controls' socio-economic background

Controls	Parents' employment history		Parents' education history	
	Both parents employed	One parent employed	Both parents high school graduates	One parent high school graduate
	64%	38%	57%	43%

v) Adequate educational opportunities

vi) Not on any psychoactive medication known to affect cognitive processes or within its washout period

vii) No overt emotional problems, which influence their performance

viii) No overt neurological handicaps that could account for reading problems *(i.e. brain injury, brain malformation, brain tumor, seizure)*

All the above criteria were applied for the selection of both groups, and dyslexics in particular, except for the first, which is related to intelligence and behaviour. With regard to the dyslexic group, their IQ was not tested, because they all had formal diagnoses of dyslexia and IQ measurement is an essential component for the diagnosis to be successfully made. Regarding non-dyslexic students, their IQ wasn't tested, because, as the control group consisted of normal and high-educated population, they were expected to have at least normal intelligence.

An additional criterion was applied for the inclusion of adult dyslexic students. Having a formal diagnosis from a recognised public or private diagnostic center was required for their participation. Students without a formal diagnosis were excluded from the research.

The control group was roughly matched for age, sex and educational history to dyslexics. They neither differ in their socio-economic background nor were drawn from socially disadvantaged or educationally indifferent homes.

3.2.6. Sampling Areas

Participants were selected from the broad urban area of Thessaloniki and Larissa, Greece. The specific areas were chosen for the sampling, because:

- Thessaloniki is the second largest city in Greece with its population exceeding 1.000.000 residents. Larissa is among the five biggest cities and the mean socio-economic background is average or above average, as aforementioned.
- There are both Universities (H.E.I.) and Technological Educational Institutions (T.E.I.) based in both areas. For instance, Aristotle University of Thessaloniki is the most multitudinous University throughout Greece counting approximately 95000 students coming from the entire Greek territory. Similarly, the Technological Educational Institutions of both areas are among the largest in Greece counting more than 6000 students.
- The access to the sample was easier, while at the same time it wasn't extra time or money consuming (Cohen, Manion & Morisson, 2009).
- "Dyslexia Centers – Pavlidis Method" of Thessaloniki and Larissa provided an adequate number of dyslexic students to participate.

3.2.7. Participants & Ethical Consideration

As discussed in the previous chapter, all ethical procedures were faithfully followed during the conduct of the present study. For a more detailed description of all ethical matters taken into account in the framework of the research see the corresponding section of the previous chapter (p. 60-62).

3.2.8. Gaining Access to the Sample

As aforementioned, more than half of adult dyslexic students were collected from "Dyslexia Centers-Pavlidis Method", which were founded by Prof. Pavlidis and function under his continuous supervision. Prof. Pavlidis willingly gave his permission to get access and gather information from his database of thousands of students. Thus, those willing to participate and to whom access was feasible were selected. The rest were collected from Universities of the broad urban area of Thessaloniki and Larissa, Greece. Gaining access to them was by far more difficult, as the majority of Greek Universities have not official records of their dyslexic students. As a result, they had to be individually and informally identified and asked to participate. However, even when identified, it was sometimes hard to convince them to take part.

As far as the target group concerned adult population (University students), they were individually informed in written about the aims of the research and the experimental procedure (Appendix 3). Furthermore, they became aware of the academic qualifications of the researcher and were given contact details, in case that any matter arose, before being asked for their voluntary participation. Prior to proceed to the main experimental procedure, they were also asked to fill in a questionnaire (developed by Prof. Pavlidis) giving details about their family as well as their developmental, educational and personal history (Appendix 6), in order to guarantee to the greater possible extent the homogeneity of the sample.

Fifty (50) information letters accompanied by the relevant consent forms and questionnaires were sent to the dyslexic students and thirty seven (37) of them, a percentage of 74%, were returned with the questionnaire completed and the consent form signed (Appendices 3, 4 & 6). Then, thirty (30) dyslexic students, who fulfilled all the inclusion criteria, were selected. From them, one was excluded, as Greek was not his mother tongue, although he did not fill in the relevant question of the questionnaire. Two others were excluded after the experimental procedure, because their reading performance was too heterogeneous compared to the group. Finally, another dyslexic decided to withdraw during testing, as he had the right to. Hence, twenty-six (26) dyslexics remained in the group.

The majority of them were willing to participate and found the experimental procedure very interesting in spite of the difficulties they had while reading and even though testing was hard enough for them. Only a few of them were hesitating, something that was totally comprehensible and respectable, as unfortunately in our society dyslexics are frequently treated incorrectly and unfairly. However, after they were ensured that their physical, social and psychological welfare would not be affected by the research and that their personal data would be kept confidential and anonymous, they were convinced to continue.

Similarly, in order to select the control group, the same procedure was followed. All non-dyslexic students were selected from the same Universities as dyslexics. Gaining access to them was much easier. Every undergraduate or postgraduate student willing to participate was given the opportunity. However, it is noteworthy that the control group should be matched for age, sex and socio-educational level with dyslexics and, therefore, it was necessary to have a sufficient number of non-dyslexics, in order to match the two groups as accurately as possible. According to Pavlidis (1990), if we want to obtain valid results, it is really important to employ the appropriate control group, although this is frequently overlooked.

Seventy-five (75) information letters accompanied by the relevant consent forms and questionnaires were sent to the students, who could possibly compose the control group. Sixty-two (62) of them, a percentage of 88.6%, were returned with their informed consent and the questionnaire completed. Then, thirty (30) students matched for age, sex and socio-educational level, who fulfilled all the inclusion criteria, were selected. Two of them were excluded after the experimental procedure, as their reading performance was too heterogeneous compared to the other participants in the group. Thus, twenty-eight (28) non-dyslexics remained in the control group.

The majority of students in the control group were willing and cooperative. They did enjoy the idea of being recorded while reading in front of the microphone and found the experimental procedure amusing. Nevertheless, despite their positive and cooperative attitude, they were reassured that their personal details would remain confidential and that the tapes would be used for the sole purposes of the research. In general, everything possible was done, in order to make all participants feel comfortable and safe during the experimental procedure.

3.2.9. Experimental Procedure

Testing took place in accessible and suitable settings that provided comfortable, private and safe place for both the participant and the researcher *(e.g. the participant's home)*. Participants were individually tested in reading. Based on their performance, reading speed, comprehension and accuracy were evaluated. The majority of them completed the testing in one session, even though for most dyslexics reading is usually painful. The room in which the testing took place was full-lighted, empty and secluded and as away as possible from all other external disturbances (Lehtola & Lehto, 2000). Each participant sat on a desk, where only the reading material, a tape recorder and the microphone of the computer were in front of him, in order to record his performance.

Each participant was asked to read four (4) pieces of Greek texts *(2 texts divided into two halves each)* and he/she was tape-recorded (Appendix 8). The texts were of varying difficulty, but, as terms "easy" and "difficult" are subjective, a pilot study was necessary, in order to be evaluated as such. After a pilot study with ten (10) participants, it was concluded that the first text was easier *(easier words used, more simple syntax, smaller sentences)* for the participants to read *(less reading errors, greater speed)* and understand *(higher level of comprehension)* than the second. Furthermore, both groups read a List of 150 words of raising difficulty (Appendix 8).

Participants read each piece of text while they were timed and tape-recorded for further analysis, in order to find out whether differences exist between groups in terms of reading speed, accuracy as well as the kind and the amount of errors made. After reading each piece of text, they had to answer in relative reading comprehension questions *(5 questions for* *each piece of text),* but without given the opportunity to go back and confirm their answer, aiming to find out the group differences in the level of comprehension (Appendix 8). Moreover, each participant read two out of the four pieces of text aloud whereas the other two silently *(half text aloud & half silently)*, in order to investigate, within each group, whether there are differences in reading speed and comprehension between aloud and silent reading. Finally, each participant read the List of words aloud while being tape-recorded.

The texts were presented in a counterbalanced fashion *(different order for each participant)*, in order to neutralise the possible order effect (see table 7 below). According to Field (2009), participants could perform differently in the second reading condition, because of familiarity with the experimental procedure, tiredness or boredom. By counterbalancing, the possibility that the order could influence their reading performance was minimised or even eliminated (Heim et al., 2008).

Table 7. Dyslexics & Controls: Counterbalanced Fashion

COUNTERBALANCED FASHION

1	Easy 1st half Aloud	Easy 2nd half Silently	Difficult 1st half Silently	Difficult 2nd half Aloud
2	Difficult 1st half Silently	Difficult 2nd half Aloud	Easy 1st half Aloud	Easy 2nd half Silently
3	Easy 1st half Silently	Easy 2nd half Aloud	Difficult 1st half Aloud	Difficult 2nd half Silently
4	Difficult 1st half Aloud	Difficult 2nd half Silently	Easy 1st half Silently	Easy 2nd half Aloud

The duration of the experimental procedure was approximately 25 minutes. Each piece of text was read in about 1-2 minutes, with 2-3 minutes for answering the reading comprehension questions and a resting-preparation time of 1 minute between texts. Finally, the list of words was read in about 3΄-5΄.

Table 8. Duration of the testing procedure

READING MATERIALS		TIME (min)
Easy – 1st half	Aloud or Silent Reading	1 – 2
	Reading Comprehension Questions	2 – 3
	Resting & Preparation	1
Easy – 2nd half	Silent or Aloud Reading	1 – 2
	Reading Comprehension Questions	2 – 3
	Resting & Preparation	1
Difficult – 1st half	Aloud or Silent Reading	1 – 2
	Reading Comprehension Questions	2 – 3
	Resting & Preparation	1
Difficult – 2nd half	Silent or Aloud Reading	1 – 2
	Reading Comprehension Questions	2 – 3
	Resting & Preparation	1
Word List	Aloud reading	3 – 5
	TOTAL TIME	**19 – 29**

3.2.10. Materials

The materials used during the experimental procedure were the following:

3.2.10.1. Reading Materials

a) Reading texts:

Participants read two (2) Greek texts of varying difficulty and a list of 150 words of raising difficulty (Appendix 8):

- Easy

- Difficult
- List of Words

The Word List was given to examine the single word identification, which is not facilitated by the grammatical, syntactic and comprehension abilities of the reader. Conversely, texts test the abilities beyond word identification, because contextual cues such as grammar, syntax and meaning are helpful for the reader, in order to identify a word. The specific Word List was used for over fifteen (15) years for the diagnosis of thousands of Greek dyslexics at the "Dyslexia and Ophthalmokinesis Laboratory" in AHEPA Hospital of Thessaloniki directed by Prof. Pavlidis, while it is still used throughout "Dyslexia Centers – Pavlidis Method" across Greece and Cyprus.

Furthermore, the text difficulty of the texts was evaluated via the various readability formulas and their results are given below:

Table 9. Readability Formulas

Readability Formula	Easy text	Difficult text
Flesch Reading Ease score	– 42.2[1] Impossible to comprehend	– 95.7[1] Impossible to comprehend
Gunning Fog	64.8[2] Extremely difficult to read	85.9[2] Extremely difficult to read
Flesch-Kincaid Grade Level	59.4[3] College graduate and above	79.9[3] College graduate and above
The Coleman-Liau Index	– 18[4]	– 18[4]
Automated Readability Index	59.6[5] College graduate	85.9[5] College graduate
Linsear Write Formula	81[6] College Graduate and above	107.3[6] College Graduate and above

[1] Scores below 0: Extremely confusing.

[2] Scores above 12: Too hard for most people to read.

[3, 4] Scores above 12: College graduate and above.

[5] This formula tests the understandability of texts. Scores above 12: College graduates or above.

[6] Scores above 12: College graduate and above.

As aforementioned, all readability formulas take into account the "technical" parameters of the text *(e.g. sentence length, syllables per word, number of characters in words, etc.)*. Even though both texts were demanding enough (see the above table) as far as the target population was high educated (University students), the various readability formulas established the greater difficulty of the second reading material further confirming the results of the pilot study conducted.

b) Reading Comprehension: All participants answered in reading comprehension questions for each piece of text. They were advised from the beginning that they should read for meaning. Thus, they were all reading for the same purpose (Appendix 8).

3.2.10.2. Tape Recorder

All participants were **tape-recorded** during aloud reading for further analysis of the reading errors.

3.2.10.3. Chronometer

A **chronometer** was used during reading (aloud & silent) for the evaluation of participants' reading speed.

3.2.10.4. Reading Speed & Comprehension Scoring Sheet

As aforementioned, a scoring sheet was used to record reading speed and comprehension data (for details go back to p. 70 and see Appendix 9).

3.2.10.5. "Reading Errors Analysis Instrument"

The same instrument used in the first research project was similarly used for the categorisation and the analysis of the reading errors made by dyslexic and non-dyslexic university students (go back to p. 70-73). For a more detailed and thorough description of the

"Reading Errors Analysis Instrument" see Appendix 10. The reliability and validity of the specific instrument was thoroughly evaluated, as discussed in p.74-75.

3.2.10.6. Scoring Sheet for Reading Errors

The scoring sheet for reading errors described earlier in p.74 was also used in the current research project for recording and further analysis of the reading errors made by dyslexics and controls (see also Appendix 11).

3.2.11. Quantitative Analysis

After the recording of reading errors was completed, percents were calculated, as to be quantitatively analysed. In order to have comparable values, it was necessary to transform the error values to number of errors per 100 words (%), because of the different number of words per reading material. Hence, a score of 100% means that the participant has made 1 error per each word read. Reading speed, comprehension and errors data were analysed with the appropriate statistical tests of SPSS 20.

3.2.12. Qualitative Analysis

The aim of the qualitative analysis was to investigate the kind of reading errors that both groups have made and to detect the more and less frequent ones. The qualitative analysis focused on the categories, where a great amount of reading errors have been made, excluding those ones, where none or very limited errors were recorded. Besides, it would be difficult to find differences between groups, when minimum errors were recorded. Furthermore, Greek is a consistent language with a transparent orthography, a fact that explains why certain types of errors are rare in Greek.

3.3. STATISTICAL ANALYSIS – RESULTS

3.3.1. Introduction

In the current chapter, the results that describe the quantitative and qualitative differences found between and within groups are presented. The findings regarding the differences in the reading performance of adult dyslexic university students and age-matched normal controls are presented in relation to: a) an easy text, b) a difficult text, and c) a word list of raising difficulty. Analyses have been carried out between groups as well as among the different reading conditions.

3.3.2. Comparison Between Adult Dyslexic & Non-Dyslexic Students

Primarily, comparisons have been made between adult dyslexic university students and normal controls in terms of reading speed, comprehension and accuracy. The individual reading performance of each dyslexic and non-dyslexic participant is given in Appendix 12.

3.3.2.1. Reading Speed & Comprehension Between Dyslexics & Controls

Before processing in the main statistical analysis, in order to investigate which reading speed and comprehension variables were statistically significantly different between groups, it was necessary to check the normality of the sample:

Assessing Normality: Based on normality tests, both groups had a normal distribution on all reading speed variables ($p > .05$), while normality was violated on reading comprehension ones ($p < .05$). Normality was also confirmed by the shapes of the respective plots and histograms. In an attempt to compute not normally distributed variables using the log transformation, in order to establish normality, no change occurred. Consequently, the Independent-samples t-test and the Mann-Whitney test have respectively been used, in order to determine which variables significantly differentiated dyslexics and controls. The results are presented per reading material:

a) Easy Text

- **Comparing Reading Speed Between Groups**

H_1: Adult dyslexic students will read the easy text more slowly than non-dyslexics in both aloud and silent reading conditions.

H_0: Adult dyslexic students will not read the easy text more slowly than non-dyslexics in the aloud and silent reading conditions.

Easy: Aloud Speed Difference Between Groups

On average, dyslexics read the easy text aloud more slowly (M = 113.15 words/1′, SE = 4.97) than their non-dyslexic peers (M = 165.14, SE = 4.06). The speed difference was highly significant, $t(52) = -8.15$, $p < .001$, $r = .75$.

Easy: Silent Speed Difference Between Groups

The reading speed of dyslexics (M = 107.12, SE = 5.32) was significantly slower than normal controls' (M = 193.43, SE = 8.89), when reading the easier text silently. The speed difference was highly significant, $t(44) = -8.34$, $p < .001$, $r = .78$.

These findings suggest that the experimental hypothesis should be accepted as true, as dyslexics read significantly more slowly than non-dyslexics in both aloud and silent conditions of the easy material **(Hypothesis accepted)**.

- **Comparing Reading Comprehension Between Groups**

H_1: Adult dyslexic students will attain lower level of reading comprehension than non-dyslexics in both aloud and silent reading conditions.

H_0: Adult dyslexic students will not attain lower level of reading comprehension than non-dyslexics in the aloud and silent reading processes.

Easy: Aloud Comprehension Difference Between Groups

Although Mean Findings suggested that the level of reading comprehension of dyslexic students (M = 24.62%) was lower than controls' (M = 30.36%) after having read the easier text aloud, the difference between the former (Mdn = 20.00) and the latter (Mdn = 30.00) was not statistically significant, U = 320.000, z = –.774, *ns* (p > .05), r = –.11.

Easy: Silent Comprehension Difference Between Groups

However, as suggested by Mean Findings, when reading the easy text silently, the level of reading comprehension of dyslexics (M = 16.92%) was much lower compared to controls' (M = 40.36%). The comprehension difference between dyslexics (Mdn = 10.00) and controls (Mdn = 30.00) was highly significant, U = 172.000, z = –3.406, p < .001, r = –.46.

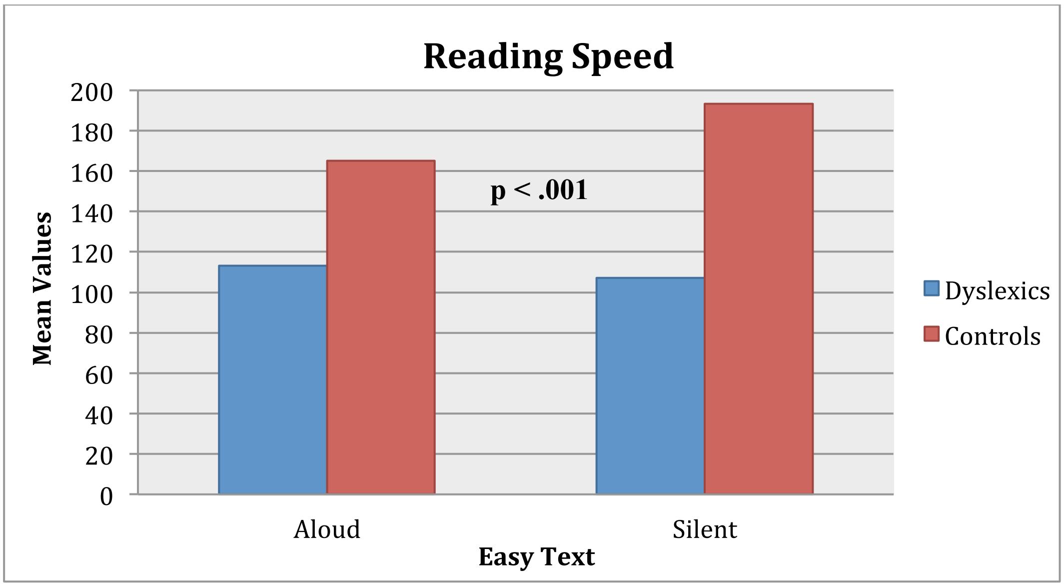
These findings suggest that the experimental hypothesis regarding aloud reading comprehension should be rejected, as there was no significant difference in the level of comprehension between groups **(Hypothesis rejected)**, whereas the experimental hypothesis regarding silent comprehension should be accepted, as dyslexics comprehended significantly worse than controls in the silent process **(Hypothesis accepted)**.

Table 1. Easy Text: Reading Speed & Comprehension Differences Between Dyslexics & Controls

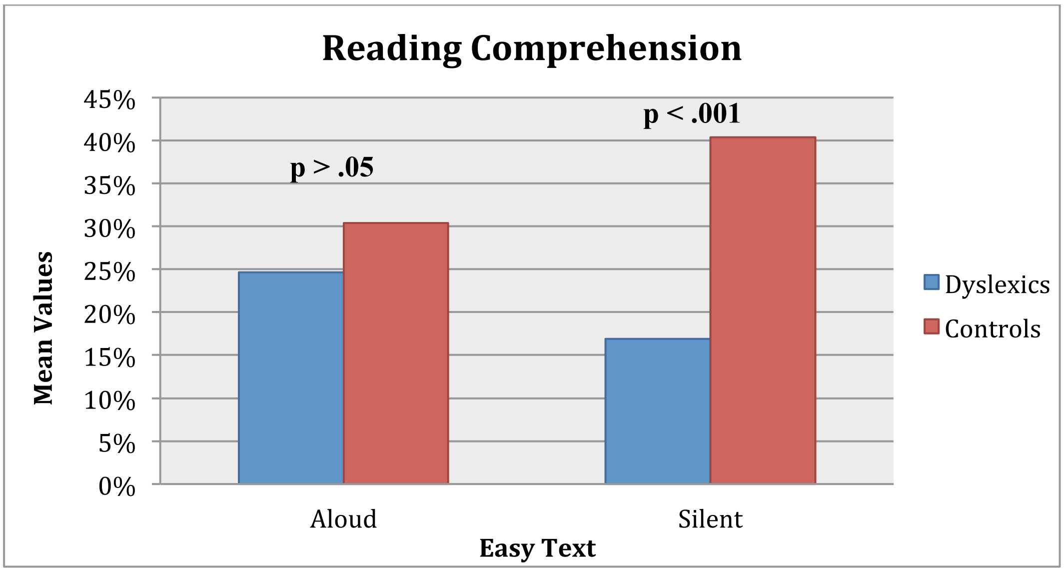
Easy Text **GROUP**

	Dyslexic Students			Normal Controls				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio %**	**p-value**
Reading Speed Aloud	**113**	25.35	114	**165**	21.47	165	**68**	**.000**
Reading Speed Silent	**107**	27.11	111	**193**	47.02	191	**55**	**.000**
Reading Comprehension Aloud %	**25%**	21.40	20	**30%**	25.46	30	**83**	**.222**
Reading Comprehension Silent %	**17%**	21.31	10	**40%**	28.09	30	**43**	**.000**

<u>Easy Text</u>: Reading Speed & Comprehension Differences Between Groups



<u>Figure 1(a)</u>. Mean values representing reading speed (words/1΄) of dyslexics and non-dyslexics in both aloud and silent reading processes. Dyslexics' reading speed was significantly lower than controls' in both conditions ($p < .001$).



<u>Figure 1(b)</u>. Mean values representing reading comprehension levels (%) attained by dyslexics and controls in both aloud and silent reading conditions. Statistically significant difference between groups was found only in the silent condition ($p < .001$), whereas the group difference in the aloud process was not significant ($p > .05$).

b) Difficult Text

- **Comparing Reading Speed Between Groups**

H_1: Adult dyslexic students will read the difficult text more slowly than non-dyslexics in both aloud and silent reading processes.

H_0: Adult dyslexic students will not read the difficult text more slowly than non-dyslexics in the aloud and silent reading processes.

Difficult: Aloud Speed Difference Between Groups

Mean Findings suggested that the reading speed of dyslexics (M = 115.13, SE = 4.51) was lower than controls' (M = 173.20, SE = 4.22), when reading the difficult material. The speed difference was further confirmed by the statistically significant result, $t(52) = –9.41$, $p < .001$, $r = .79$.

Difficult: Silent Speed Difference Between Groups

Dyslexics were significantly slower (M = 116.42, SE = 5.60) than their non-dyslexic peers (M = 205.07, SE = 9.44), when reading the difficult text. The speed difference between groups was highly significant, $t(44) = –8.08$, $p < .001$, $r = .79$.

These findings suggest that the experimental hypothesis should be accepted, as adult dyslexics read significantly more slowly in both aloud and silent reading conditions of the difficult material **(Hypothesis accepted)**.

- **Comparing Reading Comprehension Between Groups**

H_1: Adult Dyslexic Students will attain lower level of reading comprehension than Non-Dyslexics in the aloud-reading process.

H_0: Adult Dyslexic Students will attain lower level of reading comprehension than Non-Dyslexics in the aloud-reading process.

Difficult: Aloud Comprehension Difference Between Groups

Although the Mean Findings suggested that the level of reading comprehension of dyslexics (M = 19.62%) was lower than controls' (M = 26.79%) after having read the difficult material aloud, the difference between the former (Mdn = 20.00) and the latter group (Mdn = 20.00) was not statistically significant, U = 292.500, z = –1.268, *ns* ($p > .05$), r = –.17.

Difficult: Silent Comprehension Difference Between Groups

As suggested by Mean Findings, when reading the difficult text silently, the level of reading comprehension of dyslexics (M = 15.00%) was lower compared to controls' (M = 33.57%). The comprehension difference between dyslexics (Mdn = 0.00) and non-dyslexics (Mdn = 30.00) was further confirmed by the statistically significant result, U = 197.500, z = –2.983, $p < .05$, r = –.41.

Such findings suggest that the experimental hypothesis regarding the aloud reading comprehension should be rejected, as there was no statistically significant difference between dyslexics and controls **(Hypothesis rejected)**, while the experimental hypothesis regarding silent reading comprehension is accepted, as dyslexics attained significantly lower level of comprehension in the silent process **(Hypothesis accepted)**.

Table 2. Difficult Text: Reading Speed & Comprehension Differences Between Dyslexics & Controls

Difficult Text			**GROUP**					
	Dyslexic Students			**Normal Controls**				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio %**	**p-value**
Reading Speed Aloud	**115**	23.00	121	**173**	22.35	171	**66**	**.000**
Reading Speed Silent	**116**	28.54	122	**205**	49.94	192	**56**	**.000**
Reading Comprehension Aloud	**20%**	20.68	20	**27%**	24.65	20	**74**	**.104**
Reading Comprehension Silent	**15%**	25.02	0	**34%**	26.28	30	**44**	**.001**

Difficult Text: Reading Speed & Comprehension Differences Between Groups

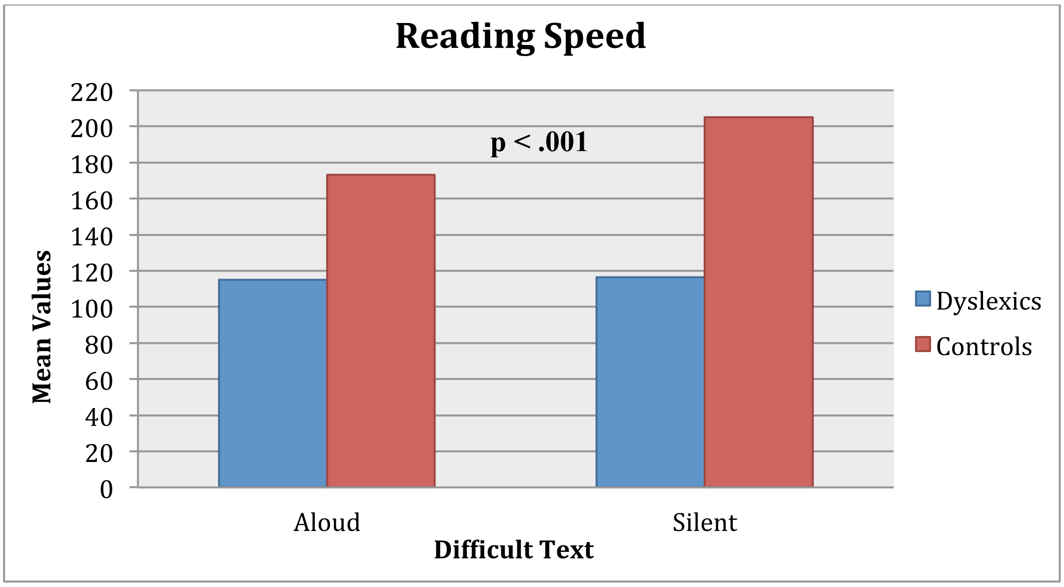


Figure 2(a). Mean values representing the reading speed of the 2 groups in both aloud and silent reading conditions. The reading speed of dyslexics was significantly lower in both conditions ($p < .001$).

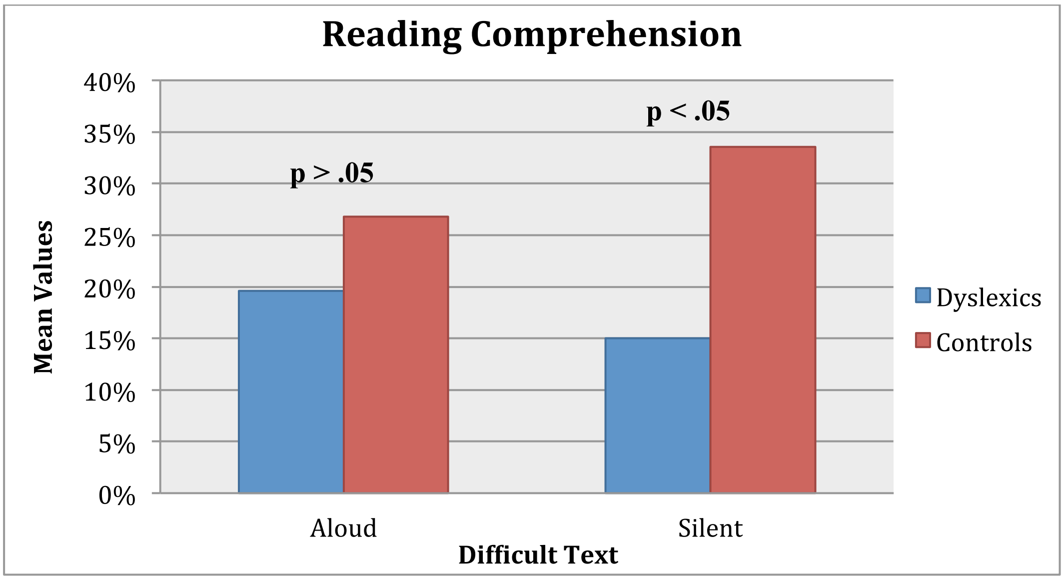


Figure 2(b). Mean values representing the level of reading comprehension (%) attained by both groups in aloud and silent reading process. Statistically significant difference between groups was found only in the silent condition ($p < .05$). The group difference in the aloud condition was not significant ($p > .05$).

c) List of Words

- **Comparing Reading Speed Between Groups**

H_1: Adult dyslexic students will read the list of words more slowly than non-dyslexics.

H_0: Adult dyslexic students will not read the list of words more slowly than non-dyslexics.

List: Total Speed Difference Between Groups

As suggested by Mean Finding, the total reading speed of dyslexics was significantly slower (M = 45.50, SE = 2.16) compared to that of non-dyslexics (M = 71.89, SE = 2.21), $t(52) = –8.52$, $p < .001$, r = .76.

List: Difference in Speed 1´ Between Groups

As occurs by Mean Findings, reading speed 1´*(defined as the number of words read in the 1st minute of reading)* was lower in dyslexics (M = 66.35, SE = 1.10) than in controls (M = 86.46, SE = 2.03). The speed difference was further confirmed by the highly significant result, $t(52) = –7.05$, $p < .001$, r = .70.

List: Difference in Speed beyond 1´ Between Groups

Mean Findings suggested that the reading speed beyond 1´*(defined as the number of words read beyond the 1st minute of reading)* of dyslexics (M = 36.42, SE = 1.81) was significantly slower than controls' (M = 58.28, SE = 1.75), $t(52) = –8.69$, $p < .001$, r =.77.

These findings suggest that the experimental hypothesis should be accepted as true, as all reading speeds of dyslexics evaluated in the list of words were significantly lower than the corresponding of non-dyslexics **(Hypothesis accepted)**.

Table 3. Word List: Reading Speed Differences Between Dyslexics & Controls

Word List	**GROUP**					
	Dyslexic Students		**Normal Controls**			
Variables	**Mean**	**SD**	**Mean**	**SD**	**Ratio %**	**p-value**
Reading Speed Total	**45**	11.04	**72**	11.69	**63**	**.000**
Reading Speed 1´	**66**	10.19	**86**	10.74	**77**	**.000**
Reading Speed beyond 1´	**36**	9.22	**58**	9.26	**62**	**.000**

Word List: Reading Speed Differences Between Groups

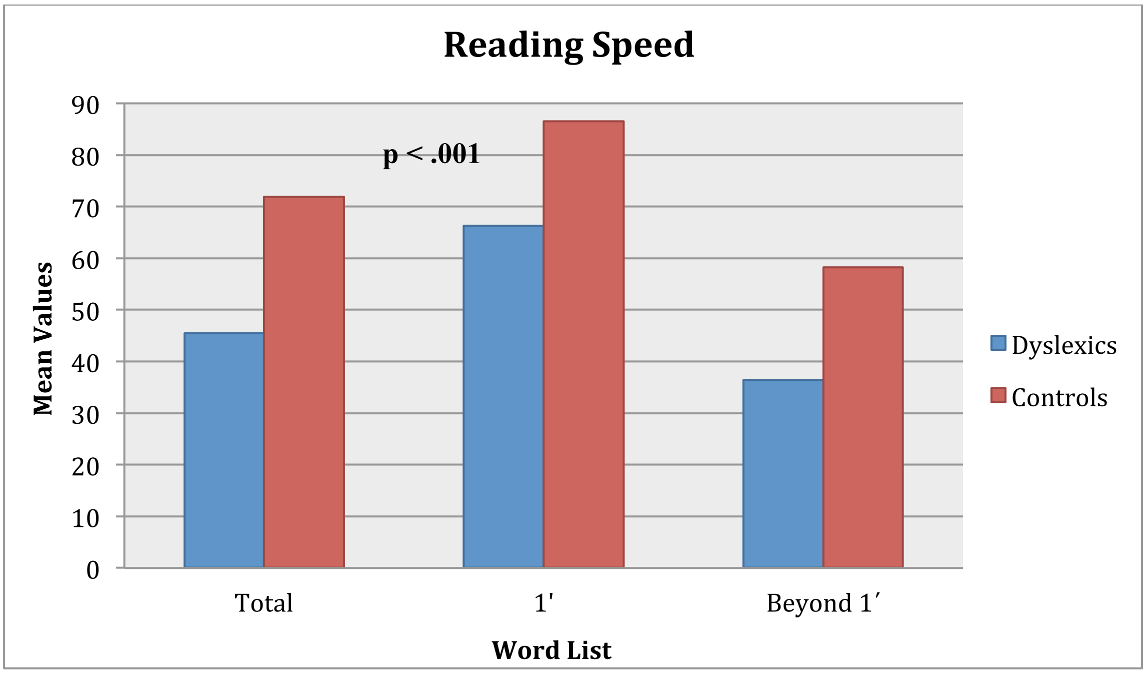


Figure 3. Mean values representing the 3 reading speeds of both groups evaluated in the list of words, namely total (words/1´), 1´(number of words read in the 1st minute), and beyond 1´ (number of words read after the 1st minute). All reading speeds highly differed in dyslexics from non-dyslexics ($p < .001$).

Summary: Reading Speed & Comprehension Between Groups

The following table cumulatively represents the reading speed of both groups in all reading conditions.

Table 4(a). Overall Reading Speeds of Dyslexics & Controls

Reading Speed

	Dyslexic Students				Normal Controls				
Reading Speed	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Ratio %**
Easy Aloud	**113**	25	49	150	**165**	21	123	200	**68**
Easy Silent	**107**	27	56	154	**193**	47	120	278	**55**
Difficult Aloud	**115**	23	54	153	**173**	22	138	224	**66**
Difficult Silent	**116**	29	41	164	**205**	50	140	320	**57**
List Total	**45**	11	25	66	**72**	12	54	96	**63**
List 1´	**66**	10	50	84	**86**	11	66	109	**77**
List beyond 1´	**36**	9	20	57	**58**	9	41	73	**62**

Ratio values (dyslexics/controls speed %) suggest that dyslexics' reading speed lagged from 23% up to 45% behind controls', meaning that they read from 23% up to 45% more slowly.

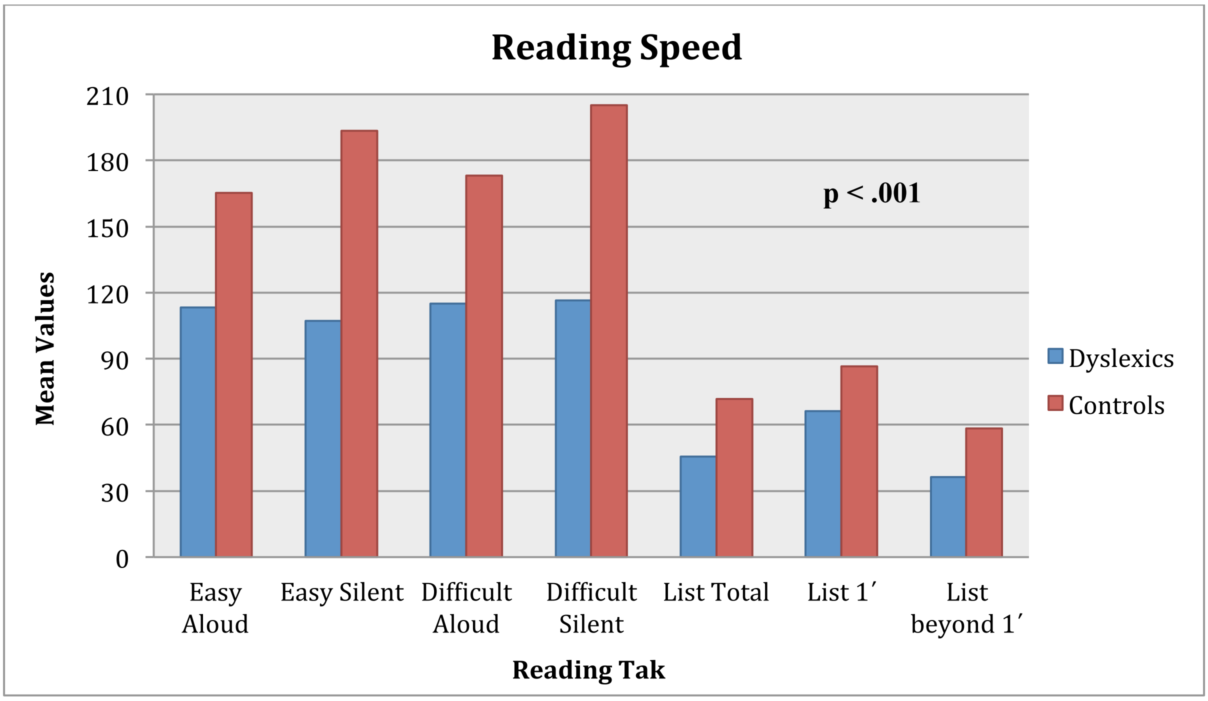


Figure 4(a). Mean values representing the reading speeds of both groups in all reading materials administered to them. In an overall view, dyslexics were significantly slower than controls ($p < .001$) in all reading materials *(Easy, Difficult & Word List)* and conditions *(aloud & silent)*.

The following table represents the levels of reading comprehension (%) of both groups in all reading processes.

Table 4(b). Overall Reading Comprehension of Dyslexics & Controls

Reading Comprehension

	Dyslexic Students				Normal Controls				
Reading Comprehension	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Ratio %**
Easy Aloud	**25%**	21	0%	70%	**30%**	25	0%	80%	**83**
Easy Silent	**17%**	21	0%	70%	**40%**	28	0%	100%	**43**
Difficult Aloud	**20%**	21	0%	70%	**27%**	25	0%	90%	**74**
Difficult Silent	**15%**	25	0%	100%	**34%**	26	0%	100%	**44**

Looking at the ratio values (dyslexics/controls comprehension %), dyslexics' reading comprehension was from 17% up to 57% worse compared to non-dyslexics'.

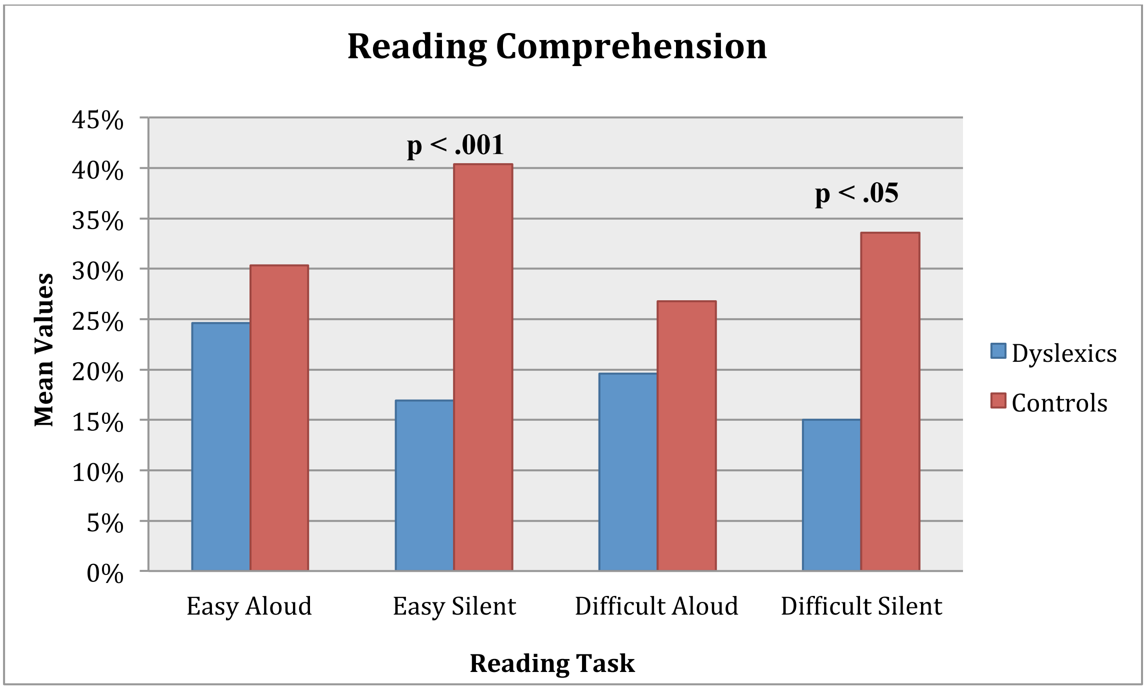


Figure 4(b). Mean values representing the level of reading comprehension (%) attained by both groups in all reading materials and conditions. On average, the level of reading comprehension of dyslexics was lower than controls' in all processes. However, the comprehension difference between groups was statistically significant only in the silent condition ($p \leq .001$).

To sum up, the variables that highly differed in adult dyslexic students from normal controls in all experimental conditions ($p < .001$), having a strong effect to the population at the same time, were Reading Speed and Reading Comprehension Silent.

Table 4(c). Variables highly differentiating the 2 groups: Significance & effect size

Reading Variables	Easy Text		Difficult Text		Word List	
	p	**r**	**p**	**r**	**p**	**r**
Reading Speed Aloud (Total)	< .001	.75	< .001	.79	< .001	.76
Reading Speed Silent	< .001	.78	< .001	.79		
Reading Comprehension Silent	< .001	.46	= .001	.41		
Reading Speed 1΄					< .001	.70
Reading Speed beyond 1΄					< .001	.77

3.3.2.2. Reading Accuracy Between Dyslexics & Controls

Prior to proceed in the main statistical analysis, in order to find out which reading errors variables statistically significantly differentiated adult dyslexic and non-dyslexic students, the normality of the sample should be examined:

Assessing Normality: Based on normality tests and looking at the shapes of the appropriate histograms and plots, it was concluded that the scores of both groups on most reading errors variables were not normally distributed ($p < .05$). Therefore, the Mann-Whitney test and the Independent samples t-test were respectively applied, in order to determine which reading errors variables statistically significantly differentiated the two groups. Computing not normal variables using the log transformation in an attempt to correct data and establish normality minor changes occurred. Only a few reading errors variables became normal. However, even analysing these transformed data using parametric tests the level of significance did not change at all (see also Appendix 13). The results are presented per reading material:

a) Easy Text

Main Hypothesis tested

H_1: Adult dyslexic students will make more reading errors than non-dyslexics, when reading the easier text.

H_0: Adult dyslexic students will not make more reading errors than non-dyslexics, when reading the easier text.

Sub-Hypotheses tested: Several sub-hypotheses have been tested, each of which related to each single category of reading errors. These sub-hypotheses followed the pattern:

H_1: Adult dyslexic students will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than non-dyslexics, when reading the easier text.

H_0: Adult dyslexic students will not make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than Non-Dyslexics, when reading the easier text.

The variables that significantly differentiated the 2 groups in the easy text are reported below:

Easy Text: Hems

Adult dyslexic students made more hesitation errors (M = 9.28) than their non-dyslexic peers (M = 1.00), when reading a relatively easy text. *Hems* errors in dyslexics (Mdn = 6.00) highly differed from normal controls (Mdn = 0.50), $U = 22.500$, $z = –5.970$, $p < .001$, $r = –.81$.

Easy Text: Repetitions

Dyslexic University students made significantly more Repetitions errors (M = 9.12) than non-dyslexics (M = 2.76) while reading the easy text. *Repetitions* errors in dyslexics (Mdn = 6.38) highly differed from non-dyslexics (Mdn = 1.67), $U = 168.000$, $z = –3.408$, $p < .001$, $r = –.46$.

Easy Text: Syllabications

The dyslexic group made significantly more Syllabications (M = 1.58) than the group of controls (M = 0.04). *Syllabication* errors in dyslexics (Mdn = 0.00) differed significantly from non-dyslexics (Mdn = 0.00), when reading the easy text, $U = 232.500$, $z = –3.235$, $p < .001$, $r = –.44$.

Easy Text: Substitutions

Dyslexic students made significantly more Substitutions errors (M = 2.29) than non-dyslexics (M = 0.39) while reading the easy text. *Substitutions* errors highly differentiated the former (Mdn = 1.67) from the latter group (Mdn = 0.00), $U = 106.000$, $z = –4.698$, $p < .001$, $r = –.64$.

Easy Text: Misintonation

Dyslexic students misplaced the intonation mark in more words of the easier reading material (M = 0.52) than non-dyslexics (M = 0.08). *Misintonation* errors significantly differentiated dyslexics (Mdn = 0.00) from controls (Mdn = 0.00), $U = 260.500$, $z = –2.550$, $p < .05$, $r = –.35$.

Easy Text: Endings

Adult dyslexic students made on average more errors in the endings of the words of the easy text (M = 1.30) than non-dyslexics did (M = 0.04). *Endings* errors highly differentiated dyslexics (Mdn = 0.50) from controls (Mdn = 0.00), $U = 189.500$, $z = -3.923$, $p < .001$, $r = -.53$.

Easy Text: Errors Repetitions

Dyslexic University students repeated more of their errors while reading the easy material (M = 0.38) compared to normal controls, who did not repeat any of theirs (M = 0.00). *Errors Repetitions* in dyslexics (Mdn = 0.00) significantly differed from non-dyslexics (Mdn = 0.00) $U = 308.000$, $z = -2.135$, $p < .05$, $r = -.29$.

Easy Text: Pseudo-Words

The group of dyslexics pronounced more Pseudo-words in reading the easy text (M = 0.94) than the control group (M = 0.41). *Pseudo-Words* errors significantly differentiated the former (Mdn = 1.00) from the latter group (Mdn = 0.00), $U = 268.000$, $z = -1.857$, $p < .05$, $r = -.25$.

Easy Text: Non-Corrected Errors

Dyslexics did not correct the majority of their reading errors in the easy text (M = 81.44) in contrast to non-dyslexics, who left half of their errors uncorrected (M = 52.21). *Non-Corrected Errors* in dyslexics (Mdn = 83.63) differed significantly from non-dyslexics (Mdn = 50.00), $U = 236.000$, $z = -2.249$, $p < .05$, $r = -.31$.

Easy Text: Wrong Words

The dyslexic group incorrectly read more words of the easier text they read (M = 17.76) than the control group (M = 3.99). *Wrong Words* highly differentiated dyslexics (Mdn = 15.54) from controls (Mdn = 2.85), $U = 38.500$, $z = -5.639$, $p < .001$, $r = -.77$.

Easy Text: Total Errors

Adult dyslexic students made significantly more reading errors in total (M = 27.12) than their non-dyslexic peers (M = 6.16) in the easier reading material. *Total errors* highly differentiated dyslexics (Mdn = 21.62) from non-dyslexics (Mdn = 5.00), $U = 64.000$, $z = -5.187$, $p < .001$, $r = -.71$.

Easy Text: Timing Errors

Dyslexic students made significantly more timing errors (M = 20.35) than non-dyslexics (M = 3.79) in reading the easy text. *Timing Errors* highly differed in quantity between dyslexics (Mdn = 14.26) and controls (Mdn = 2.35), $U = 71.500$, $z = -5.073$, $p < .001$, $r = -.69$.

Easy Text: Accuracy Errors

As occurs by Mean Findings, accuracy errors were significantly more in dyslexics (M = 6.79, SE = 0.79) than in controls (M = 2.36, SE = 0.34) in reading the easier material. *Accuracy Errors* highly differentiated between dyslexics and controls, $t(34) = 5.17$, $p < .001$, $r = -.66$.

These findings suggest that all experimental hypotheses regarding the aforementioned categories of reading errors, which were found to be significantly more in dyslexics, should be accepted as true **(Hypotheses accepted)**. Even though dyslexics did not make significantly more reading errors in each single reading errors category, the main experimental hypothesis should be accepted, as they made significantly more reading errors in total than non-dyslexics, when reading the easier text **(Hypothesis accepted)**.

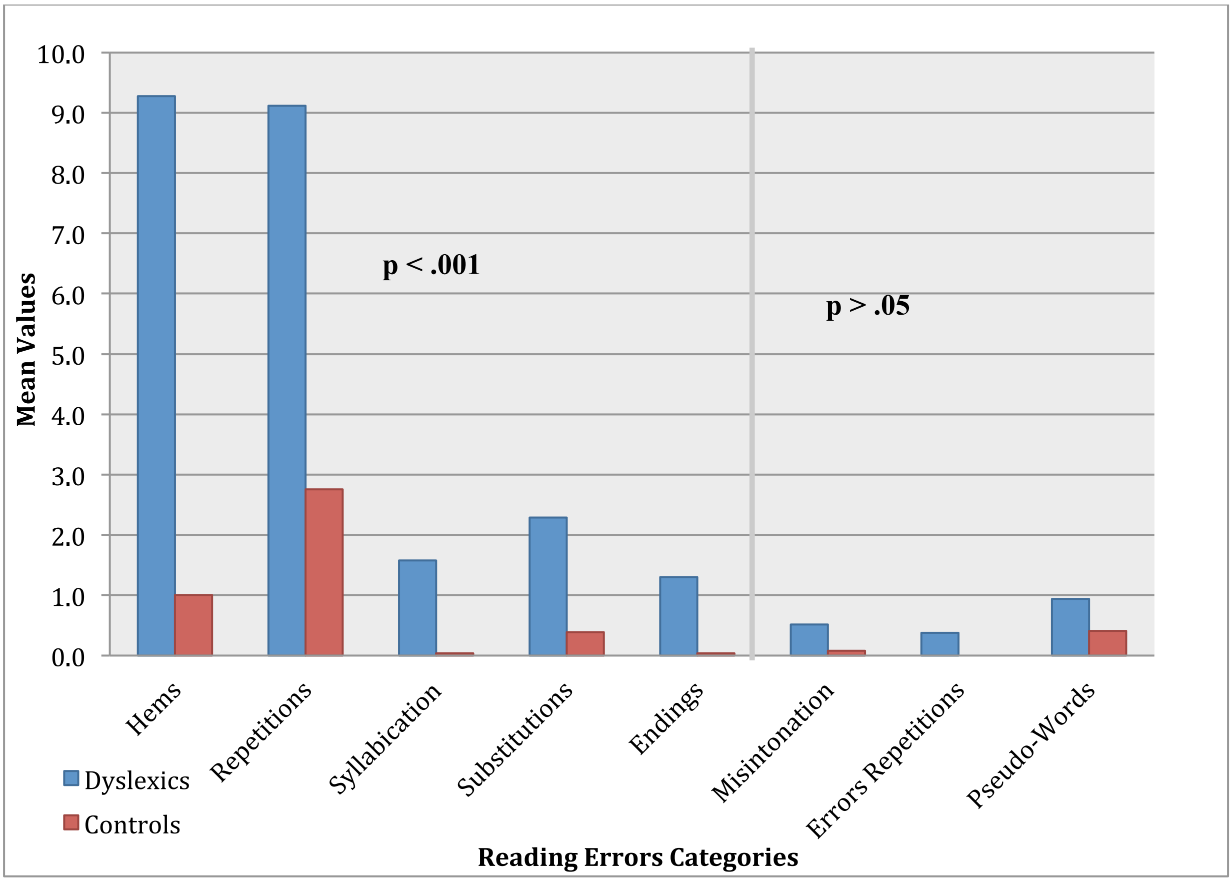
The following table includes the reading errors categories that significantly differentiated dyslexic and non-dyslexic students in the easy reading material:

Table 5. Reading Errors Differences Between Dyslexics & Controls in the Easy Text

Easy Text	**GROUP**							
	Dyslexic Students			**Normal Controls**				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio**	**p-value**
Hems	9.28	8.69	6.00	1.00	1.37	0.50	**11**	**.000**
Repetitions	9.12	9.48	6.38	2.76	3.07	1.67	**30**	**.000**
Syllabication	1.58	3.09	0.00	0.04	0.19	0.00	**3**	**.000**
Substitutions	2.29	1.71	1.67	0.39	0.76	0.00	**17**	**.000**
Misintonation	0.52	0.79	0.00	0.08	0.31	0.00	**15**	**.006**
Endings	1.30	1.79	0.50	0.04	0.19	0.00	**3**	**.000**
Errors Repetitions	0.38	1.00	0.00	0.00	0.00	0.00	**0**	**.047**
Pseudo Words	0.94	1.04	1.00	0.41	0.61	0.00	**44**	**.032**
Non-Corrected Errors	81.44	16.86	83.63	52.21	40.67	50.00	**64**	**.012**
Wrong Words	17.76	10.37	15.54	3.99	3.40	2.85	**19**	**.000**
Total Errors	27.12	21.53	21.62	6.16	5.27	5.00	**23**	**.000**
Timing Errors	20.35	19.68	14.26	3.79	4.12	2.35	**19**	**.000**
Accuracy Errors	6.79	4.02	6.00	2.36	1.77	2.52	**35**	**.000**

As suggested by the ratio values (controls/dyslexics errors %) shown in the table, dyslexics' reading performance in the easy text lagged from 36% up to 100% behind non-dyslexics'. With regard to the 3 last overall categories, they made 77% more reading errors in total, 81% more timing and 65% more accuracy errors compared to controls in the easy material.

<u>Easy Text</u>: Reading Errors Differences Between Groups



<u>Figure 5(a)</u>. Mean values representing the reading errors made by both groups. Statistically significant differences were found between groups in the above categories. The errors that highly differed in dyslexics from controls were Hems, Repetitions, Syllabication, Substitutions, and Endings ($p < .001$).

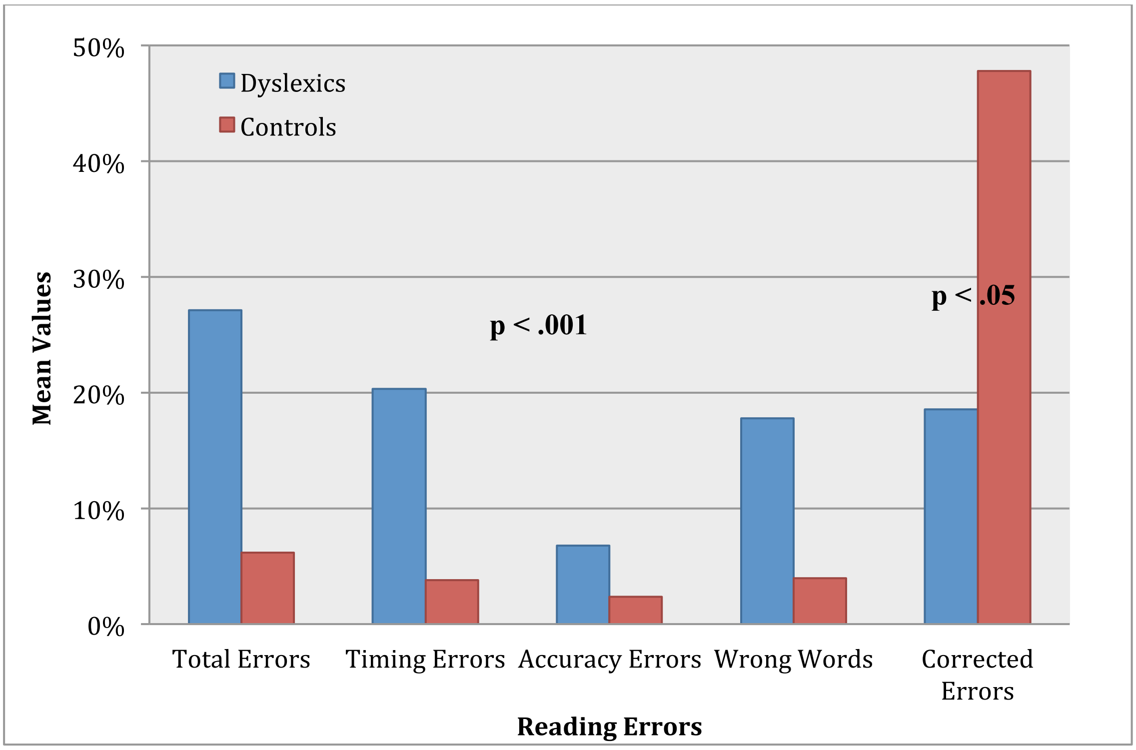


Figure 5(b). Mean values representing the percent of total reading errors made by both groups, their timing and accuracy errors as well as the amount of words they incorrectly read and their corrected errors. Significant differences were found between groups ($p < .001$ and $p < .05$).

b) Difficult Text

Main Hypothesis tested

H_1: Adult dyslexic students will make more reading errors than non-dyslexics, when reading the difficult text.

H_0: Adult dyslexic students will not make more reading errors than non-dyslexics, when reading the difficult text.

Sub-Hypotheses tested: Several sub-hypotheses have been tested, each of which related to each single category of reading errors. They read as follows:

H_1: Adult dyslexic students will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than non-dyslexics, when reading the difficult text.

H_0: Adult dyslexic students will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than Non-Dyslexics, when reading the difficult text.

The variables that significantly differentiated the two groups in the difficult material were the following:

Difficult Text: Hems

Dyslexics hesitated significantly more (M = 9.66) than their non-dyslexic peers (M = 1.28), when reading a difficult text. *Hems* errors in dyslexic University students (Mdn = 6.25) highly differed from normal controls (Mdn = 0.82), *U* = 25.500, z = –5.886, p < .001, r = –.80.

Difficult Text: Repetitions

Adult dyslexic students made significantly more Repetition errors (M = 11.22) than non-dyslexics (M = 2.17) while reading the difficult material. *Repetitions* errors in dyslexics (Mdn = 10.17) were highly different in quantity from normal controls (Mdn = 0.89), *U* = 78.500, z = –4.961, p < .001, r = –.67.

Difficult Text: Syllabications

The dyslexic group made significantly more Syllabication errors (M = 1.24) than the control group (M = 0.03). *Syllabication* errors highly differentiated dyslexics (Mdn = 0.75) from normal controls (Mdn = 0.00), *U* = 175.000, z = –4.145, p < .001, r = –.56.

Difficult Text: Substitutions

Dyslexic University students made significantly more Substitutions (M = 2.64) than non-dyslexics (M = 0.57) while reading the difficult text. *Substitutions* errors in the former group (Mdn = 2.68) highly differed from the latter (Mdn = 0.00), *U* = 87.000, z = –4.895, p < .001, r = –.67.

Difficult Text: Omissions

Dyslexic students made more Omissions errors (M = 1.01) than non-dyslexics (M = 0.34) in the difficult text. *Omissions* errors in dyslexics (Mdn = 0.89) significantly differed from non-dyslexics (Mdn = 0.00), $U = 216.500$, $z = -2.746$, $p < .05$, $r = -.37$.

Difficult Text: Misintonation

The dyslexic group misplaced the intonation mark in significantly more words of the difficult material (M = 1.30) than the group of controls (M = 0.22). *Misintonation* errors highly differentiated the former (Mdn = 0.89) from the latter group (Mdn = 0.00), $U = 90.500$, $z = -4.999$, $p < .001$, $r = -.68$.

Difficult Text: Endings

Dyslexics made significantly more errors in the endings of the words of the difficult text (M = 1.82) than controls did (M = 0.75). *Endings* errors significantly differentiated dyslexics (Mdn = 1.50) from controls (Mdn = 0.75), $U = 198.000$, $z = -2.993$, $p < .05$, $r = -.41$.

Difficult Text: Errors Repetitions

Dyslexic University students repeated more of their errors while reading the difficult text (M = 0.54) compared to controls (M = 0.06). *Errors Repetitions* in dyslexics (Mdn = 0.00) differed significantly from non-dyslexics (Mdn = 0.00), $U = 245.500$, $z = -2.821$, $p < .05$, $r = -.38$.

Difficult Text: Pseudo-Words

Dyslexic students read significantly more Pseudo-Words (M = 0.85) than non-dyslexics (M = 0.27) in the difficult material. Pseudo-Words were significantly different in the former (Mdn = 0.75) from the latter group (Mdn = 0.00), $U = 215.000$, $z = -2.844$, $p < .05$, $r = -.39$.

Difficult Text: Non-Corrected Errors

Dyslexics did not correct less of their reading errors in the difficult text (M = 76.22) in comparison to non-dyslexics (M = 81.19). Non-Corrected Errors in dyslexics (Mdn = 73.88) differed significantly from non-dyslexics (Mdn = 88.20), $U = 219.500$, $z = -2.520$, $p < .05$, $r = -.34$.

Difficult Text: Wrong Words

Dyslexics incorrectly read more words of the difficult reading material (M = 20.26, SE = 2.03) than non-dyslexics (M = 5.85, SE = 0.72). *Wrong Words* highly differentiated dyslexics from normal controls, $t(31) = 6.70$, $p < .001$, $r = -.77$.

Difficult Text: Total Errors

Adult dyslexic students made significantly more reading errors in total (M = 31.41) than their non-dyslexic peers (M = 6.99) in the difficult reading material. *Total Errors* were highly more in dyslexics (Mdn = 23.68) than in controls (Mdn = 6.13), $U = 48.000$, $z = -5.472$, $p < .001$, $r = -.74$.

Difficult Text: Timing Errors

Dyslexic students made significantly more Timing errors (M = 22.66) than non-dyslexics (M = 3.53) while reading the difficult text. *Timing Errors* highly differentiated dyslexics (Mdn = 17.13) from normal controls (Mdn = 2.40), $U = 53.500$, $z = -5.382$, $p < .001$, $r = -.73$.

Difficult Text: Accuracy Errors

The group of dyslexics made significantly more Accuracy errors (M = 8.67, SE = 0.89) that the control group (M = 3.49, SE = 0.37) in the difficult material. Accuracy Errors highly differentiated between the former and the latter group, $t(34) = 5.35$, $p < .001$, $r = .68$.

These findings suggest that all experimental hypotheses regarding the above categories of reading errors, which were found to be significantly more in dyslexics, should be accepted as true **(Hypotheses accepted)**. However, it is noteworthy that in terms of Non-Corrected errors, “the image was reversed”. Dyslexics left significantly less of their errors uncorrected *(and consequently corrected more of their errors)* compared to non-dyslexics. This finding indicates that the experimental hypothesis regarding Non-Corrected errors should be rejected **(Hypothesis rejected)**. Although dyslexics did not make significantly more reading errors in each single category, the main hypothesis should be accepted, as they made significantly more reading errors in total than controls in the difficult material **(Hypothesis accepted)**.

The following table includes the reading errors that significantly differentiated the 2 groups in the difficult text:

Table 6. Reading Errors Differences Between Dyslexics & Controls in the Difficult Text

Difficult Text	**GROUP**							
	Dyslexic Students			**Normal Controls**				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio**	**p-value**
Hems	9.66	7.88	6.25	1.28	1.33	0.82	**13**	**.000**
Repetitions	11.22	8.21	10.17	2.17	3.18	0.89	**19**	**.000**
Syllabication	1.24	1.69	0.75	0.03	0.14	0.00	**2**	**.000**
Substitutions	2.64	1.67	2.68	0.57	0.82	0.00	**22**	**.000**
Omissions	1.01	1.01	0.89	0.34	0.54	0.00	**34**	**.003**
Misintonation	1.06	0.67	0.89	0.22	0.35	0.00	**21**	**.000**
Endings	1.82	1.58	1.50	0.75	0.74	0.75	**41**	**.001**
Errors Repetitions	0.54	0.89	0.00	0.06	0.22	0.00	**11**	**.002**
Pseudo-Words	0.85	0.87	0.75	0.27	0.47	0.00	**32**	**.002**
Non-Corrected Errors	76.22	11.13	73.88	81.19	27.43	88.20	**107**	**.006**
Wrong Words	20.26	10.34	17.57	5.85	3.81	5.80	**29**	**.000**
Total Errors	31.41	19.25	23.68	6.99	5.34	6.13	**22**	**.000**
Timing Errors	22.66	16.28	17.13	3.53	4.06	2.40	**16**	**.000**
Accuracy Errors	8.67	4.55	8.59	3.49	1.97	3.56	**40**	**.000**

As it could be concluded from the ratio values (controls/dyslexics' errors %), dyslexics' reading performance lagged from 59% up to 98% behind non-dyslexics'. Regarding the 3 last overall categories of reading errors, they made 78% more errors in total, 84% more timing and 60% more accuracy errors compared to controls.

Difficult Text: Reading Errors Differences Between Groups

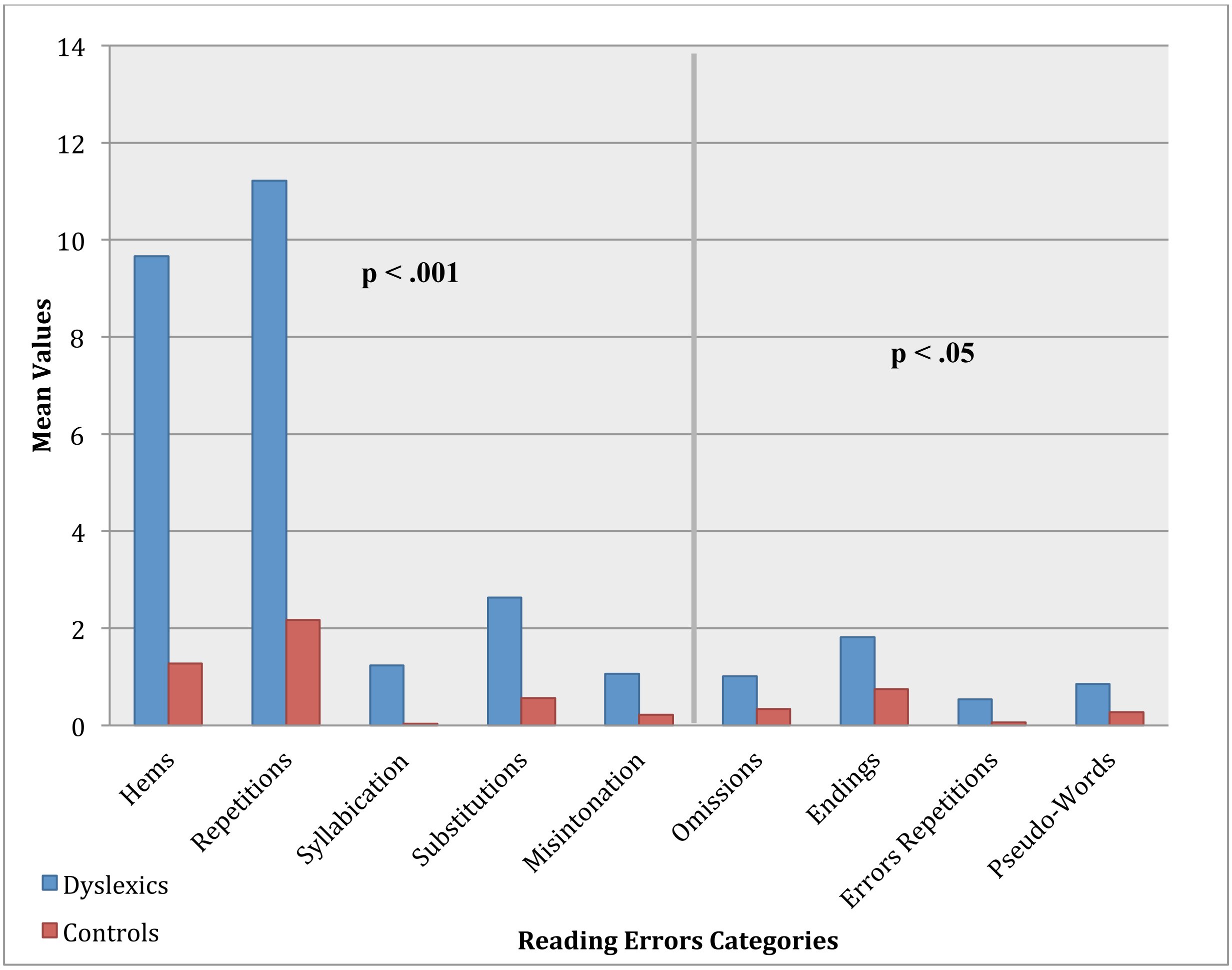


Figure 6(a). Mean values representing the reading errors made by both groups. Statistically significant differences were found between groups in the above categories. The errors that highly differed in dyslexics from controls were Hems, Repetitions, Syllabications, Substitutions, and Misintonation ($p < .001$).

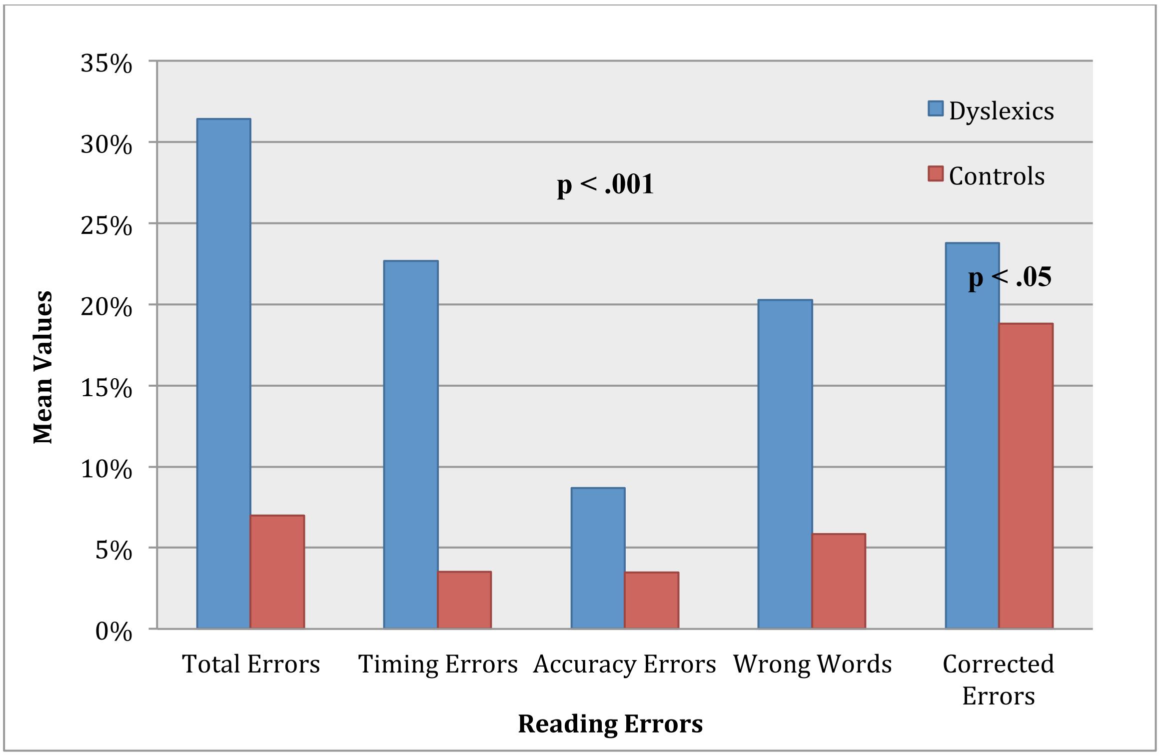


Figure 6(b). Mean values representing the total amount of reading errors made by both groups, their timing and accuracy errors as well as the amount of words they incorrectly read and their corrected errors. Statistically significant differences between groups have been found ($p < .001$ and $p < .05$).

c) List of Words

Main Hypothesis tested

H_1: Adult dyslexic students will make more reading errors than non-dyslexics, when reading the list of words.

H_0: Adult dyslexic students will not make more reading errors than non-dyslexics, when reading the list of words.

Sub-Hypotheses tested: Several sub-hypotheses have been tested, each of which was related to each different category of reading errors. These sub-hypotheses followed the pattern:

H_1: Adult dyslexic students will make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than non-dyslexics, when reading the list of words.

H_0: Adult Dyslexic Students will not make more *Hems, Repetitions, Syllabication, Substitutions, etc.* than Non-Dyslexics, when reading the list of words.

The variables that significantly differentiated the 2 groups while reading the list of words are reported below:

List: Hems

Adult dyslexic students hesitated significantly more (M = 17.14) than their non-dyslexic peers (M = 2.18) while reading a list of words of raising difficulty. *Hems* errors in dyslexics (Mdn = 13.00) highly differed from normal controls (Mdn = 1.33), $U = 61.500$, $z = –5.250$, $p < .001$, $r = –.71$.

List: Repetitions

Dyslexic University students made significantly more Repetitions errors (M = 21.62) than non-dyslexics (M = 4.29) in the word list. *Repetitions* errors in dyslexics were highly different (Mdn = 15.00) from normal controls (Mdn = 2.00), $U = 80.500$, $z = –4.915$, $p < .001$, $r = –.67$.

List: Syllabication

The dyslexic group made significantly more Syllabications (M = 9.49) than the group of controls (M = 0.55) in the word list. *Syllabication* errors in dyslexic students (Mdn = 6.67) highly differed from controls (Mdn = 0.00), $U = 30.500$, $z = –5.876$, $p < .001$, $r = –.80$.

List: Substitutions

Adult dyslexics made significantly more Substitutions errors (M = 4.85) than non-dyslexics (M = 1.79) while reading the list. *Substitutions* errors highly differentiated the former (Mdn = 4.67) from the latter group (Mdn = 1.33), $U = 114.000$, $z = –4.356$, $p < .001$, $r = –.59$.

List: Omissions

The group of dyslexics made significantly more Omissions errors (M = 2.18) than the control group (M = 0.60), when reading the word list. *Omissions* errors highly differentiated dyslexics (Mdn = 1.33) from non-dyslexics (Mdn = 0.33), U = 179.000, z = –3.304, p < .001, r = –.45.

List: Additions

Dyslexics made on average more Additions errors in reading the list of words (M = 0.56) than controls (M = 0.19). *Additions* errors in dyslexics (Mdn = 0.00) differed significantly from non-dyslexics (Mdn = 0.00), U = 271.000, z = –1.902, p < .05, r = –.26.

List: Misintonation

Dyslexic students misplaced the intonation mark of significantly more words of the word list (M = 2.39) than non-dyslexics (M = 0.24). *Misintonation* errors highly differentiated dyslexics (Mdn = 1.66) from controls (Mdn = 0.00), U = 92.000, z = –5.006, p < .001, r = –.68.

List: Endings

Adult dyslexics made significantly more errors in the endings of the words of the list (M = 2.21) than normal controls did (M = 0.33). *Endings* errors highly differentiated dyslexic students (Mdn = 2.00) from their non-dyslexic peers (Mdn = 0.00), U = 84.500, z = –5.013, p < .001, r = –.68.

List: Errors Repetitions

Dyslexic students repeated more of their errors while reading the list of words (M = 0.64) compared to non-dyslexics, who did not repeat any of theirs (M = 0.00). *Errors Repetitions* in dyslexics (Mdn = 0.00) highly differed from controls (Mdn = 0.00), U = 266.000, z = –2.907, p < .05, r = –.40.

List: Pseudo-Words

Adult dyslexic students created significantly more pseudo-words while reading the word list (M = 3.95) than non-dyslexics did (M = 0.86). *Pseudo Words* highly differentiated dyslexics (Mdn = 2.33) from controls (Mdn = 0.67), U = 130.500, z = –4.099, p < .001, r = –.56.

List: Non-Corrected Errors

Dyslexics did not correct the majority of their reading errors in the list (M = 76.76) in contrast to non-dyslexics, who left a little more than half of theirs uncorrected (M = 59.59). *Non-Corrected Errors* in dyslexics (Mdn = 76.50) differed significantly from controls (Mdn = 58.57), *U* = 241.500, z = –2.123, p < .05, r = –.29.

List: Wrong Words

The dyslexic group incorrectly read significantly more words of the list (M = 26.51) than the control group (M = 5.45). *Wrong Words* highly differentiated dyslexics (Mdn = 26.33) from non-dyslexics (Mdn = 4.00), *U* = 40.000, z = –5.612, p < .001, r = –.76.

List: Total Errors

Adult dyslexic students made significantly more reading errors in total (M = 62.18) than their non-dyslexic peers (M = 10.36) in the word list. *Total Errors* highly differentiated dyslexics (Mdn = 50.33) from normal controls (Mdn = 7.00), *U* = 44.000, z = –5.541, p < .001, r = –.75.

List: Timing Errors

The group of dyslexics made significantly more timing errors (M = 48.88) than the control group (M = 7.01) while reading the word list. *Timing Errors* in dyslexics (Mdn = 39.66) highly differed from controls (Mdn = 4.66), *U* = 40.000, z = –5.611, p < .001, r = –.76.

List: Accuracy Errors

Dyslexic students made significantly more accuracy errors (M = 12.39) than normal controls (M = 3.22) in the list of words. *Accuracy Errors* highly differentiated the former (Mdn = 10.67) from the latter group (Mdn = 2.66), *U* = 78.500, z = –4.951, p < .001, r = –.67.

These findings suggest that all experimental hypotheses regarding the above categories of reading errors, which were found to be significantly more in dyslexics, should be accepted **(Hypotheses accepted)**. In addition, the main experimental hypothesis should be accepted as true, as they made significantly more reading errors in total than controls, when reading the list of words **(Hypothesis accepted)**.

The following table includes the reading errors categories that significantly differentiated dyslexic and non-dyslexic students in the word list:

Table 7. Reading Errors Differences Between Dyslexics & Controls in the List of Words

Word List **GROUP**

	Dyslexic Students			Normal Controls				
Variables	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**Ratio**	**p-value**
Hems	17.14	16.55	13.00	2.18	2.45	1.33	**13**	**.000**
Repetitions	21.62	22.29	15.00	4.29	4.91	2.00	**20**	**.000**
Syllabication	9.49	10.23	6.67	0.55	0.93	0.00	**6**	**.000**
Substitutions	4.85	2.67	4.67	1.79	1.88	1.33	**37**	**.000**
Omissions	2.18	2.23	1.33	0.60	0.78	0.33	**28**	**.000**
Additions	0.56	0.81	0.00	0.19	0.36	0.00	**34**	**.031**
Misintonation	2.39	2.94	1.66	0.24	0.55	0.00	**10**	**.000**
Endings	2.21	1.78	2.00	0.33	0.53	0.00	**15**	**.000**
Errors Repetitions	0.64	1.42	0.00	0.00	0.00	0.00	**0**	**.004**
Pseudo Words	3.95	4.00	2.33	0.86	0.97	0.68	**22**	**.000**
Non-Corrected Errors	76.76	7.77	76.50	59.59	32.58	58.57	**78**	**.017**
Wrong Words	26.51	14.47	26.33	5.45	4.34	4.00	**21**	**.000**
Total Errors	62.18	52.74	50.33	10.36	9.47	7.00	**17**	**.000**
Timing Errors	48.88	45.55	39.66	7.01	7.05	4.66	**14**	**.000**
Accuracy Errors	12.39	8.34	10.67	3.22	3.04	2.66	**26**	**.000**

Ratio values (controls/dyslexics' errors %) suggest that dyslexics made from 22% up to 100% more reading errors than controls. With regard to the last 3 categories (overall categories), they made 83% more reading errors in total, 86% more timing and 74% more accuracy errors compared to non-dyslexics.

List: Reading Errors Differences Between Groups

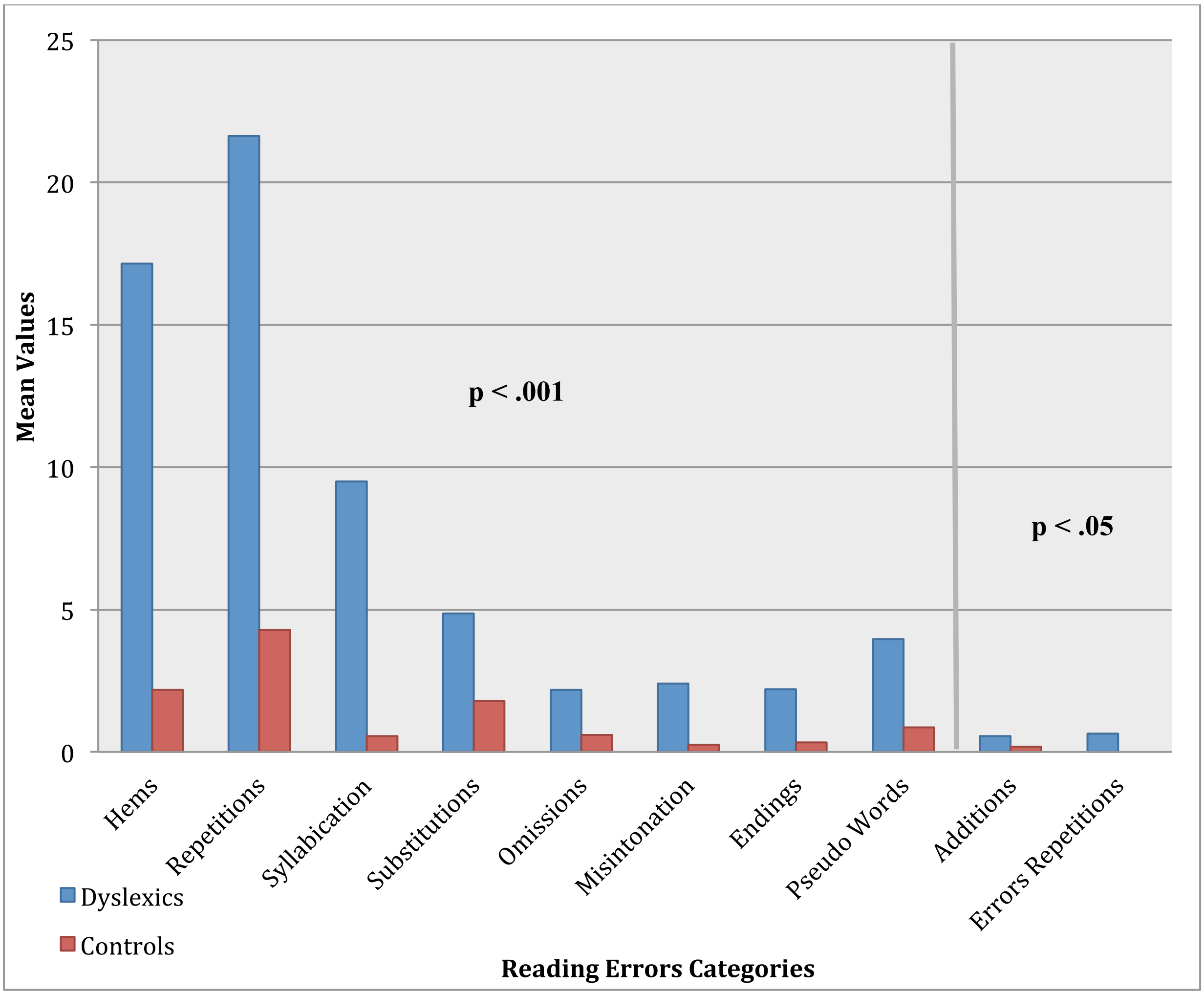


Figure 7(a). Mean values representing the reading errors made by both groups. Statistically significant differences were found between groups in the above categories. The errors that highly differed in dyslexics from controls were Hems, Repetitions, Syllabications, Substitutions, Omissions, Misintonation, Endings, and Pseudo Words ($p < .001$).

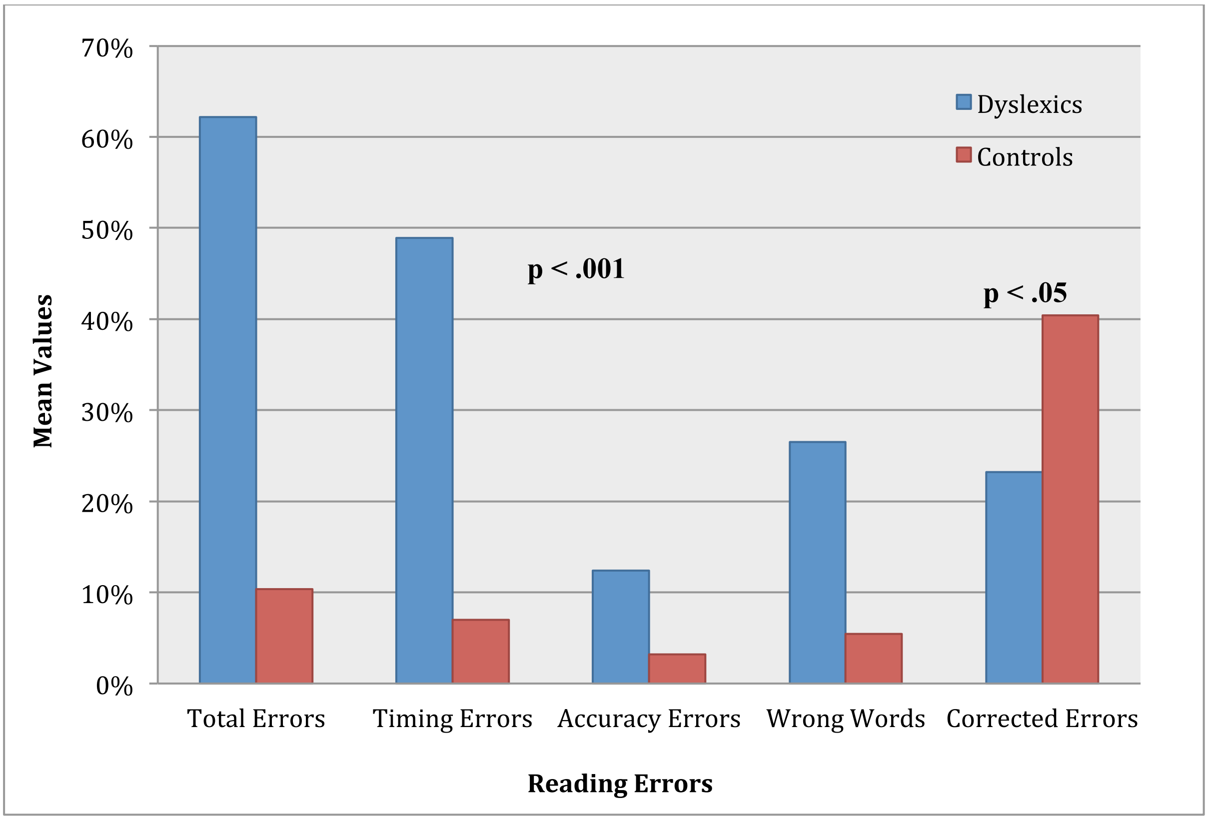


Figure 7(b). Mean values representing the total reading errors made by both groups, their timing and accuracy errors as well as the amount of words they incorrectly read and their corrected errors. Statistically significant differences between groups have been found ($p < .001$ and $p < .05$).

Summary: Reading Errors Between Dyslexics & Non-Dyslexics

To sum up, the reading errors variables that highly differed in adult dyslexic students from controls ($p < .001$) in all 3 experimental conditions having a strong effect to the population at the same time are shown in the following table. It is noteworthy that the majority of reading errors highly differentiating dyslexics and controls are timing errors, which are related to the speed of reading *(e.g. Hems or Repetitions)*.

Table 8. Reading errors variables highly differentiating the 2 groups: Significance & effect size

Reading Errors	Easy Text		Difficult Text		Word List	
	p	r	p	r	p	r
Hems	< .001	–.81	< .001	–.80	< .001	–.71
Repetitions	< .001	–.46	< .001	–.67	< .001	–.67
Syllabication	< .001	–.44	< .001	–.56	< .001	–.80
Substitutions	< .001	–.64	< .001	–.67	< .001	–.59
Wrong Words	< .001	–.77	< .001	–.77	< .001	–.76
Correct Words	< .001	–.77	< .001	–.77	< .001	–.76
Total Errors	< .001	–.71	< .001	–.74	< .001	–.75
Timing Errors	< .001	–.69	< .001	–.73	< .001	–.76
Accuracy Errors	< .001	–.66	< .001	–.68	< .001	–.67

3.3.3. Comparison Within Groups: Dyslexics & Controls

In the current section comparisons have been made within each group a) between aloud & silent reading conditions, and b) among the different reading materials *(Easy & Difficult Text, and List of Words)* in terms of reading accuracy, speed and comprehension.

3.3.3.1. Reading Speed & Comprehension Within Groups

Before processing in the main statistical analysis, in order to investigate whether there were differences, within each group, between the different reading conditions and materials in terms of reading speed and comprehension, it was necessary to explore the normality of the sample.

Assessing normality: Since the same groups were tested in different reading conditions, according to the number of the experimental conditions a) the Paired-samples t-test or its non-parametric equivalent Wilcoxon signed-rank test *(2 experimental conditions)*, and b) the repeated-measures ANOVA or its non-parametric Friedman's ANOVA *(3 experimental conditions)* seemed appropriate for the next step of the statistical analysis, based on the sampling distribution. All these tests are appropriate for comparisons within a group, which has been examined in different experimental conditions (Field, 2009, p. 325, 458).

a) Comparison Between Aloud & Silent Reading

Initially, comparisons have been made, within each group, between aloud and silent reading, in order to investigate whether dyslexics and controls performed better in aloud or silent reading speed and comprehension tasks. The results are presented per group.

H_1: Within each group, participants will read faster and comprehend better in the silent than in the aloud condition.

H_0: Within each group, participants will not read faster and comprehend better in the silent than in the aloud condition.

- **Dyslexics**

As discussed earlier (p.95), the differences between scores were computed and explored, in order to establish normality. Based on normality tests, dyslexics' speed and comprehension differences between aloud and silent reading were not normal for the easier text ($p < .05$), but instead normal for the difficult ($p > .05$). Consequently, the Wilcoxon signed-rank test and the Paired-samples t-test were respectively used for the analysis:

Easy: Speed Difference Between Aloud & Silent Reading

As occurs by Mean findings, dyslexic University students read slightly faster aloud (Mdn = 114.00) than silently (Mdn = 111.00) in the easier text. However, the speed difference between aloud and silent conditions was not significant, $T = 121.00$, $z = –1.385$, $p > .05$, $r = –.27$.

Easy: Comprehension Difference Between Aloud & Silent Reading

Dyslexics' level of reading comprehension was higher after having read the easy text aloud (Mdn = 20.00) than silently (Mdn = 10.00). However, neither their comprehension difference between aloud and silent reading tasks was significant, $T = 58.00$, $z = –1.203$, $p > .05$, $r = –.24$.

Difficult: Speed Difference Between Aloud & Silent Reading

As suggested by Mean findings, adult dyslexic students read slightly slower aloud (M = 115.13, SE = 4.51) than silently (M = 116.42, SE = 5.6) in the difficult material. However, the two reading speed conditions *(aloud and silent)* were not significantly different, $t(25) = –.394$, $p > .05$, $r = .07$.

Difficult: Comprehension Difference Between Aloud & Silent Reading

As occurs by Mean findings, dyslexic students attained higher level of comprehension after having read the difficult text aloud (M = 19.62, SE = 4.06) than silently (M = 15.00, SE =

4.91). However, the difference between the 2 reading conditions was not significant, $t(25) = .831$, $p > .05$, $r = .16$.

These findings suggest that the experimental hypothesis cannot be accepted, as there were no significant differences in dyslexics' reading speed and level of comprehension between aloud and silent reading **(Hypothesis rejected)**. The results may not have been significant, but they reveal a trend for dyslexics to read almost at the same rate aloud and silently, whereas to comprehend better aloud.

Table 9. Dyslexics' Speed & Comprehension Differences Between Aloud & Silent Reading

Dyslexics	**Reading Condition**						
	Aloud		**Silent**		**Aloud - Silent**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Easy Reading Speed	**113**	25.35	**107**	27.11	**6**	**95**	**.085**
Easy Reading Comprehension	**25%**	21.40	**17%**	21.31	**8%**	**68**	**.121**
Difficult Reading Speed	**115**	23.00	**116**	28.54	**–1**	**101**	**.349**
Difficult Reading Comprehension	**20%**	20.68	**15%**	25.02	**5%**	**75**	**.207**

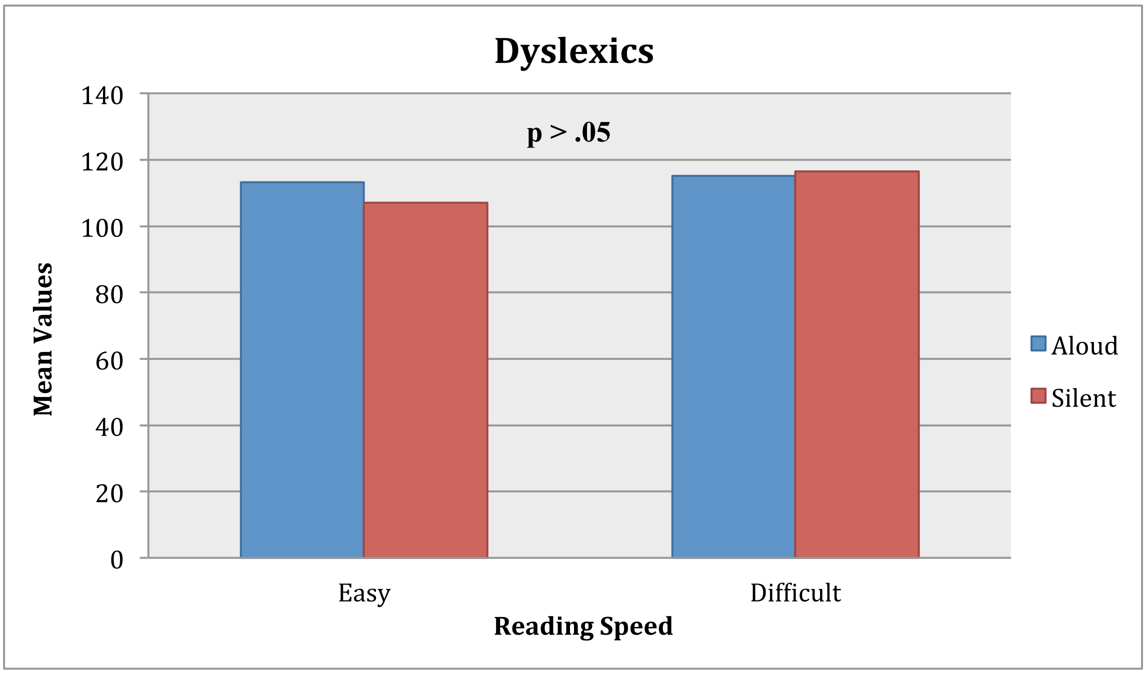


Figure 9(a). Mean values representing dyslexics' reading speed (words/1′) in both aloud and silent reading conditions. In general, dyslexics read at approximately the same rate aloud and silently, irrespective of reading material (p > .05).

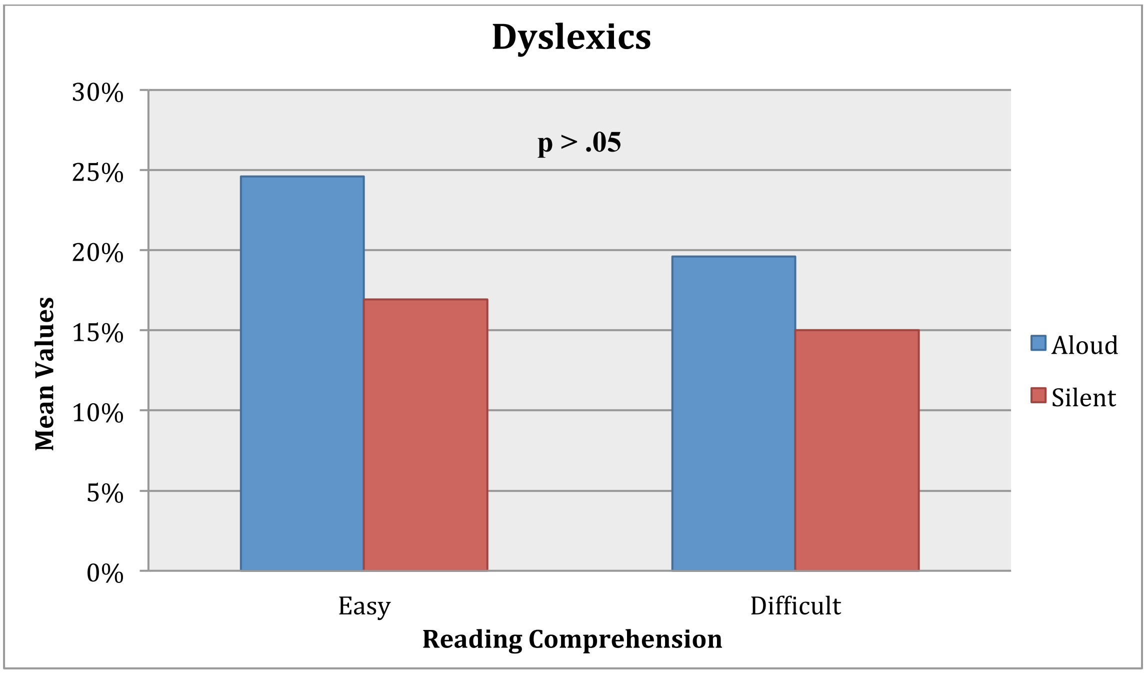


Figure 9(b). Mean values representing the level of reading comprehension (%) attained by dyslexic students in both aloud and silent reading conditions. Generally, dyslexics attained higher level of comprehension after having read aloud than silently, irrespective of reading material. However, these differences were not significant for any material (p > .05).

- **Controls**

According normality tests, controls' speed and comprehension differences between aloud and silent reading were all normal (p > .05). Consequently, the Paired-samples t-test was used for the analysis:

Easy: Speed Difference Between Aloud & Silent Reading

As suggested by Mean findings, non-dyslexic University students read the easier material significantly more slowly aloud (M = 165.14, SE = 4.06) than silently (M = 193.43, SE = 8.89), $t(27) = -3.436$, p < .05, r = .55.

Easy: Comprehension Difference Between Aloud & Silent Reading

As occurs by Mean findings, non-dyslexic students attained higher level of comprehension after having read the easy text silently (M = 40.36, SE = 5.31) than aloud (M = 30.36, SE = 4.81). However, their comprehension difference between the 2 reading conditions was not significant, $t(27) = -.1.332$, $p > .05$, $r = .25$.

Difficult: Speed Difference Between Aloud and Silent Reading

On average, non-dyslexics read the difficult text significantly more slowly aloud (M = 173.20, SE = 4.22) than silently (M = 205.07, SE = 9.44), $t(27) = -3.744$, $p < .001$, $r = .58$.

Difficult: Comprehension Difference Between Aloud and Silent Reading

As suggested by Mean findings, controls' level of comprehension was higher after having read the difficult text silently (M = 33.57, SE = 4.97) than aloud (M = 26.79, SE = 4.66). However, the comprehension difference was not significant, $t(27) = -1.293$, $p > .05$, $r = .24$.

These findings suggest that the experimental hypothesis regarding reading speed should be accepted, as non-dyslexics read significantly faster silently than aloud, as predicted **(Hypothesis accepted)**. In terms of reading comprehension, the experimental hypothesis cannot be accepted, as there were no significant differences in controls' level of comprehension between aloud and silent reading **(Hypothesis rejected)**. However, the comprehension results may not have been significant, but they reveal a trend for non-dyslexics to comprehend better silently than aloud.

Table 10. Controls' Speed & Comprehension Differences Between Aloud & Silent Reading

Controls	**Reading Condition**						
	Aloud		**Silent**		**Aloud - Silent**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Easy Reading Speed	**165**	21.47	**193**	47.02	**– 28**	**85**	**.001**
Easy Reading Comprehension	**30%**	25.46	**40%**	28.09	**– 10%**	**75**	**.097**
Difficult Reading Speed	**173**	22.35	**205**	49.94	**– 32**	**84**	**.000**
Difficult Reading Comprehension	**27%**	24.65	**34%**	26.28	**– 8%**	**79**	**.104**

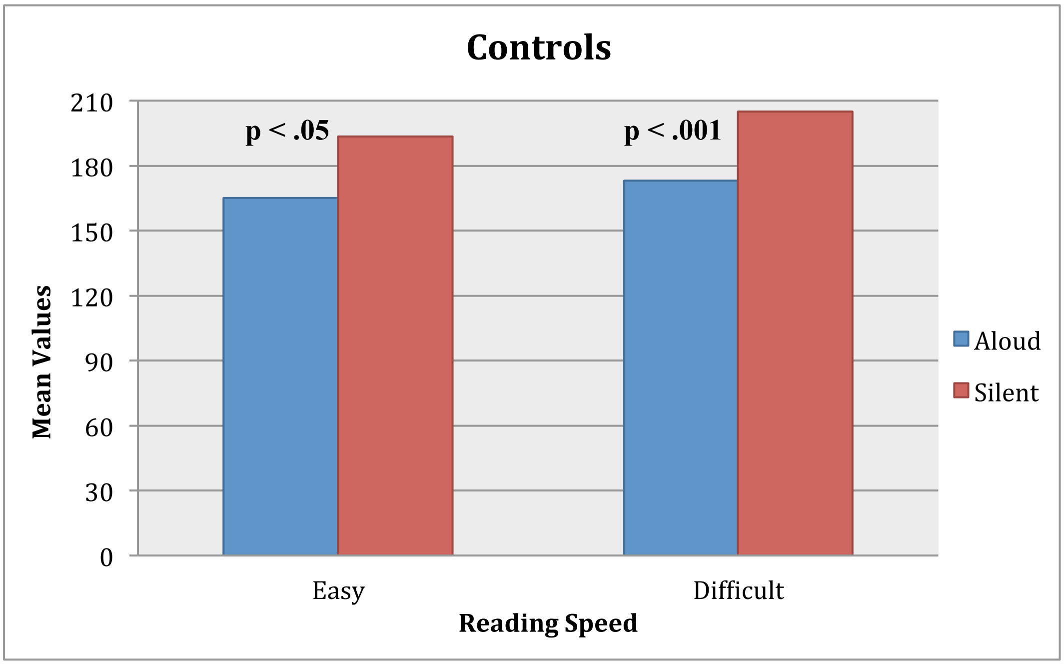


Figure 10(a). Mean values representing controls' reading speed (words/1′) in both aloud and silent reading conditions. Irrespective of reading material, non-dyslexics were found to read significantly faster silently than aloud ($p < .001$ & $p < .05$).

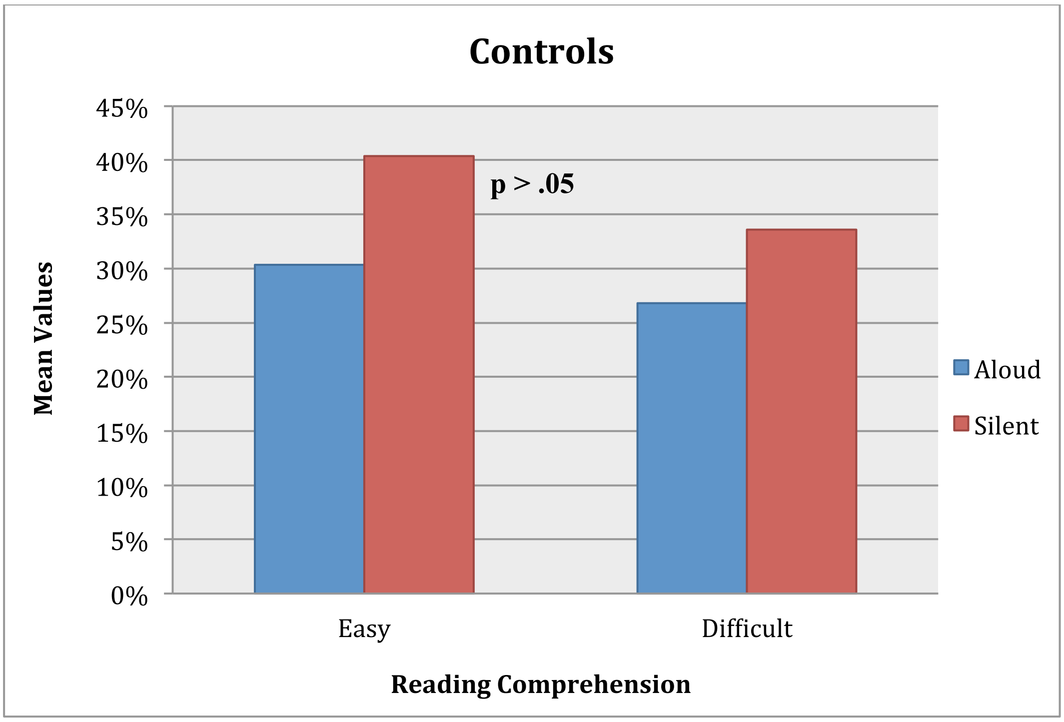


Figure 10(b). Mean values representing the level of reading comprehension (%) attained by non-dyslexic students in both aloud and silent reading conditions. On average, they attained higher level of comprehension after having read silently than aloud, irrespective of reading material. However, these differences between the 2 conditions were not significant ($p > .05$).

Summary: Reading Speed & Comprehension Between Aloud & Silent Reading

The following table cumulatively represents the reading speed and level of comprehension of both groups in aloud and silent reading conditions. The last column includes the mean differences of both groups between aloud and silent reading.

Table 11. Overall Reading Speed & Comprehension Differences Between Aloud & Silent Reading (D = Dyslexics, C = Controls)

Group	**Reading Condition**									
	Aloud				**Silent**				**Aloud-Silent**	
	Mean		**SD**		**Mean**		**SD**		**Mean Difference**	
Variables	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**
Easy Reading Speed	**113**	**165**	25	21	**107**	**193**	27	47	**6**	**–28**
Easy Reading Comprehension	**25%**	**30%**	21	25	**17%**	**40%**	21	28	**8%**	**–10%**
Difficult Reading Speed	**115**	**173**	23	22	**116**	**205**	29	50	**–1**	**–32**
Difficult Reading Comprehension	**20%**	**27%**	21	25	**15%**	**34%**	25	26	**5%**	**–7%**

In an overall view, non-dyslexic students read significantly faster ($p < .001$ & $p < .05$) and attained higher levels of comprehension – *even though not significantly ($p > .05$)* – when reading silently than aloud. On the other hand, it is remarkable that dyslexics showed a different "image". Regarding the reading speed, they read at almost the same rate aloud and silently ($p > .05$). In terms of reading comprehension, dyslexics comprehended better aloud than silently – *although not significantly either ($p > .05$)* – displaying the opposite pattern from controls. These findings are evident in the following figures as well:

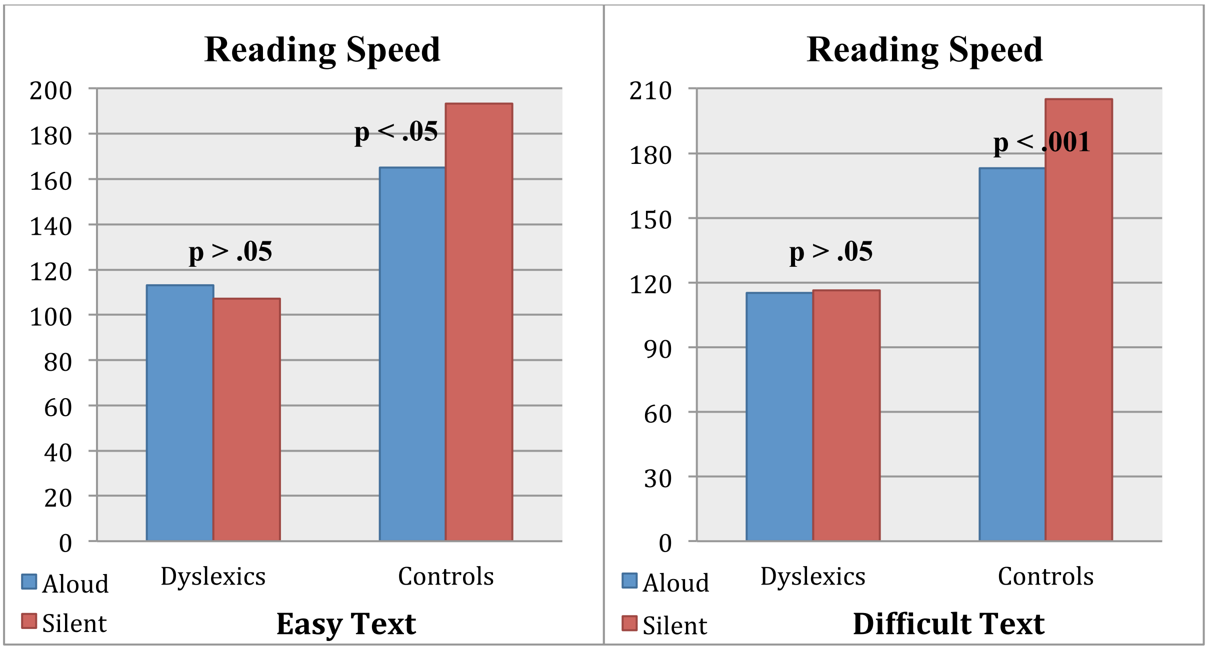


Figure 11(a). Mean values representing the reading speed of dyslexics and controls in both aloud and silent reading conditions of the 2 materials. In general, non-dyslexics read significantly faster silently ($p < .05$ & $p < .001$), while dyslexics read at approximately the same rate aloud and silently ($p > .05$).

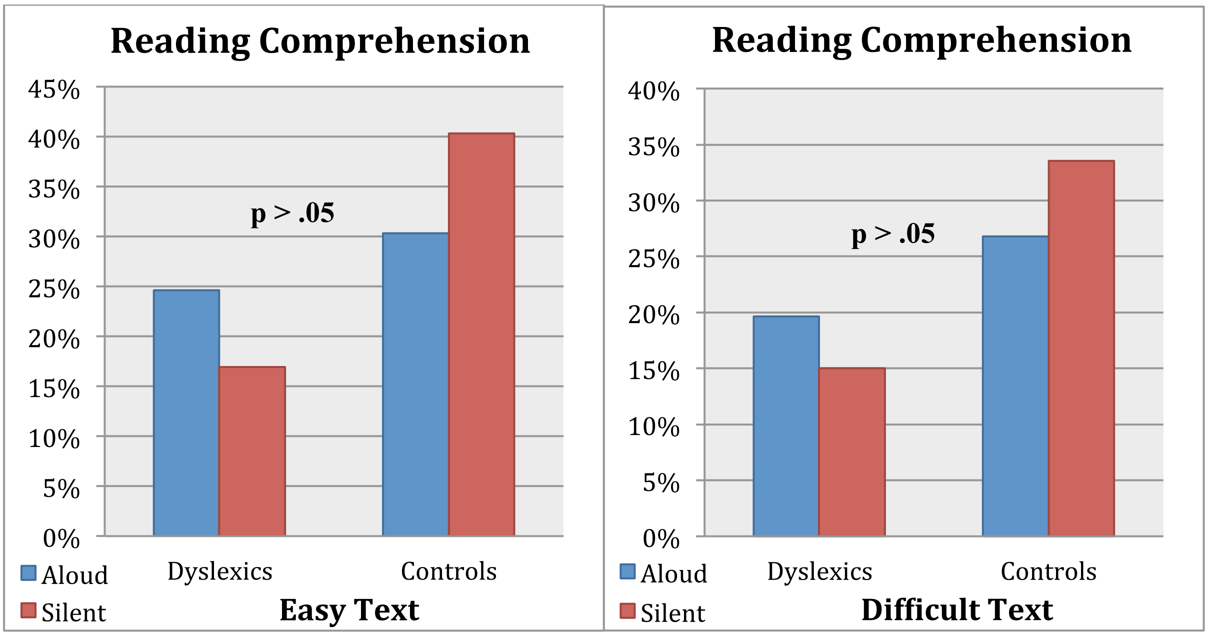


Figure 11(b). Mean values representing the level of reading comprehension (%) attained by the two groups in both aloud and silent reading conditions. On average, non-dyslexics comprehended consistently better after having read silently than aloud, whereas dyslexics displayed the opposite pattern showing better comprehension aloud. However, none of these differences was statistically significant ($p > .05$).

b) Comparison Among Reading Materials: Easy – Difficult – Word List

Next, comparisons have followed, within each group, among the 3 different reading materials administered to them, in order to find out in which of them dyslexics and controls performed better in terms of reading speed and comprehension.

Precisely, aloud reading speed was evaluated in all 3 reading materials and, hence, comparisons have been made among the 3 experimental conditions participants were subjected in. Thus, as the purpose was to compare 3 reading conditions *(Easy, Difficult & Word List)*, in which the same participants were tested, the repeated-measures ANOVA or its non-parametric equivalent Friedman's ANOVA seemed appropriate for the next step of the statistical analysis, based on whether assumptions were violated or not. It is worth mentioning that ANOVA is preferable than conducting several t-tests, when there are more than two experimental conditions to compare, as this way the possibility of Type I error is limited (Field, 2009, p. 348). However, ANOVA may tell us whether there was a significant difference between the experimental conditions, but without indicating which condition differed from which (Field, 2009, p. 349, 476). Hence, post hoc tests designed to compare all different combinations of experimental conditions followed (Field, 2009, p. 372).

On the other hand, reading speed *(silent condition)* and reading comprehension were evaluated only in the 2 texts, and, thus, comparisons have been made between the easy and the difficult material. Therefore, as the purpose was to compare 2 conditions *(Easy & Difficult Text)*, in which the same participants were tested, the Paired-samples t-test or the Wilcoxon signed-rank test seemed appropriate for the analysis, according to the normality of the sample. The results are presented per group:

- **Dyslexics**

i. Aloud Reading Speed: Comparison Among Reading Materials

H_1: Within the dyslexics' group, participants will read more slowly in the list of words compared to both texts.

H_0: Within the dyslexics' group, participants will not read more slowly in the list of words compared to both texts.

Based on normality tests, dyslexics' aloud reading speed was normal for all 3 reading materials ($p > .05$). Thus, the repeated-measures ANOVA was used for the analysis of the speed differences among them.

Aloud Speed Difference Among the 3 Reading Materials

Mauchly's test indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 2.37$, $p > .05$. The repeated-measures ANOVA determined that dyslexics' reading speed was significantly affected by the reading material they were reading, $F(2, 50) = 313.75$, $p < .001$, $\omega^2 = .71$. Post hoc tests comparing all different combinations of reading materials using Tukey's Least Significant Difference (LSD) test revealed that dyslexics read significantly more slowly the Word List compared to the Easy ($p < .001$, $r = .93$) and the Difficult text ($p < .001$, $r = .96$), whereas their reading speed was not significantly different between the 2 texts ($p > .05$, $r = .02$). We can, therefore, conclude that the List of Words decreases the speed of reading.

This finding suggests that the experimental hypothesis should be accepted as true, as dyslexics' reading speed in the List was significantly lower compared to both texts, as predicted **(Hypothesis accepted)**.

Table 12(a). Dyslexics' Aloud Speed Difference Among Reading Materials

Dyslexics		**Reading Speed Aloud (words/1´)**				
Reading Material		**Mean**		**Mean Difference**	**Ratio %**	**p-value**
Easy	Difficult	113	115	**–2**	**98**	**.489**
	Word List		45	**68**	**40**	**.000**
Difficult	Word List	115	45	**70**	**39**	**.000**

As obvious from the ratio values (list/text speed %), dyslexics reading speed was 60% and 61% slower in the list compared to the easy and difficult text, respectively. Instead, their reading speed in the easy text was only 2% slower than in the difficult.

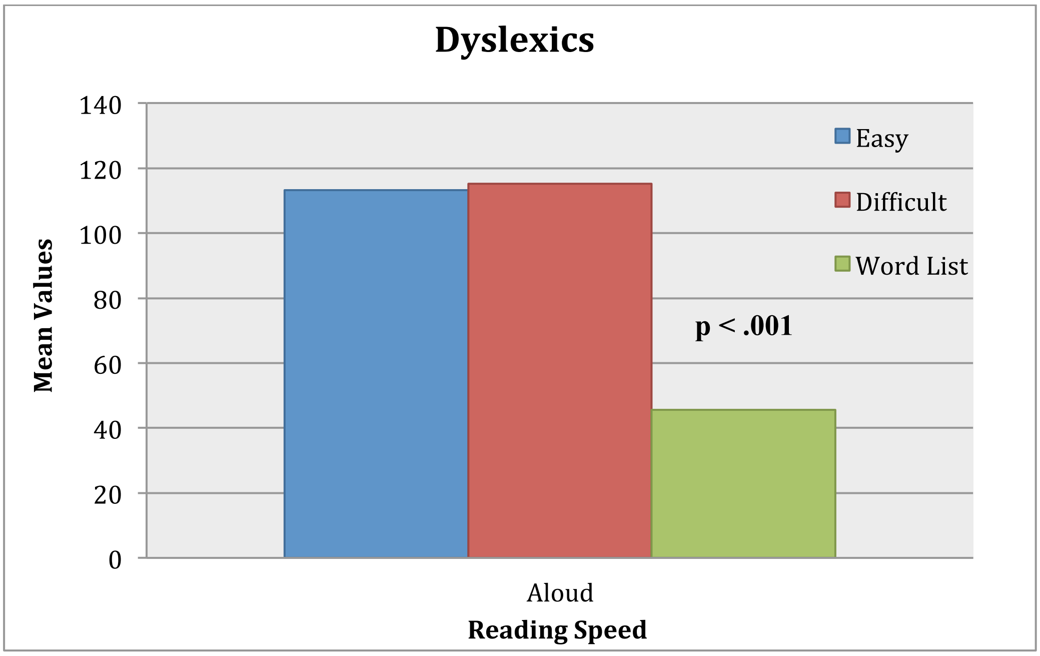


Figure 12(a). Mean values representing dyslexics' aloud reading speed (words/1´) in all 3 reading materials. As shown in the figure, dyslexic students read both texts at almost the same rate ($p > .05$), whereas their reading speed was significantly slower in the list of words compared to the other 2 reading materials ($p < .001$).

ii. Reading Speed & Comprehension: Comparison Between Easy & Difficult Text

H_1: Within the dyslexics' group, participants will read faster and attain higher level of comprehension in the easy than in the difficult text.

H_0: Within the dyslexics' group, participants will not read faster and attain higher level of comprehension in the easy than in the difficult text.

Based on the results of normality tests, dyslexics' reading speed and comprehension score differences between the easy and difficult text were all normal ($p > .05$), except for the comprehension difference in the silent condition ($p < .05$). Therefore, the Paired-samples t-test and the Wilcoxon signed-rank tests were respectively used for the analysis:

Silent Speed Difference Between Easy & Difficult Text

As occurs by Mean findings, dyslexic participants read slower the Easy (M = 107.12, SE = 5.32) than the Difficult text (M = 116.42, SE = 5.60) in the silent condition. The speed difference between texts was further confirmed by the statistically significant result, $t(25) = –2.484$, $p < .05$, $r = .44$.

Aloud Comprehension Difference Between Easy & Difficult Text

Dyslexics' comprehension difference between the Easy (M = 24.62%, SE = 4.20) and Difficult text (M = 19.62%, SE = 4.06) in the aloud condition was not statistically significant, $t(25) = .944$, $p > .05$, $r = .19$.

Silent Comprehension Difference Between Easy & Difficult Text

In the silent condition, dyslexics' comprehension difference between the Easy (Mdn = 10.00) and Difficult material (Mdn = 30.00) was not statistically significant, $T = 38.00$, $z = –.529$, $p > .05$, $r = –.7$.

These findings suggest that the experimental hypothesis regarding reading speed cannot be accepted, as dyslexics did not read faster the easy material **(Hypothesis rejected)**. Namely, in the aloud condition, there was no significant speed difference between easy & difficult texts.

In the silent condition, dyslexics read significantly faster the difficult text. In terms of reading comprehension, the experimental hypothesis should be rejected, as there were no significant differences in dyslexics' level of comprehension between texts **(Hypothesis rejected)**. However, the comprehension results may not have been significant, but they reveal a trend for dyslexics to have better comprehension in the easier text.

Table 12(b). Dyslexics' Reading Speed and Comprehension Differences between Easy & Difficult Text

Dyslexics	**Reading Material**						
	Easy		**Difficult**		**Easy – Difficult**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Reading Speed Aloud	113	25.35	115	23.00	**– 2**	**98**	**.489**
Reading Speed Silent	107	27.11	116	28.54	**– 9**	**92**	**.01**
Reading Comprehension Aloud	25%	21.40	20%	20.68	**5%**	**80**	**.165**
Reading Comprehension Silent	17%	21.31	15%	25.02	**2%**	**88**	**.321**

As suggested by the ratio values, dyslexics' reading speed was 2% (aloud) and 8% (silent) slower in the easy than in the difficult text. Their reading comprehension was 20% and 12% worse in the difficult reading material in the aloud and silent process, respectively.

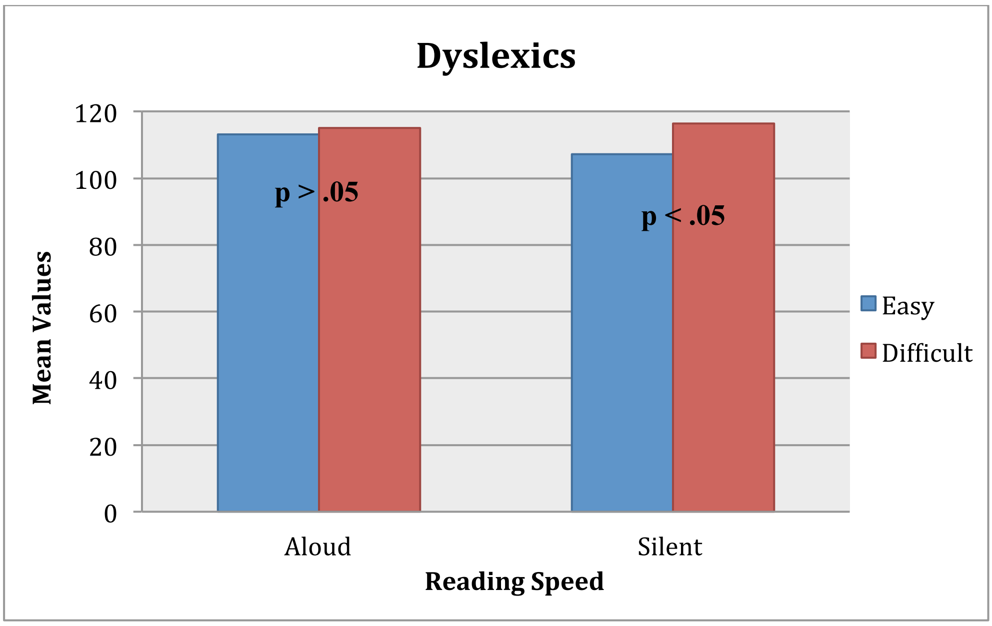


Figure 12(b). Mean values representing dyslexics' reading speed in both texts. In the aloud condition, they read both texts at almost the same rate ($p > .05$), whereas, in the silent process, they read significantly faster in the difficult material ($p < .05$).

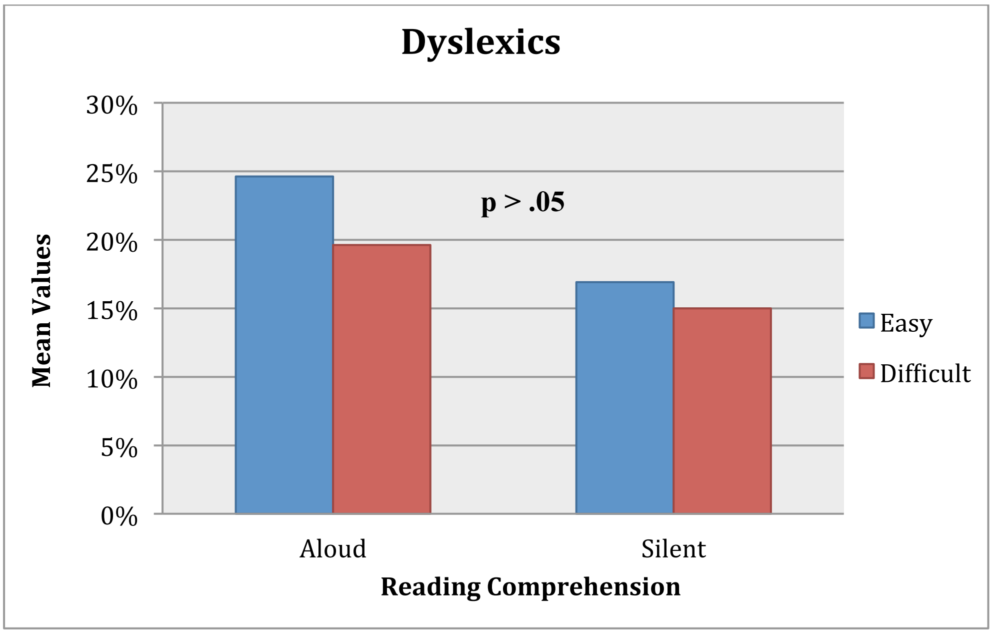


Figure 12(c). Mean values representing the level of reading comprehension (%) attained by dyslexics in the easy & difficult text. Generally, they attained higher level of comprehension in the easier material, irrespective of whether having read aloud or silently. However, none of these differences was statistically significant ($p > .05$).

- **Controls**

i. Aloud Reading Speed: Comparison Among Reading Materials

H_1: Within the control group, participants will read more slowly in the list compared to both texts.

H_0: Within the control group, participants will not read more slowly in the list.

As has repeatedly reported so far, before processing in the main statistical analysis, checking the normality of the sample is vital. According to the outcomes of normality tests, controls' aloud reading speed was normal for all 3 reading materials ($p > .05$). Hence, the repeated-measures ANOVA was applied for the analysis of the speed differences among them.

Aloud Speed Difference Among the 3 Reading Materials

Mauchly's test indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 1.07$, $p > .05$. Results showed that non-dyslexics' reading speed was significantly affected by the reading material they were reading, $F(2, 54) = 510.31$, $p < .001$, $\omega^2 = .85$. Post hoc tests using Tukey's Least Significant Difference (LSD) test were performed comparing all different combinations of reading materials. These contrasts revealed that non-dyslexics read significantly more slowly the Word List compared to the Easy ($p < .001$, $r = .97$) and the Difficult text ($p < .001$, $r = .97$), while their reading speed was significantly slower in the Easier material compared to the Difficult ($p < .05$, $r = .15$). We can, therefore, conclude that the List of Words decreases the speed of reading.

This finding suggests that the experimental hypothesis should be accepted, as non-dyslexics' reading speed in the list was significantly lower compared to both texts **(Hypothesis accepted)**.

Table 13(a). Controls' Aloud Speed Difference Among Reading Materials

Controls — **Reading Speed Aloud (words/1´)**

Reading Material		Mean		Mean Difference	Ratio %	p-value
Easy	Difficult	165	173	**–8**	**95**	**.042**
	Word List		72	**93**	**44**	**.000**
Difficult	Word List	173	72	**101**	**42**	**.000**

As suggested by the ratio values (list/text speed %), non-dyslexics' reading speed was 56% and 58% slower in the list compared to the easy and difficult text, respectively. Their reading speed in the easy material was only 5% slower than in the difficult.

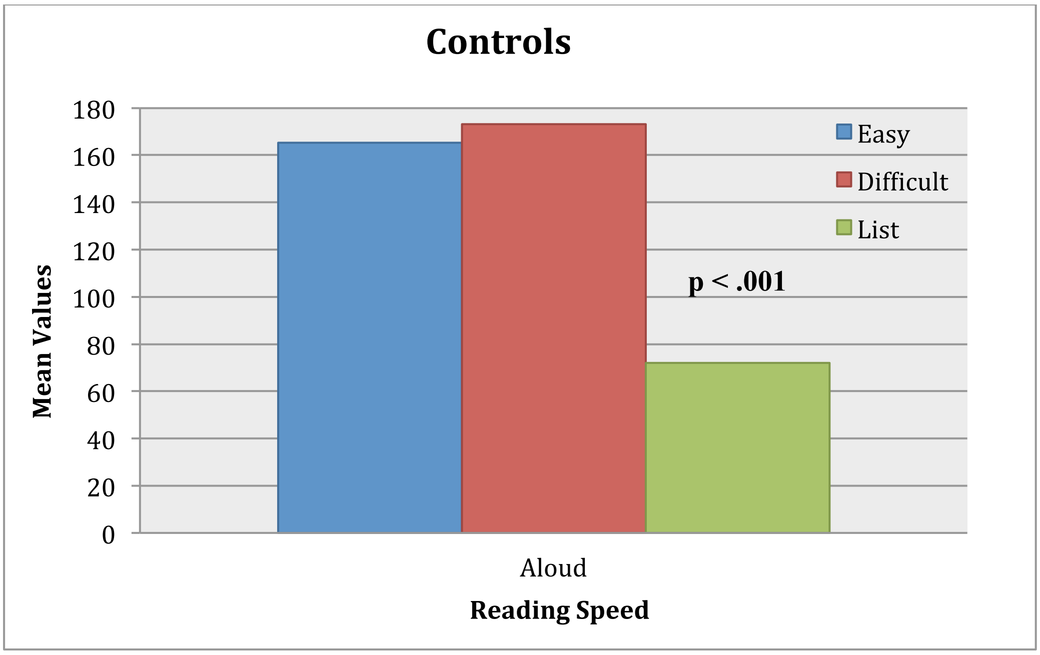


Figure 13(a). Mean values representing non-dyslexics' aloud reading speed (words/1΄) in all 3 reading materials. As shown, non-dyslexics read the difficult text slightly faster than the easier, with the difference being barely statistically significant ($p < .05$). On the other hand, their reading speed was significantly slower in the list of words compared to the other two reading materials ($p < .001$).

ii. Reading Speed & Comprehension: Comparison Between Easy & Difficult Text

H_1: Within the control group, participants will read faster and attain higher level of comprehension in the easy than in the difficult text.

H_0: Within the control group, participants will not read faster and attain higher level of comprehension in the easy than in the difficult text.

The reading speed and comprehension score differences of non-dyslexics between the easy and difficult text were computed and checked for normality (Field, 2009, p.329). According to normality tests, the resulting score differences were all normal ($p > .05$), except for the speed difference in the silent condition ($p < .05$). Consequently, the Paired-samples t-test and the Wilcoxon signed-rank test were respectively used for the analysis:

Silent Speed Difference Between Easy & Difficult Text

As occurs by Mean findings, non-dyslexic students read the Difficult text faster (Mdn = 190.50) than the Easier (Mdn = 192.00) in the silent condition. The speed difference between reading materials was further confirmed by the statistically significant result, $T = 123.00$, $z = -1.822$, $p < .05$, $r = -.34$.

Aloud Comprehension Difference Between Easy & Difficult Text

Non-Dyslexics' comprehension difference between the Easy (M = 30.36%, SE = 4,81) and Difficult text (M = 26.79%, SE = 4.66) in the aloud condition was not statistically significant, $t(27) = 0.715$, $p > .05$, $r = .14$.

Silent Comprehension Difference Between Easy & Difficult Text

In the silent condition, non-dyslexics' comprehension difference between the Easy (M = 40.36%, SE = 5.31) and Difficult (M = 33.57%, SE = 4.97) material was not statistically significant, $t(27) = 1.339$, $p > .05$, $r = .25$.

These findings suggest that the experimental hypothesis regarding reading speed should be rejected, as non-dyslexics read significantly faster the difficult material, unlike prediction **(Hypothesis rejected)**. In terms of reading comprehension, the experimental hypothesis cannot be accepted, as there were no significant differences in controls' level of comprehension between texts **(Hypothesis rejected)**. Although the comprehension results may not have been significant, they reveal a trend for controls to comprehend better the easier text.

Table 13(b). Controls' Reading Speed and Comprehension Differences between Easy & Difficult Text

Controls — **Reading Material**

	Easy		**Difficult**		**Easy - Difficult**		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean Difference**	**Ratio %**	**p-value**
Reading Speed Aloud	165	21.47	173	22.35	**– 8**	**95**	**.042**
Reading Speed Silent	193	47.02	205	49.94	**– 12**	**94**	**.035**
Reading Comprehension Aloud	30%	25.46	27%	24.65	**3%**	**90**	**.481**
Reading Comprehension Silent	40%	28.09	34%	26.28	**6%**	**85**	**.192**

As obvious from the ratio values, non-dyslexics' reading speed in the easy text lagged 5% and 6% behind the difficult in the aloud and silent conditions, respectively. Their reading comprehension in the difficult text was 10% and 15% worse compared to the easy in the aloud and silent processes, respectively.

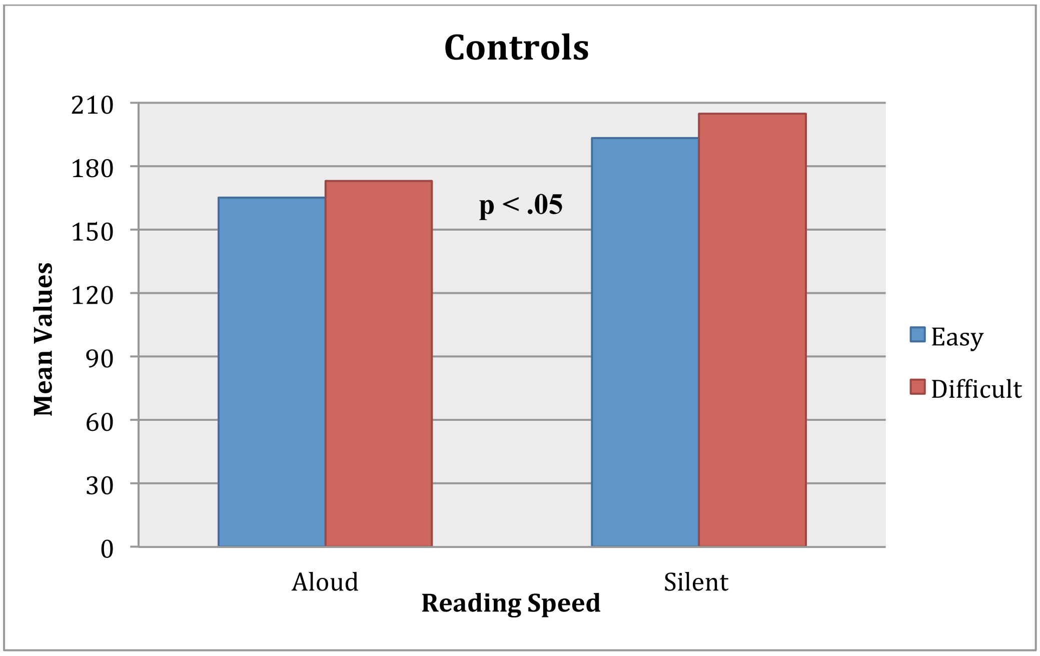


Figure 13(b). Mean values representing non-dyslexics' reading speed in both texts. Irrespective of whether reading aloud or silently, their reading speed was significantly faster in the difficult material ($p < .05$).

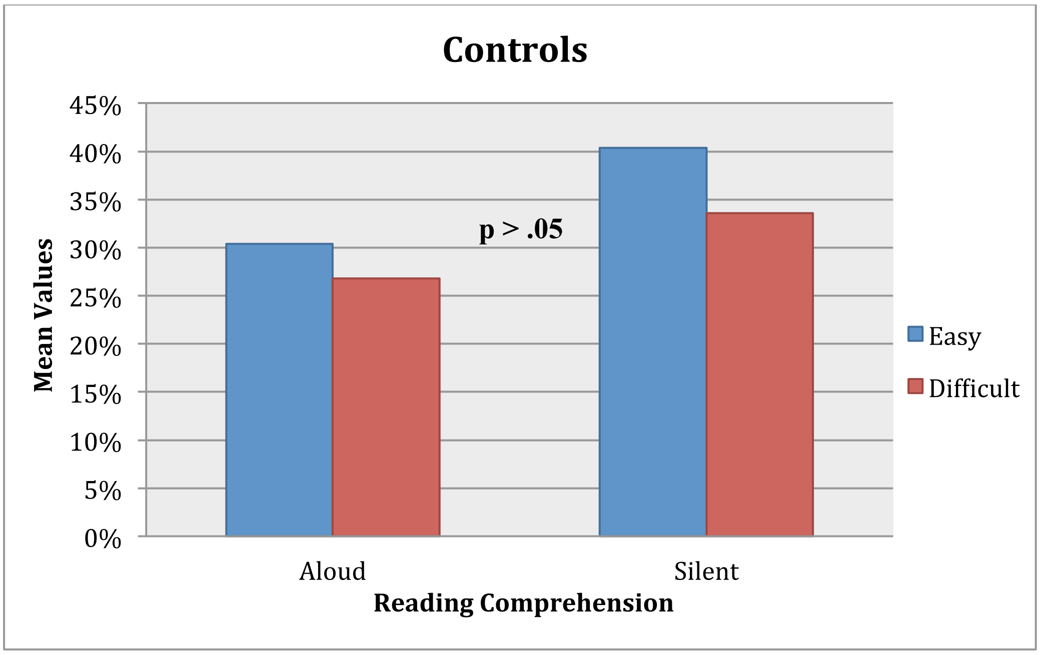


Figure 13(c). Mean values representing the level of reading comprehension (%) attained by controls in both texts. In general, they comprehended better in the easier text, irrespective of whether having read aloud or silently. However, none of these differences was statistically significant ($p > .05$).

Summary: Reading Speed & Comprehension Among Reading Materials

The following table cumulatively represents the reading speed and level of comprehension of both groups in all reading materials administered to them. The last three columns indicate the mean differences between all possible pairs of reading materials.

Table 14. Overall Reading Speed & Comprehension Differences Among Reading Materials

Group	Reading Material											
	Mean						Mean Difference					
	Easy		Difficult		List		Easy - Difficult		Easy - List		Difficult - List	
Variables	**D***	**C***	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**	**D**	**C**
Reading Speed Aloud	113	165	115	173	45	72	**– 2**	**– 8**	**68**	**93**	**70**	**101**
Reading Comprehension Aloud	25%	30%	20%	27%			**5%**	**3%**				
Reading Speed Silent	107	193	116	205			**– 9**	**– 12**				
Reading Comprehension Silent	17%	40%	15%	34%			**2%**	**7%**				

*D = Dyslexics, C = Controls

In an overall view, both groups read significantly faster the difficult material ($p < .05$) in the silent condition. In the aloud condition, controls displayed the same pattern reading significantly faster the difficult text ($p < .05$), in contrast to dyslexics, whose speed difference between texts was not statistically significant ($p > .05$), as they read both texts at almost the same rate. In terms of reading comprehension, and irrespective of whether having read aloud or silently, both groups showed better level of comprehension in the easier material, albeit not significantly ($p > .05$). Finally, both groups read the list of words significantly more slowly compared to both texts ($p < .001$). These findings are evident in the following figures as well:

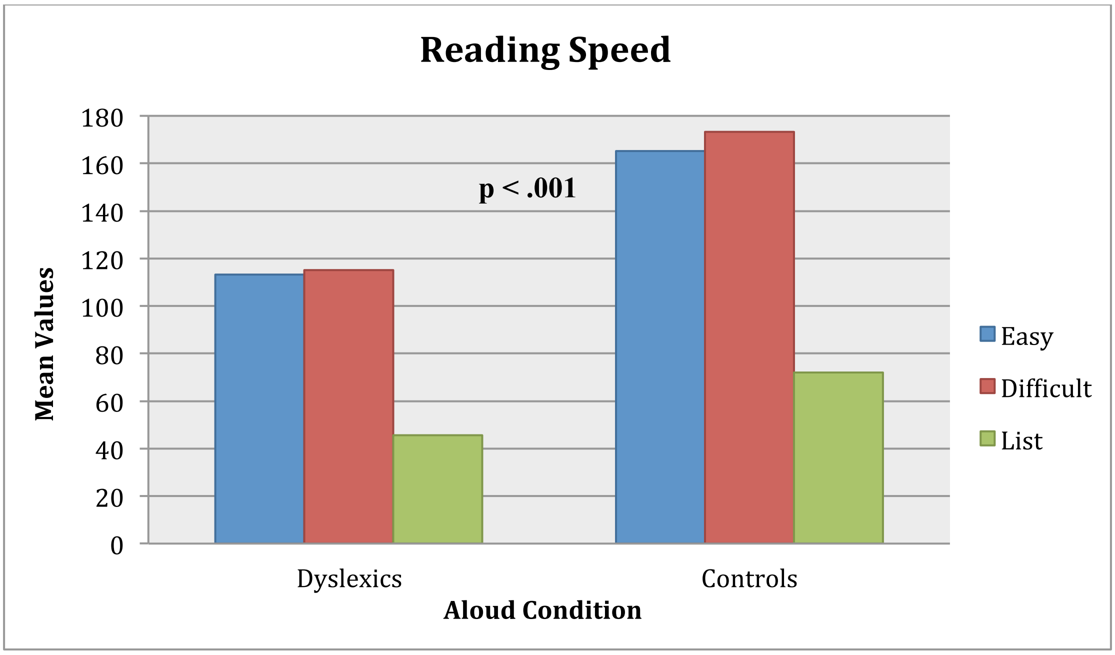
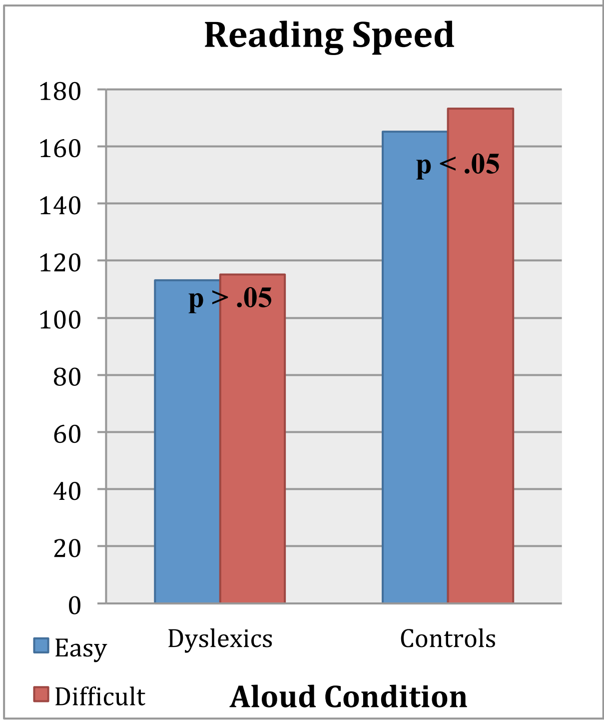


Figure 14(a). Mean values representing both groups' aloud reading speed (words/1′) in all reading materials. As shown in the figure, both dyslexics and controls read the difficult text slightly faster than the easier, with the difference being statistically significant only for the control group ($p < .05$). Conversely, the reading speed of both groups was highly slower in the list of words compared to the other 2 materials ($p < .001$).



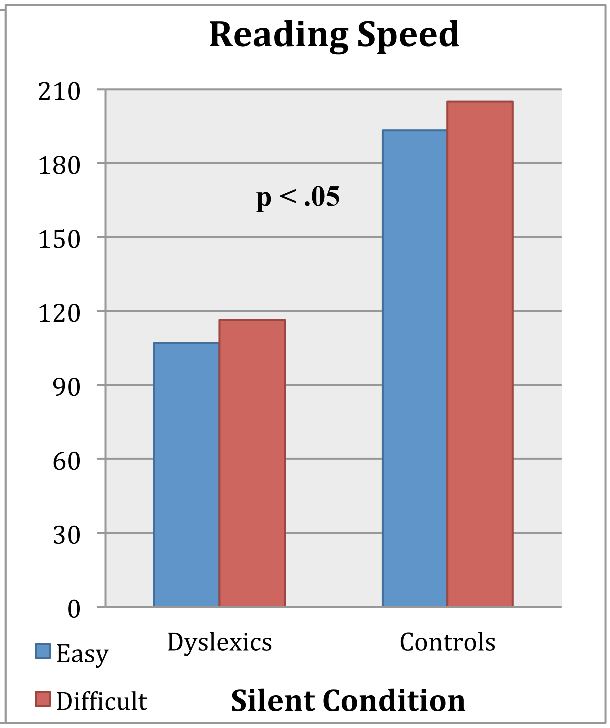


Figure14(b). Mean values representing the reading speed of dyslexics and controls in the easy and difficult text in both reading conditions (aloud & silent). In an overall view, both groups read significantly faster the difficult text ($p < .05$), irrespective of whether reading aloud or silently, except for dyslexics in the aloud condition, who read the 2 texts at almost the same rate ($p > .05$).

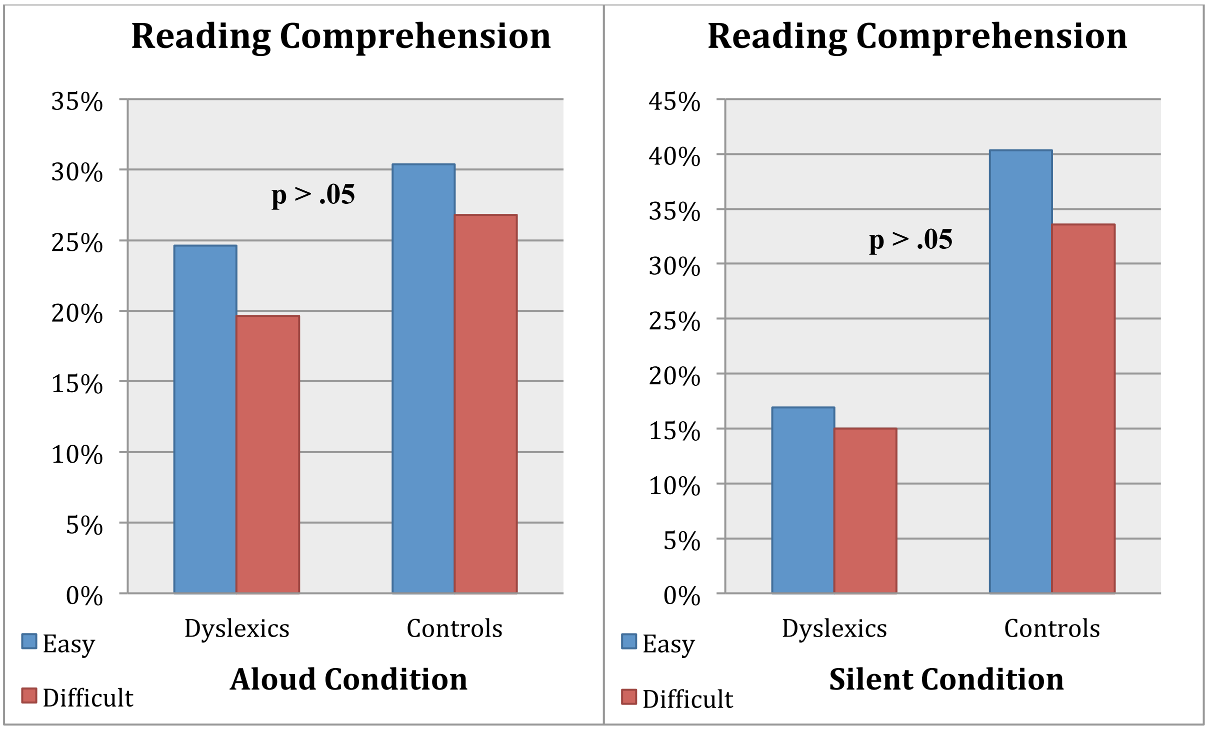


Figure14(c). Mean values representing the level of reading comprehension (%) attained by the 2 groups in the easy and difficult text in both reading conditions (aloud & silent). Generally, both groups, irrespective of whether having read aloud or silently, comprehended consistently better the easier material, albeit not significantly ($p > .05$).

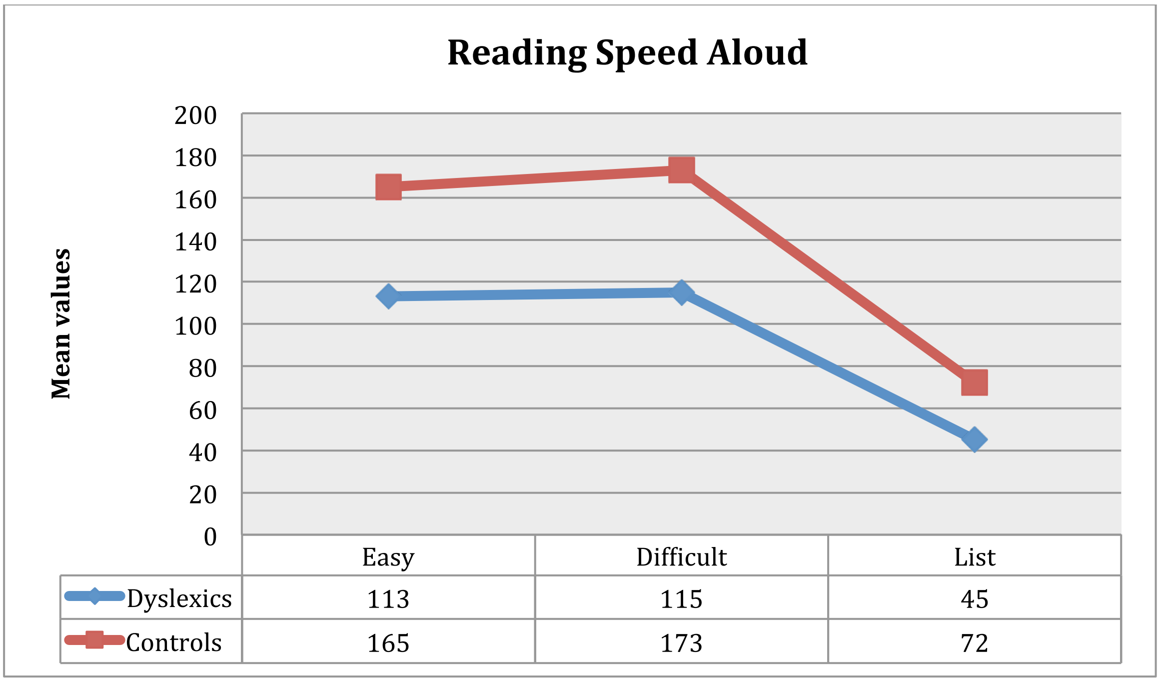


Figure 14(d). As obvious from the above figure, dyslexics and controls were similarly affected in terms of reading speed by the reading material *(easy text, difficult text & word list)*. Dyslexics read only 2% faster the more difficult material, similarly to controls, who read it 5% faster. Regarding the list of words, dyslexics read 61% more slowly the word list compared to the difficult material. Similarly, controls read the list 58% more slowly than the difficult text. Finally, it is noteworthy that dyslexics were consistently slower than controls in all reading materials.

3.3.3.2. Reading Accuracy Within Groups

Before processing in any main statistical analysis, aiming to investigate whether there were differences within each group among the different reading materials in terms of reading accuracy, the normality of the sample should be explored.

Assessing normality: As stated earlier (p.272), since the same participants were tested in 3 different experimental conditions, a repeated-measures design seemed appropriate for the next step of the statistical analysis. According to normality tests, the vast majority of the reading errors variables were not normally distributed ($p < .05$) for either group. Therefore, the non-parametric Friedman's ANOVA was applied for further analysis (Field, 2009), aiming to investigate in which reading material dyslexics and controls were less accurate.

However, ANOVA may tell us if there was a significant difference among the experimental conditions, but without indicating which condition differed from which. Thus, post-hoc tests designed to compare all different combinations of experimental conditions using the Wilcoxon-signed-rank test followed. Regarding these comparisons, a Bonferroni correction was applied and so instead of using .05 as the critical value of significance, a value of .05 divided by the number of tests conducted was used; in this case, all effects are reported at .05/3 = .017 level of significance, as there were 3 possible comparisons among the reading materials: Easy – Difficult, Easy – List, Difficult – List (Field, 2009, p.577). The reading errors that significantly differed in quantity among the reading materials are reported below, presented per group:

a) Dyslexics

Main Hypothesis tested

H_1: The reading errors of dyslexics will increase over the course of the reading materials (easy – difficult – list), resulting in more reading errors in the list.

H_0: The reading errors of dyslexics will not increase over the course of the reading materials (easy – difficult – list).

Sub-Hypotheses tested: Several sub-hypotheses have been tested, each of which was related to each single category of reading errors. The sub-hypotheses followed the pattern:

H_1: *Hems, Repetitions, Syllabication, etc*. errors of dyslexics will increase over the course of the reading materials, resulting in more errors in the list.

H_0: *Hems, Repetitions, Syllabication, etc*. errors of dyslexics will not increase over the course of the reading materials.

Hems

Hems errors made by dyslexics significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 17.15$, $p < .001$. Wilcoxon tests, used to follow up this finding, showed that hesitation errors were significantly more in the List of Words (Mdn = 13.00) compared to both Easy (Mdn = 6.00), $T = 31.00$, $z = –3.670$, $p < .001$, $r = –.51$ and Difficult text (Mdn = 6.25), $T = 32.00$, $z = –3.645$, $p < .001$, $r = –.51$. However, hems did not significantly differ between the Easy and the Difficult text ($p > .017$).

Repetitions

Repetitions errors made by the dyslexic group were significantly different in quantity over the 3 materials, $\chi^2(2) = 21.38$, $p < .001$. Post hoc tests using Wilcoxon signed-rank test revealed that dyslexics made significantly more repetitions in the Difficult (Mdn = 10.17) compared to the Easy text (Mdn = 6.38), $T = 85.00$, $z = –2.299$, $p < .017$, $r = –.32$. Furthermore, they made significantly more repetitions in the Word List (Mdn = 15.00) compared to both Easy, $T = 24.00$, $z = –3.727$, $p < .001$, $r = –.52$, and Difficult text, $T = 44.00$, $z = –3.340$, $p < .001$, $r = –.46$.

Syllabication

Syllabication errors of dyslexics significantly differed among the 3 reading materials, $\chi^2(2) = 36.57$, $p < .001$. Post hoc tests revealed that they made significantly more syllabications in the Word List (Mdn = 6.67) compared to both Easy (Mdn = 0.00), $T = 8.00$, $z = –4.256$, $p < .001$, $r = –.59$, and Difficult text (Mdn = 0.75), $T = 0.00$, $z = –4.458$, $p < .001$, $r = –.62$. However, syllabications in the Easy text did not significantly differ from the Difficult ($p > .017$).

Substitutions

Substitutions errors made by the group of dyslexics were significantly different among the 3 reading materials, $\chi^2(2) = 16.91$, $p < .001$. Wilcoxon tests were used to follow up this finding. Results showed that dyslexics made significantly more substitutions in the List (Mdn = 4.67) compared to either Easy (Mdn = 1.67), $T = 29.50$, $z = –3.709$, $p < .001$, $r = –.51$, or Difficult text (Mdn = 2.68), $T = 39.00$, $z = –3.467$, $p < .001$, $r = –.48$. However, substitutions did not significantly differ between the Easy and Difficult materials ($p > .017$).

Reversals

Reversals errors of dyslexics significantly differed over the 3 materials, $\chi^2(2) = 10.75$, $p < .05$. Post hoc tests using Wilcoxon signed-rank test revealed that dyslexics made significantly more reversals only in the List (Mdn = 0.00) compared to the Easy text (Mdn = 0.00), $T = 0.00$, $z = –2.646$, $p < .017$, $r = –.37$. Reversals did not significantly differ in the Difficult text (Mdn = 0.00) compared to the Easy or the Word List ($p > .017$).

Additions

Additions errors of dyslexics significantly differed among the 3 reading materials, $\chi^2(2) = 6.71$, $p < .05$. Post hoc tests revealed that they made significantly more additions only in the Easy text (Mdn = 0.00) compared to the Difficult (Mdn = 0.00), $T = 11.00$, $z = –2.616$, $p < .017$, $r = –.36$. However, additions did not significantly differ in the List (Mdn = 0.00) compared to both the Easy and Difficult texts ($p > .017$).

Misintonation

Misintonation errors of dyslexics were significantly different in quantity over the 3 reading materials, $\chi^2(2) = 13.58$, $p < .05$. Post hoc tests using Wilcoxon signed-rank test revealed that misintonations were significantly more in the Difficult (Mdn = 0.89) than in the Easy text (Mdn = 0.00), $T = 57.00$, $z = –2.471$, $p < .017$, $r = –.34$, as well as in the Word List (Mdn = 1.66) compared to either Easy, $T = 26.50$, $z = –3.402$, $p < .001$, $r = –.47$, or Difficult materials, $T = 0.00$, $z = –4.236$, $p < .001$, $r = –.59$.

Pseudo-Words

Pseudo-Words created by dyslexics were significantly different in quantity among the 3 materials, $\chi^2(2) = 14.61$, $p < .001$. Post hoc tests using Wilcoxon signed-rank test revealed that they read significantly more pseudo-words in the List (Mdn = 2.33) compared to both Easy (Mdn = 1.00), $T = 26.50$, $z = –3.664$, $p < .001$, $r = –.51$, and Difficult texts (Mdn = 0.75), $T = 29.00$, $z = –3.722$, $p < .001$, $r = –.62$. However, pseudo-words did not differ in the Easy from the Difficult text ($p > .017$).

Wrong Words

Wrong Words read by the dyslexic group significantly differed in quantity over the 3 reading materials, $\chi^2(2) = 16.69$, $p < .001$. Wilcoxon tests, used to follow up this finding, showed that they read significantly more wrong words in the List (Mdn = 26.33) compared to either the Easy (Mdn = 15.54), $T = 25.50$, $z = –3.810$, $p < .001$, $r = –.53$, or Difficult text (Mdn = 17.58), $T = 45.00$, $z = –3.315$, $p < .001$, $r = –.46$. However, wrong words did not significantly differ from Easy to Difficult ($p > .017$).

Total Errors

Total Errors made by the group of dyslexics significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 27.00$, $p < .001$. Post hoc tests using Wilcoxon signed-rank test followed up this finding. Results revealed that they made significantly more reading errors in the List of Words (Mdn = 50.34) compared to both the Easy (Mdn = 21.62), $T = 11.00$, z = –

4.178, $p < .001$, $r = -.58$, and Difficult material (Mdn = 23.69), $T = 16.00$, $z = -4.051$, $p < .001$, $r = -.56$. However, total reading errors did not significantly differ between Easy and Difficult ($p > .017$).

Timing Errors

Timing Errors made by dyslexics significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 24.31$, $p < .001$. Post hoc tests using Wilcoxon signed-rank test followed up this finding. Results revealed that they made significantly more timing errors in the List of Words (Mdn = 39.66) compared to both the Easy (Mdn = 14.26), $T = 10.00$, $z = -4.204$, $p < .001$, $r = -.58$, and Difficult material (Mdn = 17.13), $T = 11.00$, $z = -4.178$, $p < .001$, $r = -.58$. However, timing errors did not significantly differ between Easy and Difficult ($p > .017$).

Accuracy Errors

Accuracy Errors made by the group of dyslexics significantly differed among the 3 reading materials, $\chi^2(2) = 12.00$, $p < .05$. Post hoc tests revealed that they made significantly more accuracy errors in the List (Mdn = 10.67) compared to both the Easy (Mdn = 6.00), $T = 40.00$, $z = -3.441$, $p < .001$, $r = -.48$, and Difficult material (Mdn = 8.59), $T = 76.00$, $z = -2.527$, $p < .017$, $r = -.35$. However, accuracy errors did not significantly differ between Easy and Difficult ($p > .017$).

These findings suggest that all experimental hypotheses regarding the above categories of reading errors, which increased over the course of the reading materials and were found to be significantly more in the List, should be accepted as true **(Hypotheses accepted)**. Even though not each single category of reading errors did significantly increase over the course of the reading materials, the main experimental hypothesis should be accepted, as the total reading errors of dyslexics significantly increased over the 3 materials, resulting in highly more reading errors in the list of words **(Hypothesis accepted)**.

Table 15. Dyslexics' Reading Errors Differences Among Reading Materials

Dyslexics		**Reading Material**								
	Easy	**Difficult**	**List**	**Significance Level**			**Ratio %**			
Variables		**Mean Values**		**Easy-Difficult**	**Easy-List**	**Difficult-List**	**E/D**	**E/L**	**D/L**	**Overall Significance**
Hems	9.28	9.66	17.14	.195	.000	.000	**96**	**54**	**56**	**.000**
Repetitions	9.12	11.22	21.62	.010	.000	.000	**81**	**42**	**52**	**.000**
Syllabication	1.58	1.24	9.49	.404	.000	.000	**127**	**17**	**13**	**.000**
Substitutions	2.29	2.64	4.85	.334	.000	.000	**87**	**47**	**54**	**.000**
Reversals	0.00	0.03	0.18	.500	.008	.117	**0**	**0**	**17**	**.008**
Additions	0.74	0.18	0.56	.003	.293	.071	**411**	**132**	**32**	**.033**
Misintonation	0.52	1.06	2.39	.006	.000	.000	**49**	**22**	**44**	**.001**
Pseudo-Words	0.94	0.85	3.95	.421	.000	.000	**111**	**24**	**22**	**.000**
Wrong Words	17.76	20.26	26.51	.031	.000	.000	**88**	**67**	**76**	**.000**
Timing Errors	20.35	22.66	48.88	.045	.000	.000	**90**	**42**	**46**	**.000**
Accuracy Errors	6.79	8.67	12.39	.029	.000	.005	**78**	**55**	**70**	**.002**
Total Errors	27.12	31.41	62.18	.030	.000	.000	**86**	**44**	**51**	**.000**

Notice: The columns under the Significance Level heading indicate the level of significance for each possible comparison between pairs of materials *(Easy – Difficult, Easy – List, Difficult – List)*, while the last column indicates the overall significance of Friedman's ANOVA among all 3 reading materials. It is obvious that the quantity of reading errors in the List mainly contributed to the overall significance of Friedman's ANOVA. The 3 columns under the Ratio heading indicate the error ratio values between each possible combination of reading materials. With regard to the total reading errors, dyslexics made 56% and 49% more reading errors in the list compared to the easy and difficult text, respectively, whereas they made only 14% more errors in the difficult text than in the easy.

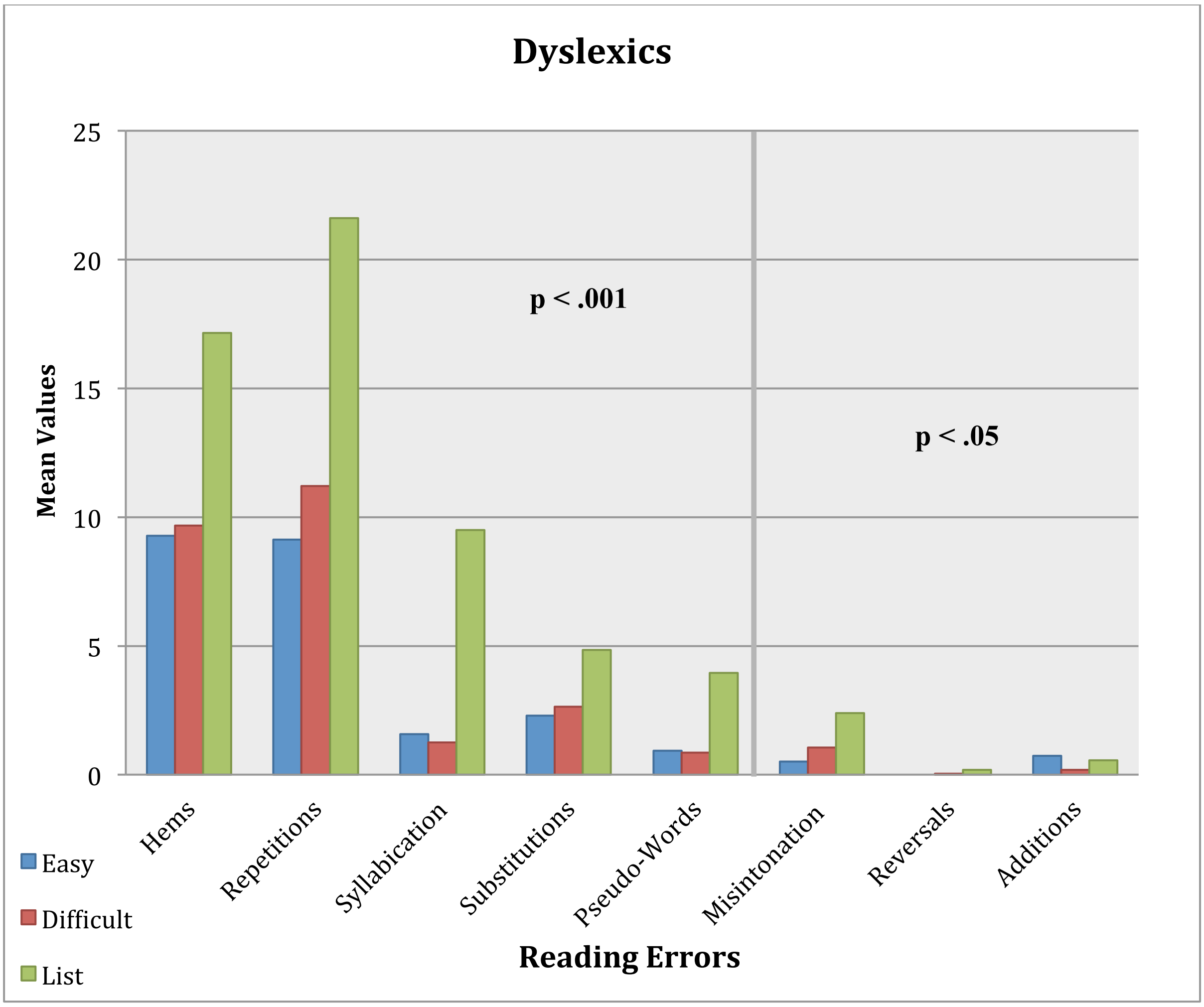


Figure 15(a). Mean values representing dyslexics' reading errors in all 3 materials. Statistically significant differences were found among materials in the above categories. Hems, Repetitions, Syllabication, Substitutions, and Pseudo-Words were highly different in quantity among the reading materials ($p < .001$). As obvious, dyslexics made significantly more reading errors in the list compared to both texts ($p < .001$ & $p < .017$), whereas the difference in the reading errors between easy and difficult texts was mostly non-significant ($p > .017$).

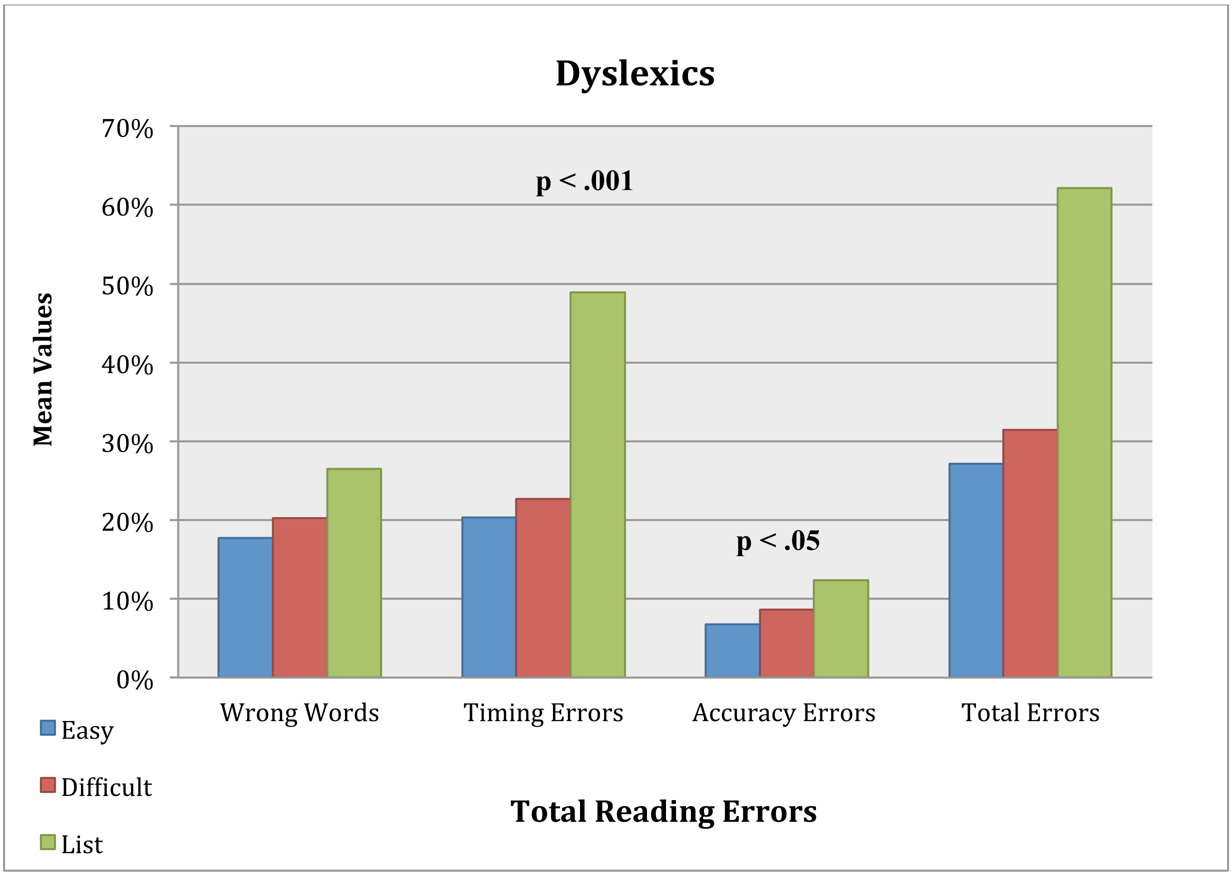


Figure 15(b). Mean values representing the total percent of reading errors made by dyslexics in all reading materials, the timing and accuracy errors, as well as the percentage of words they incorrectly read. Significant differences were found among the reading materials ($p < .001$ & $p < .05$). Dyslexics read significantly more Wrong Words, while they made significantly more timing, accuracy and total reading errors in the list compared to both texts ($p < .001$ & $p < .017$). However, the corresponding differences between easy and difficult texts were not significant ($p > .017$).

b) Controls

Main Hypothesis tested

H_1: The reading errors of non-dyslexics will increase over the course of the reading materials (easy – difficult – list), resulting in more reading errors in the list.

H_0: The reading errors of non-dyslexics will not increase over the course of the reading materials.

Sub-Hypotheses tested: Several sub-hypotheses have been tested, each of which was related to each different category of reading errors. These sub-hypotheses followed the pattern:

$\mathbf{H_1}$: *Hems, Repetitions, Syllabication, etc.* errors of non-dyslexics will increase over the course of the reading materials, resulting in more errors in the List.

$\mathbf{H_0}$: *Hems, Repetitions, Syllabication, etc.* errors of non-dyslexics will not increase over the course of the reading materials.

Hems

Hems errors made by controls significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 8.10$, $p < .05$. Wilcoxon tests, used to follow up this finding, showed that hesitation errors were significantly more in the List of Words (Mdn = 1.33) compared to both Easy (Mdn = 0.50), $T = 21.50$, $z = -3.274$, $p < .001$, $r = -.44$, and Difficult text (Mdn = 0.82), $T = 46.00$, $z = -2.416$, $p < .017$, $r = -.32$. However, hems in the Easy did not significantly differ from the Difficult material ($p > .017$).

Repetitions

Repetitions errors made by the control group were significantly different over the 3 materials, $\chi^2(2) = 6.52$, $p < .05$. Post hoc tests using Wilcoxon signed-rank test revealed that non-dyslexics made significantly more repetitions in the List (Mdn = 2.00) only compared to the Difficult material (Mdn = 0.89), $T = 54.00$, $z = -2.920$, $p < .017$, $r = -.39$. However, the difference was not significant between the List and the Easy text (Mdn = 1.67) as well as between the Easy and Difficult materials ($p > .017$).

Syllabication

Syllabication errors of controls significantly differed among the 3 reading materials, $\chi^2(2) = 17.89$, $p < .001$. Post hoc tests revealed that they made significantly more syllabications in the Word List (Mdn = 0.00) compared to both Easy (Mdn = 0.00), $T = 6.00$, $z = -2.614$, $p < .017$, $r = -.35$, and Difficult text (Mdn = 0.00), $T = 0.00$, $z = -2.966$, $p < .001$, $r = -.40$. However, syllabications did not differ between Easy and Difficult materials ($p > .017$).

Substitutions

Substitutions errors made by the group of controls were significantly different among the 3 reading materials, $\chi^2(2) = 23.47$, $p < .001$. Wilcoxon tests that followed up this finding showed that non-dyslexics made significantly more substitutions in the List (Mdn = 1.33) compared to the Easy (Mdn = 0.00), $T = 6.00$, $z = –4.134$, $p < .001$, $r = –.55$, and Difficult text (Mdn = 0.00), $T = 21.00$, $z = –3.690$, $p < .001$, $r = –.49$. However, substitutions did not significantly differ from Easy to Difficult ($p > .017$).

Endings

Endings errors made by non-dyslexics significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 23.41$, $p < .001$. Wilcoxon tests, used to follow up this finding, revealed that endings significantly differed between the Easy (Mdn = 0.00) and Difficult text (Mdn = 0.75), $T = 12.00$, $z = –3.370$, $p < .001$, $r = –.45$, as well as between the List (Mdn = 0.00) compared to both Easy, $T = 8.00$, $z = –2.288$, $p < .017$, $r = –.31$, and Difficult text, $T = 29.00$, $z = –2.844$, $p < .017$, $r = –.38$.

Pseudo-Words

Pseudo-Words created by non-dyslexics were significantly different in quantity among the 3 reading materials, $\chi^2(2) = 5.95$, $p < .05$. Post hoc tests revealed that they read significantly more pseudo-words only in the List of Words (Mdn = 0.67) compared to the Difficult material (Mdn = 0.00), $T = 45.00$, $z = –2.246$, $p < .017$, $r = –.30$. However, pseudo-words did not significantly differ between Easy (Mdn = 0.00) and Difficult and between Easy and List ($p > .017$).

Non-Corrected Errors

Non-Corrected errors of the control group significantly differed among the 3 materials, $\chi^2(2) = 7.17$, $p < .05$. Post hoc tests using Wilcoxon signed-rank test revealed that non-dyslexics did not correct significantly more of their errors in the Difficult text (Mdn = 88.20) compared to either the Easy (Mdn = 50.00), $T = 64.50$, $z = –2.642$, $p < .017$, $r = –.35$, or the Word List

(Mdn = 58.57), $T = 16.50$, $z = –3.572$, $p < .001$, $r = –.48$. However, the amount of errors they left uncorrected in the Easy material was not significantly different from the List ($p > .017$).

Wrong Words

Wrong Words read by the control group significantly differed in quantity over the 3 reading materials, $\chi^2(2) = 12.52$, $p < .05$. Wilcoxon tests were used to follow up this finding. Results showed that they read significantly more wrong words only in the Difficult (Mdn = 5.80) compared to the Easy text (Mdn = 2.85), $T = 62.00$, $z = –3.051$, $p < .017$, $r = –.41$. However, wrong words in the List (Mdn = 4.00) did not significantly differ from either Easy or Difficult texts ($p > .017$).

Timing Errors

Timing Errors made by non-dyslexics significantly differed in quantity among the 3 reading materials, $\chi^2(2) = 11.50$, $p < .05$. Post hoc tests revealed that they made significantly more timing errors in the List (Mdn = 4.66) compared to either Easy (Mdn = 2.35), $T = 80.50$, $z = –2.413$, $p < .017$, $r = –.32$, or Difficult text (Mdn = 2.40), $T = 40.00$, $z = –3.442$, $p < .001$, $r = –.46$. However, timing errors in the Easy text did not significantly differ from the Difficult ($p > .017$).

Accuracy Errors

Accuracy Errors in the non-dyslexics' group significantly differed among the 3 reading materials, $\chi^2(2) = 9.51$, $p < .05$. Wilcoxon tests, used to follow up this finding, showed that accuracy errors significantly differed only between the Easy (Mdn = 2.52) and Difficult text (Mdn = 3.56), $T = 48.00$, $z = –3.081$, $p < .017$, $r = –.41$. However, accuracy errors in the List (Mdn = 2.66) did not differ significantly from either Easy or Difficult materials ($p > .017$).

Total Errors

Total Errors made by the group of non-dyslexic students did not significantly increase in quantity over the course of the 3 reading materials, $\chi^2(2) = 4.96$, $p > .05$.

These findings suggest that the experimental hypotheses regarding Hems, Repetitions, Syllabication, Substitutions, Pseudo-Words, and Timing errors, which increased over the course of the reading materials and were found to be significantly more in the list, should be accepted **(Hypotheses accepted)**. Conversely, the experimental hypotheses regarding Endings, Non-Corrected Errors, Wrong Words, and Accuracy errors should be rejected, as there may have been a significant difference in the quantity of reading errors among materials, but not for the List as predicted **(Hypotheses rejected)**.

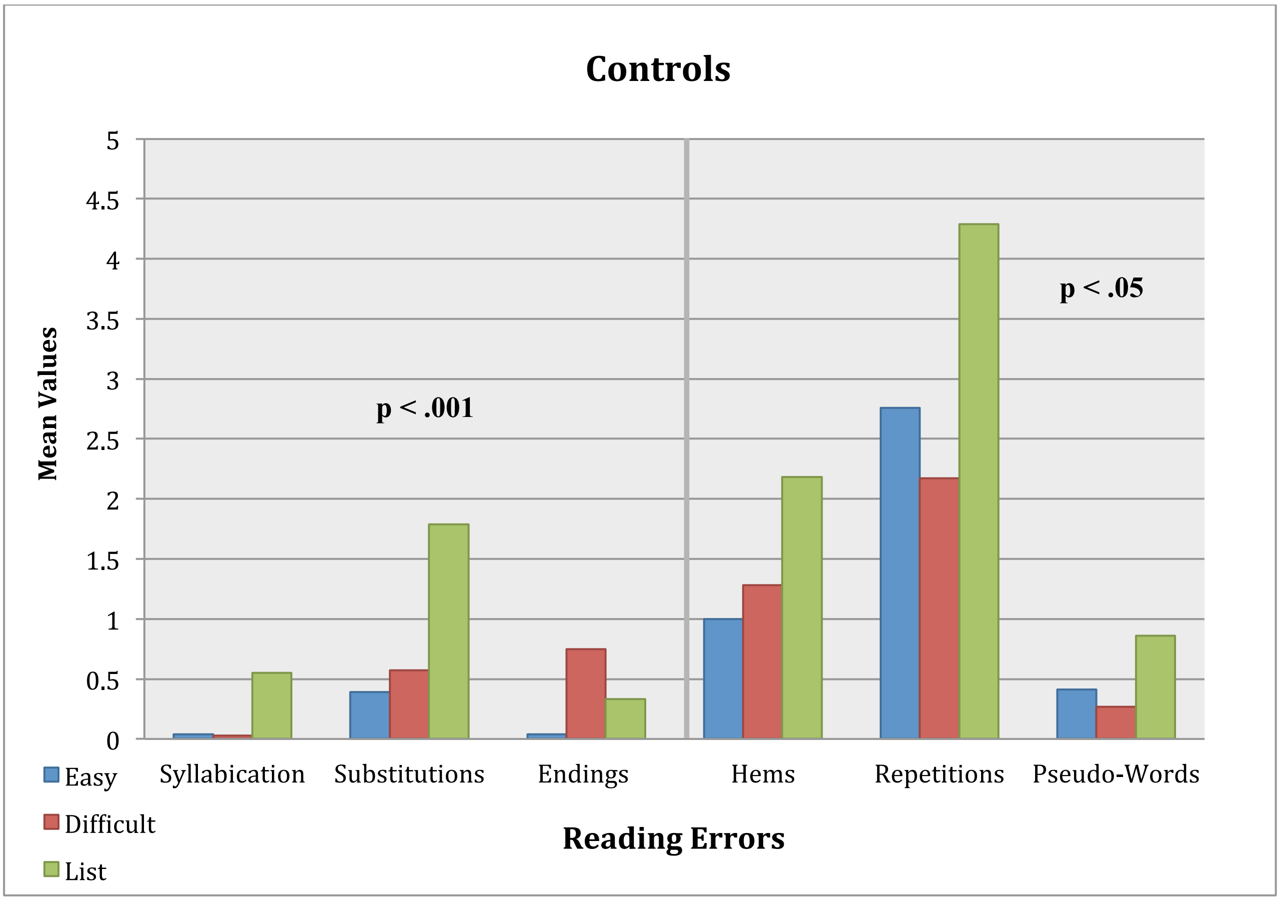
Even though non-dyslexics' reading errors of most categories significantly differed in quantity among the 3 reading materials, their total reading errors did not significantly increase over the course of the reading materials, and, hence, the main experimental hypothesis cannot be accepted **(Hypothesis rejected)**.

Table 16. Controls' Reading Errors Differences Among Reading Materials

Controls	**Reading Material**									
	Easy	**Difficult**	**List**	**Significance Level**			**Ratio**			
Variables	**Mean Values**			**Easy-Difficult**	**Easy-List**	**Difficult-List**	**E/D**	**E/L**	**D/L**	**Overall Significance**
Hems	1.00	1.28	2.18	.123	.000	.007	**78**	**45**	**59**	**.016**
Repetitions	2.76	2.17	4.29	.203	.086	.001	**127**	**64**	**51**	**.037**
Syllabication	0.04	0.03	0.55	.500	.004	.000	**133**	**73**	**5**	**.000**
Substitutions	0.39	0.57	1.79	.206	.000	.000	**68**	**22**	**32**	**.000**
Endings	0.04	0.75	0.33	.000	.015	.001	**5**	**12**	**227**	**.000**
Pseudo-Words	0.41	0.27	0.86	.206	.054	.012	**152**	**48**	**31**	**.048**
Non-Corrected Errors	52.21	81.19	59.59	.003	.205	.000	**64**	**88**	**136**	**.026**
Wrong Words	3.99	5.85	5.45	.001	.022	.090	**68**	**73**	**107**	**.002**
Timing Errors	3.77	3.53	7.01	.403	.007	.000	**94**	**54**	**50**	**.003**
Accuracy Errors	2.36	3.49	3.22	.001	.080	.103	**68**	**73**	**92**	**.008**
Total Errors	6.16	6.99	10.36	–	–	–	**88**	**59**	**67**	**.084**

<u>Notice</u>: The columns under the Significance Level heading indicate the level of significance for each possible comparison between pairs of materials *(Easy – Difficult, Easy – List &Difficult – List)*, whereas the last column

indicates the overall significance of Friedman's ANOVA among all 3 reading materials. The 3 columns under the Ratio heading indicate the error ratio values between each possible combination of reading materials. With regard to the total reading errors, dyslexics made 41% and 33% more reading errors in the list compared to the easy and difficult text, respectively, whereas they made only 12% more errors in the difficult text than in the easy.



<u>**Figure 16(a)**</u>. Mean values representing non-dyslexics' reading errors in all materials. Statistically significant differences were found among materials in the above categories. Syllabications, Substitutions, and Endings were highly different in quantity among the reading materials ($p < .001$). On average, non-dyslexics made significantly more reading errors in the list compared to the 2 texts ($p < .001$ or $p < .017$), except for Endings, which were significantly more in the difficult text ($p < .001$ and $p < .017$), whereas the difference in the reading errors between easy and difficult texts was usually non-significant ($p > .017$).

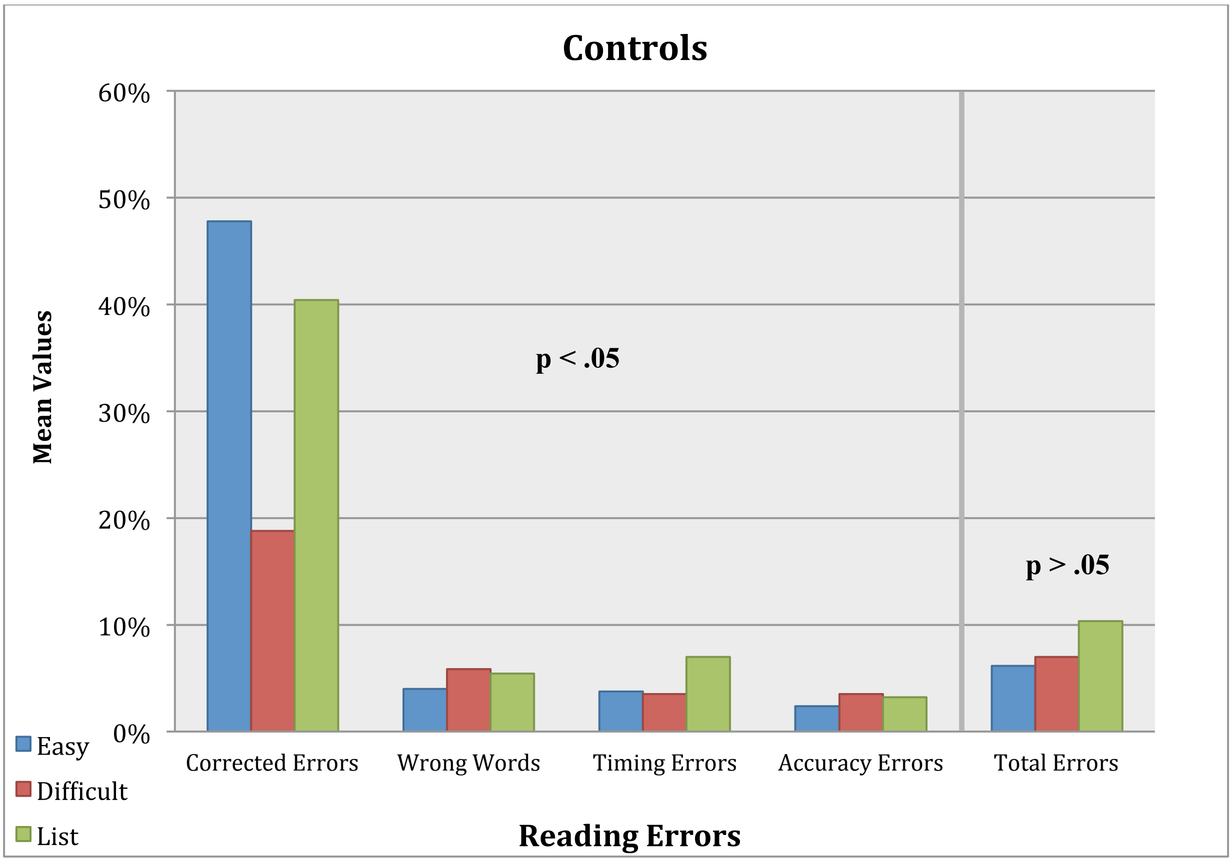


Figure 16(b). Mean values representing the total percent of reading errors made by non-dyslexics in all reading materials, the percent of timing and accuracy errors, as well as their corrected errors and the of words they incorrectly read. Significant differences were found among the reading materials in Corrected Errors, Wrong Words, Timing & Accuracy Errors ($p < .05$). Non-Dyslexics corrected significantly less of their errors in the difficult text compared to the other 2 materials ($p < .017$ & $p < .001$). Additionally, they read less Wrong Words in the easy text, but the difference was significant only compared to the Difficult ($p < .017$). Finally, they made significantly more Timing errors in the list ($p < .017$), while more Accuracy errors in the difficult text but only when compared to the Easy ($p < .017$). However, their Total Errors did not significantly differ in quantity among the 3 reading materials ($p > .05$).

<u>Summary</u>: Reading Errors Among Reading Materials

In an overall view, both groups made more reading errors in the list compared to the 2 texts. As obvious from the following figures, dyslexics made significantly more reading errors in total in the list compared to the easy and difficult text. However, this was not the case for controls, whose reading errors did not significantly differ among the reading materials. The differences in the amount of reading errors between the easy and difficult text were insignificant for either group.

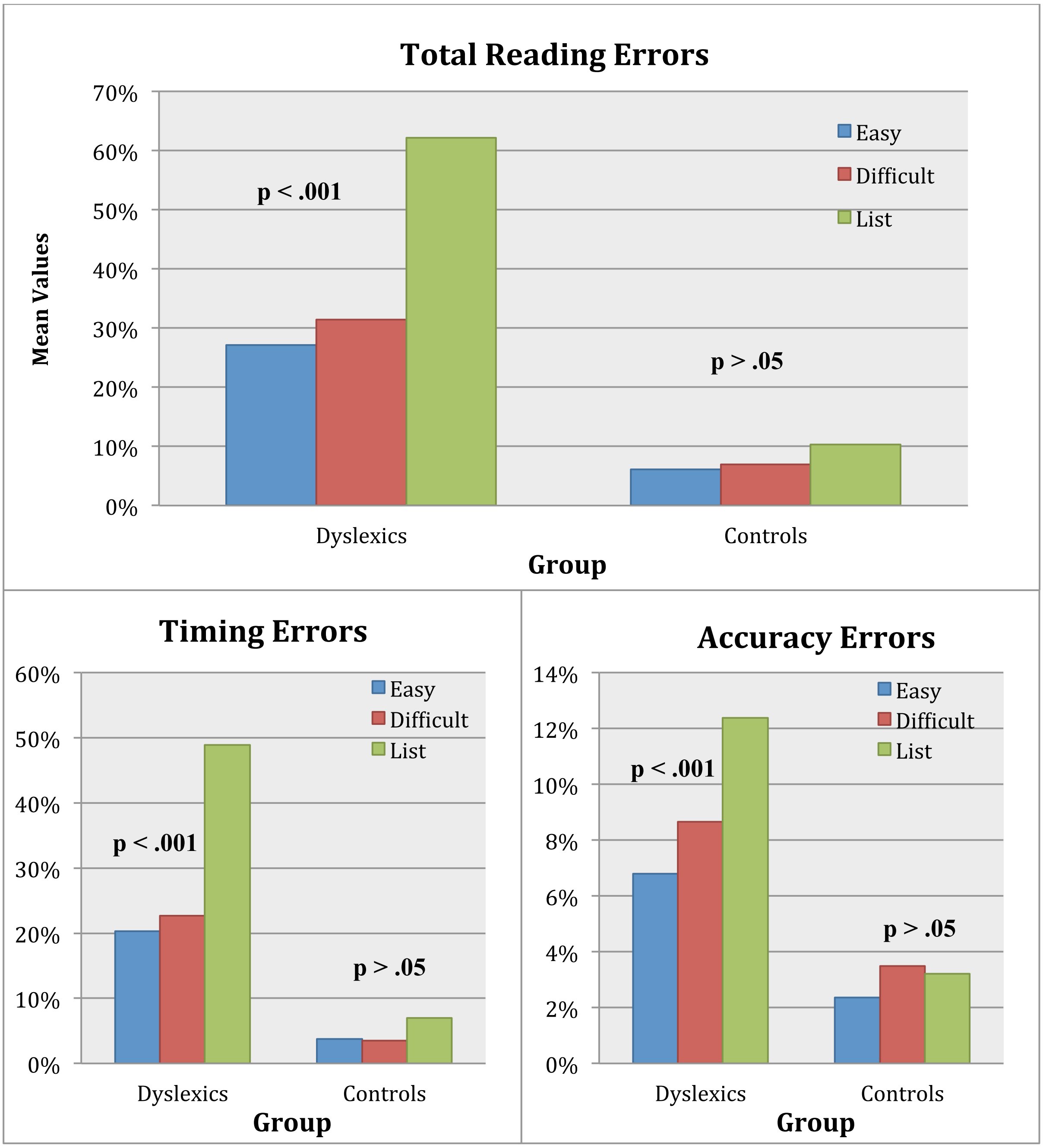
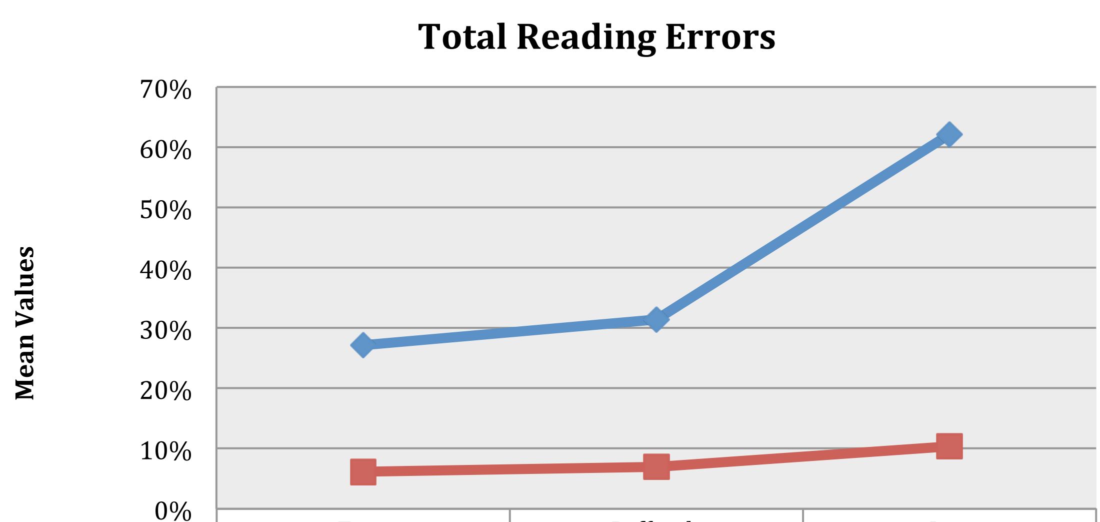
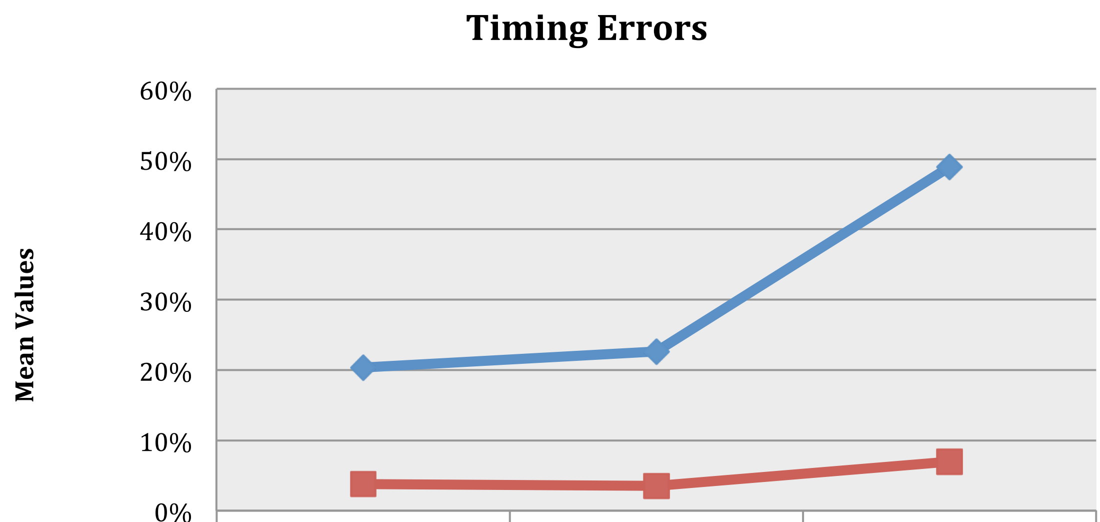


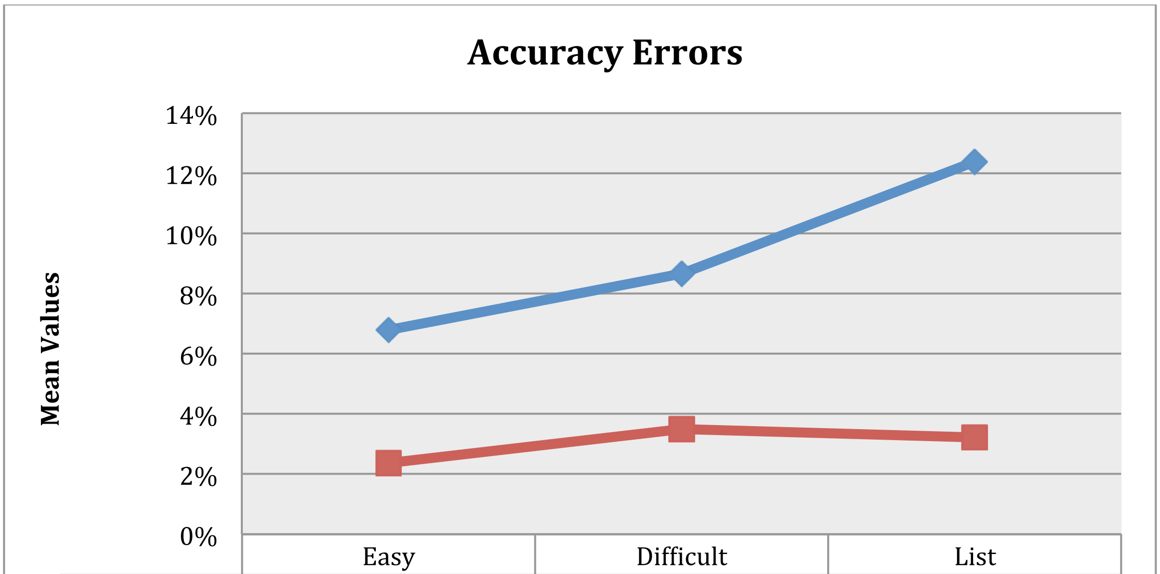
Figure 17(a). Mean values representing the total amount of reading errors as well as the timing and accuracy errors made by both groups in all 3 reading materials. As obvious, dyslexics were consistently significantly less accurate in the list (p < .001), whereas the reading errors of controls did not significantly increase over the course of the reading materials (p > .05). In fact, with regard to accuracy errors, non-dyslexics made more such errors in the difficulty text.



	Easy	Difficult	List
Dyslexics	27.12%	31.41%	62.18%
Controls	6.16%	6.99%	10.36%



	Easy	Difficult	List
Dyslexics	20.35%	22.65%	48.88%
Controls	3.77%	3.53%	7.01%



	Easy	Difficult	List
Dyslexics	6.79%	8.67%	12.39%
Controls	2.36%	3.49%	3.22%

Figures 17(b). As obvious from the above figures, dyslexics were far more affected by the reading material (text or list) in terms of the reading errors they made. Whilst both dyslexics and controls respectively made 14% and 12% more reading errors in total in the difficult text compared to the easy, the former made 50% more reading errors in the list in contrast to the latter who made 33% more errors in the list in comparison to the difficult text. A similar pattern was displayed with regard to timing errors. Dyslexics made 55% more timing errors in the list, as opposed to non-dyslexics who made 46% more timing errors. Finally, in terms of accuracy errors, whereas dyslexics' accuracy errors steadily increased (22% from easy to difficult, and 30% from the difficult to the list), controls' accuracy errors increased 32% from the easy to the difficult text, but decreased 8% from the difficult to the list. Generally, it is remarkable that an abrupt increase in the reading errors of dyslexics is observed in the word list as opposed to controls.

3.3.4. Quality of Reading Errors: Frequent & Infrequent Reading Errors

The purpose of the current section was to find out the kind of reading errors made by adult dyslexic and non-dyslexic students and to detect the more and less frequent ones. For this reason, the percentage (%) of each category of reading errors in relation to the total amount of errors was calculated and the resulting percents were then sorted in descending order using the corresponding command of the Microsoft Excel program. Therefore, the highest values corresponded to the more frequent reading errors, while the lowest to the less frequent ones.

The equation used for the calculation of the percentage of each category in the total amount of reading errors was:

$$\%\ \text{errors of x category} = \frac{\text{number of errors of x category}}{\text{total errors}} \times 100.$$

The findings are presented per group for each reading material:

3.3.4.1. Easy Text

a) Dyslexics

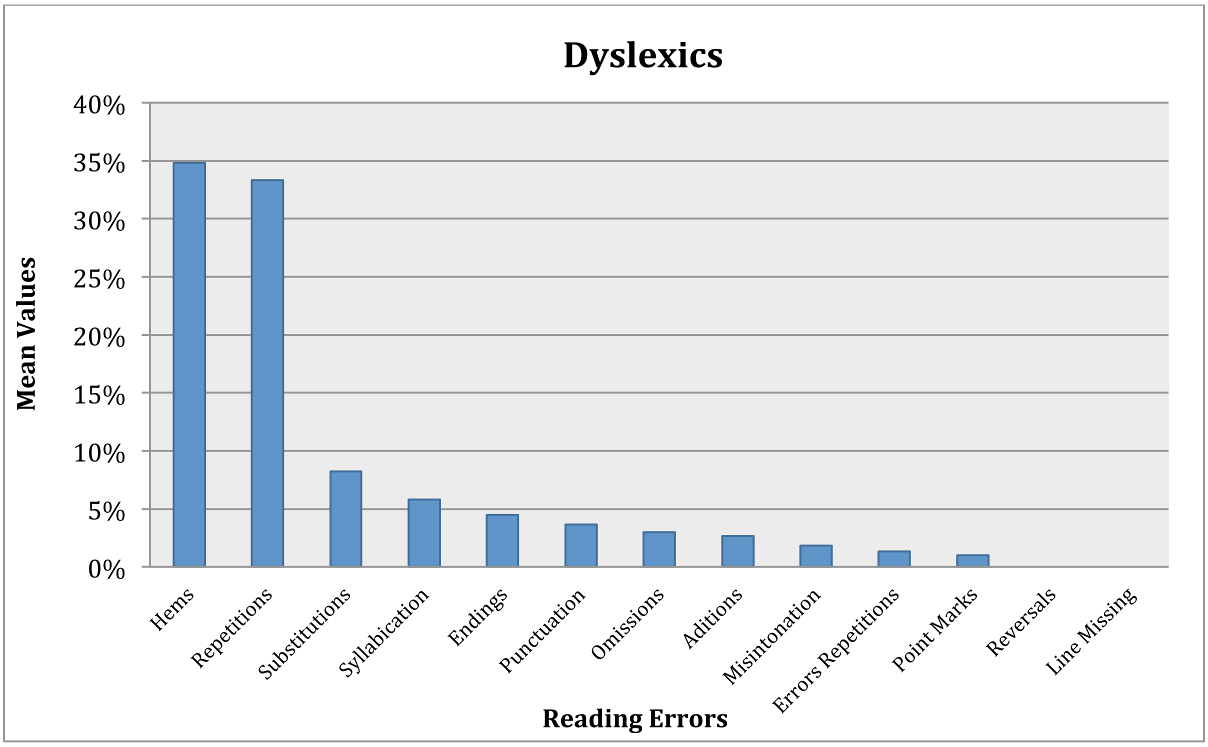


Figure 18(a). Mean values representing the more and less frequent errors of dyslexic University students made while reading the easy text. As obvious, their more frequent reading errors were Hems and Repetitions, representing percents of 34.82% and 33.33% of the total errors, respectively, followed by far by Substitutions (8.25%). Conversely, the less frequent ones were Line Missing and Reversals, both representing 0% of the total errors, followed by Point Marks, which corresponded to only 0.61% of the total errors.

b) Controls

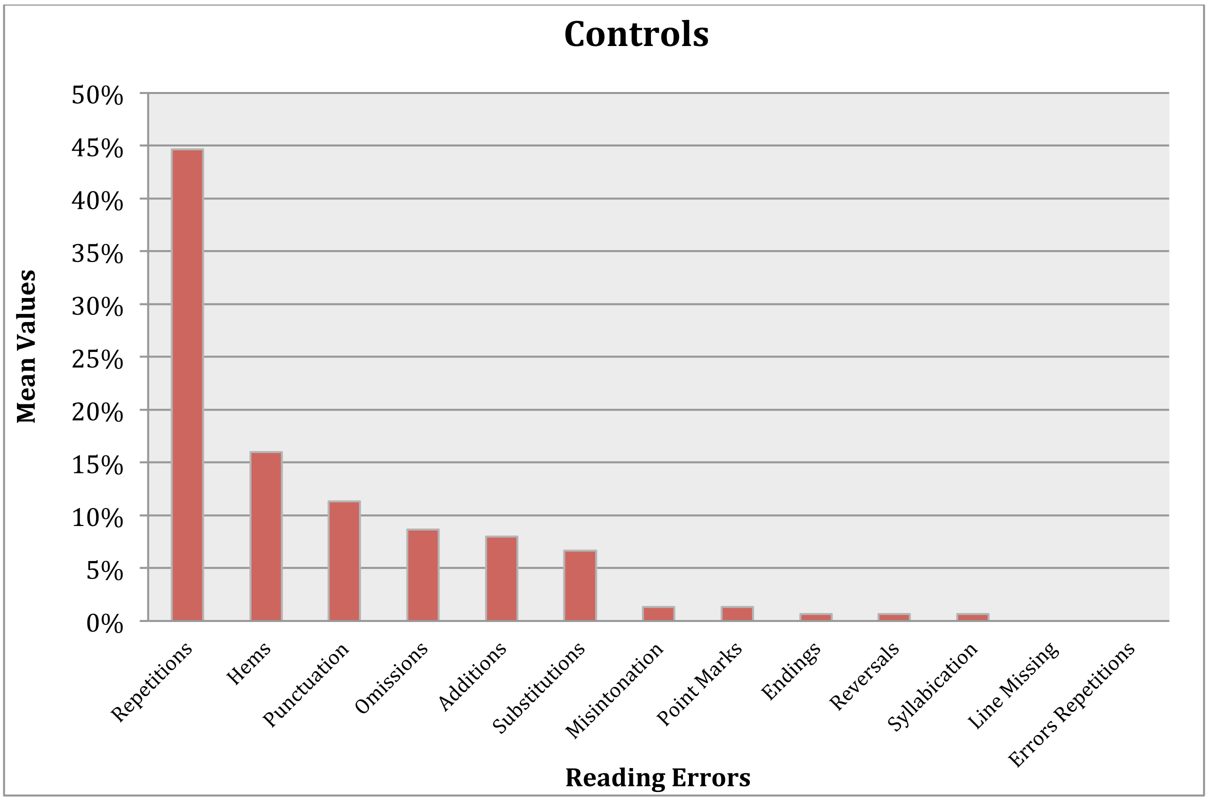


Figure 18(b). Mean values representing the more and less frequent errors made by non-dyslexics while reading the easy material. As shown, their more frequent errors were Repetitions, which corresponded to 44.67% of the total errors, followed by Hems and Punctuation errors (16.00% and 11.33%, respectively). Conversely, the less frequent errors were Errors Repetitions and Line Missing, both corresponding to 0%, followed by Syllabication, Reversals and Endings, each category representing only 0.67% of the total reading errors.

Table 17. Ranking Order of the Reading Errors made by Dyslexics & Controls in the Easy Text

Dyslexics			Controls		
Hems	8.1	34.82%	Repetitions	2.4	44.67%
Repetitions	7.8	33.33%	Hems	0.9	16%
Substitutions	1.9	8.25%	Punctuation	0.6	11.33%
Syllabication	1.3	5.78%	Omissions	0.5	8.67%
Endings	1	4.46%	Additions	0.4	8%
Punctuation	0.8	3.63%	Substitutions	0.4	6.67%
Omissions	0.7	2.97%	Misintonation	0.1	1.33%
Additions	0.6	2.64%	Point Marks	0.1	1.33%
Misintonation	0.4	1.82%	Endings	0.04	0.67%
Errors Repetitions	0.3	1.32%	Reversals	0.04	0.67%
Point Marks	0.2	0.99%	Syllabication	0.04	0.67%
Reversals	0	0%	Line Missing	0	0%
Line Missing	0	0%	Errors Repetitions	0	0%
Total	**23.3**	**100%**	**Total**	**5.4**	**100%**

Looking at the above table, it is very interesting to notice that the ranking order of the reading errors made while reading the easy text is similar for both groups. Precisely, Hems and Repetitions seem to be the most frequent errors made by both dyslexic and non-dyslexic students exceeding half of their errors. Conversely, Line Missing, Errors Repetitions, Reversals, Misintonation and Point Marks are among the less frequent ones. However, it is remarkable that, even though Endings and Syllabication errors are located relatively on the top of the ranking for dyslexics, they are among the most infrequent for the control group.

3.3.4.2. Difficult Text

a) Dyslexics

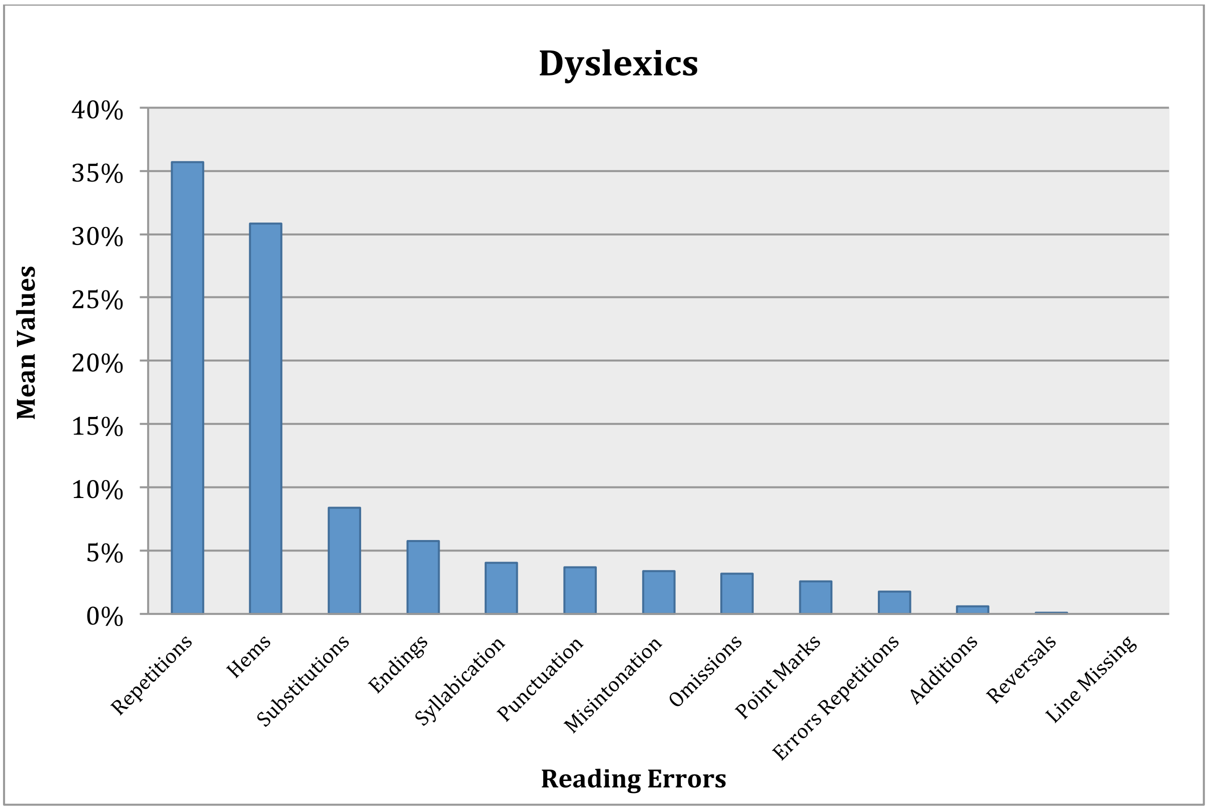


Figure 19(a). Mean values representing the more and less frequent errors of dyslexics made while reading the difficult material. Their more frequent reading errors were Repetitions and Hems, corresponding to 35.71% and 30.86% of the total errors, respectively, followed by far by Substitutions, representing 8.41%. On the other hand, the less frequent one was Line Missing (0% of the total errors), followed by Reversals and Additions, which represented percents as small as 0.10% and 0.59%, respectively.

b) Controls

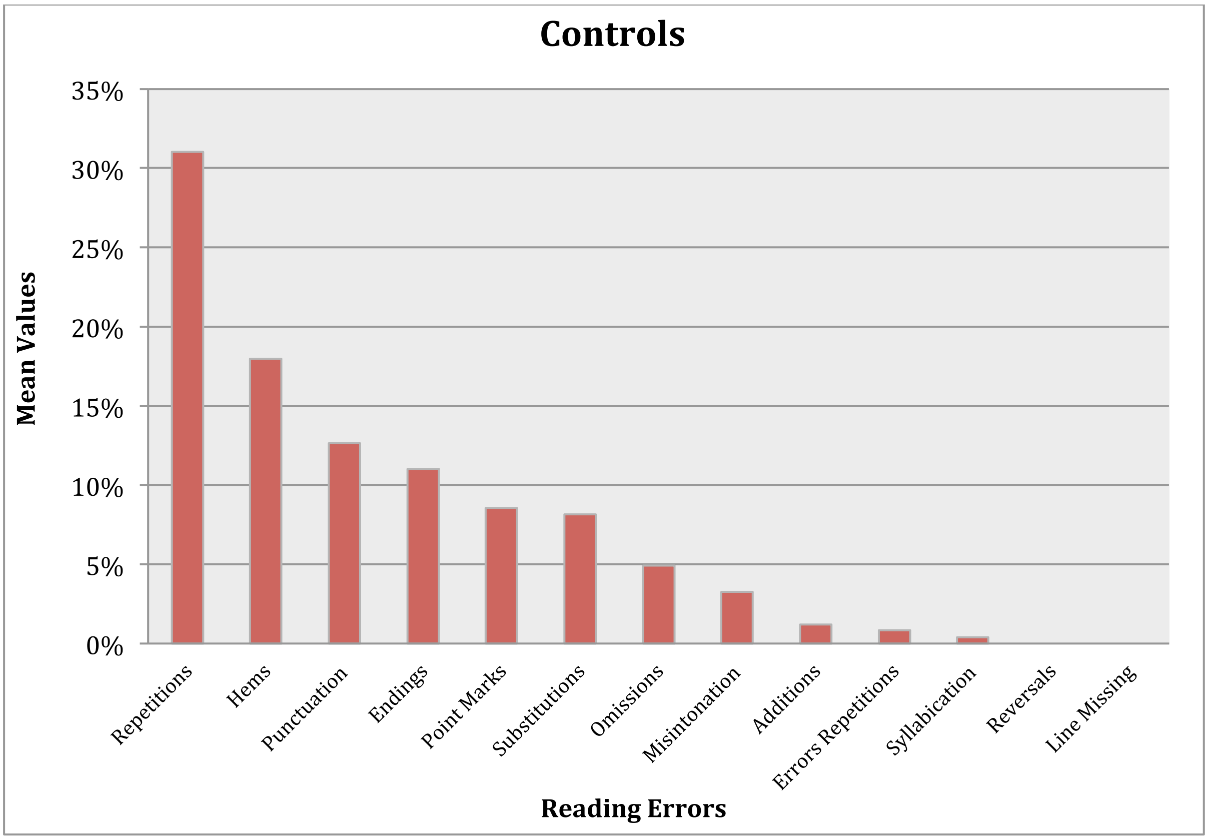


Figure 19(b). Mean values representing the more and less frequent errors made by controls, when reading the difficult text. As shown in the figure, their more frequent errors were Repetitions, which corresponded to 31.02% of their total errors, followed by Hems and Punctuation errors, representing percents of 17.96% and 12.65%, respectively. Conversely, their less frequent ones were Line Missing and Reversals (0%), followed by Syllabication, which represented a percent as small as 0.41% of the total errors made.

Table 18. Ranking Order of the Reading Errors made by Dyslexics & Controls in the Difficult Text

Dyslexics			**Controls**		
Repetitions	13.9	35.71%	Repetitions	2.7	31.02%
Hems	12	30.86%	Hems	1.6	17.96%
Substitutions	3.3	8.41%	Punctuation	1.1	12.65%
Endings	2.2	5.74%	Endings	1	11.02%
Syllabication	1.6	4.06%	Point Marks	0.8	8.57%
Punctuation	1.4	3.66%	Substitutions	0.7	8.16%
Misintonation	1.3	3.36%	Omissions	0.4	4.90%
Omissions	1.2	3.17%	Misintonation	0.3	3.27%
Point Marks	1	2.57%	Additions	0.1	1.22%
Errors Repetitions	0.7	1.78%	Errors Repetitions	0.1	0.82%
Additions	0.2	0.59%	Syllabication	0.04	0.41%
Reversals	0.04	0.10%	Reversals	0	0%
Line Missing	0	0%	Line Missing	0	0%
Total	**38.9**	**100%**	**Total**	**8.8**	**100%**

Looking at the table, it is really noteworthy that the ranking order of the reading errors made in the difficult material is similar for both groups. Similarly to the easy text, Hems and Repetitions are the more frequent errors made by both groups, significantly exceeding half of their errors for dyslexics, and constituting almost half of controls' errors. Substitutions, Endings and Punctuation follow in the ranking order. Conversely, Line Missing, Reversals, Errors Repetitions, and Additions are among the less frequent ones. However, like in the easy material, it is remarkable that Syllabication errors seem to be relatively frequent for dyslexics, but are among the most infrequent for controls.

3.3.4.3. List of Words

a) Dyslexics

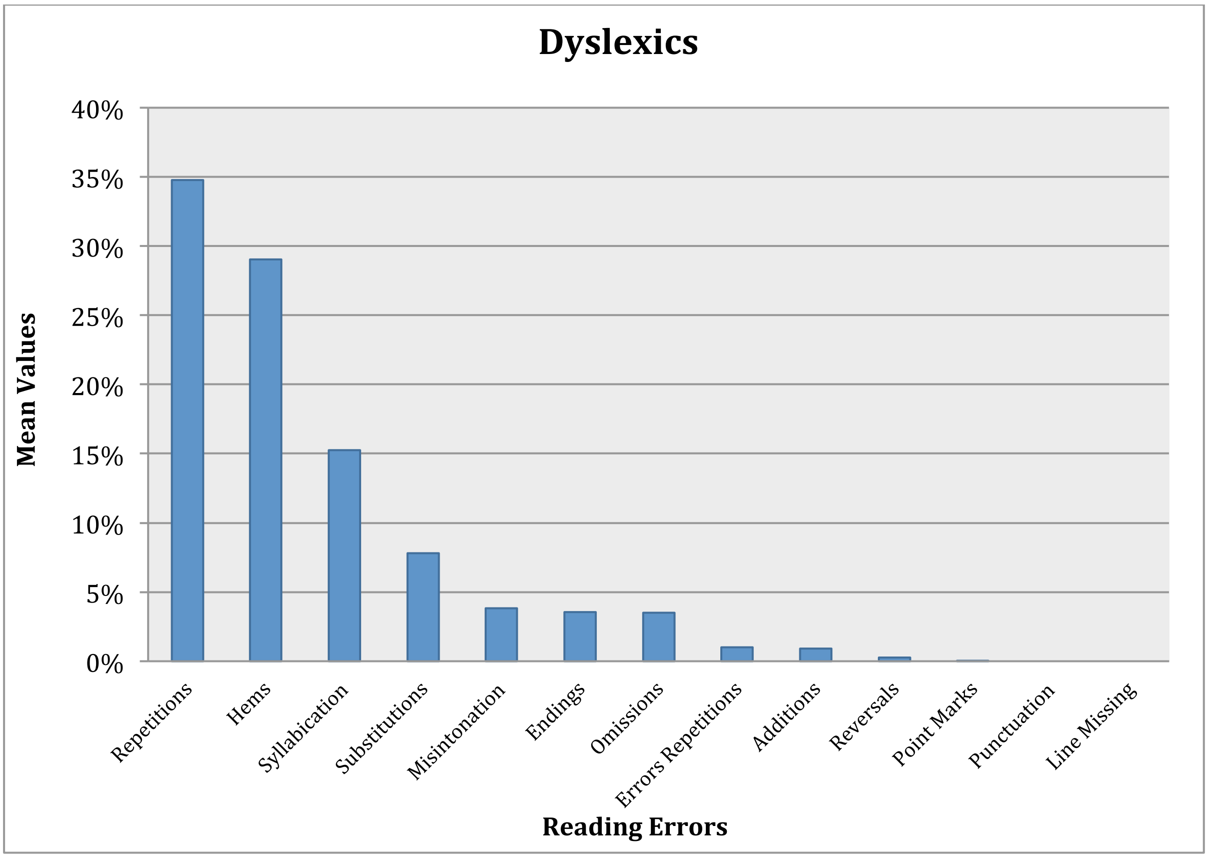
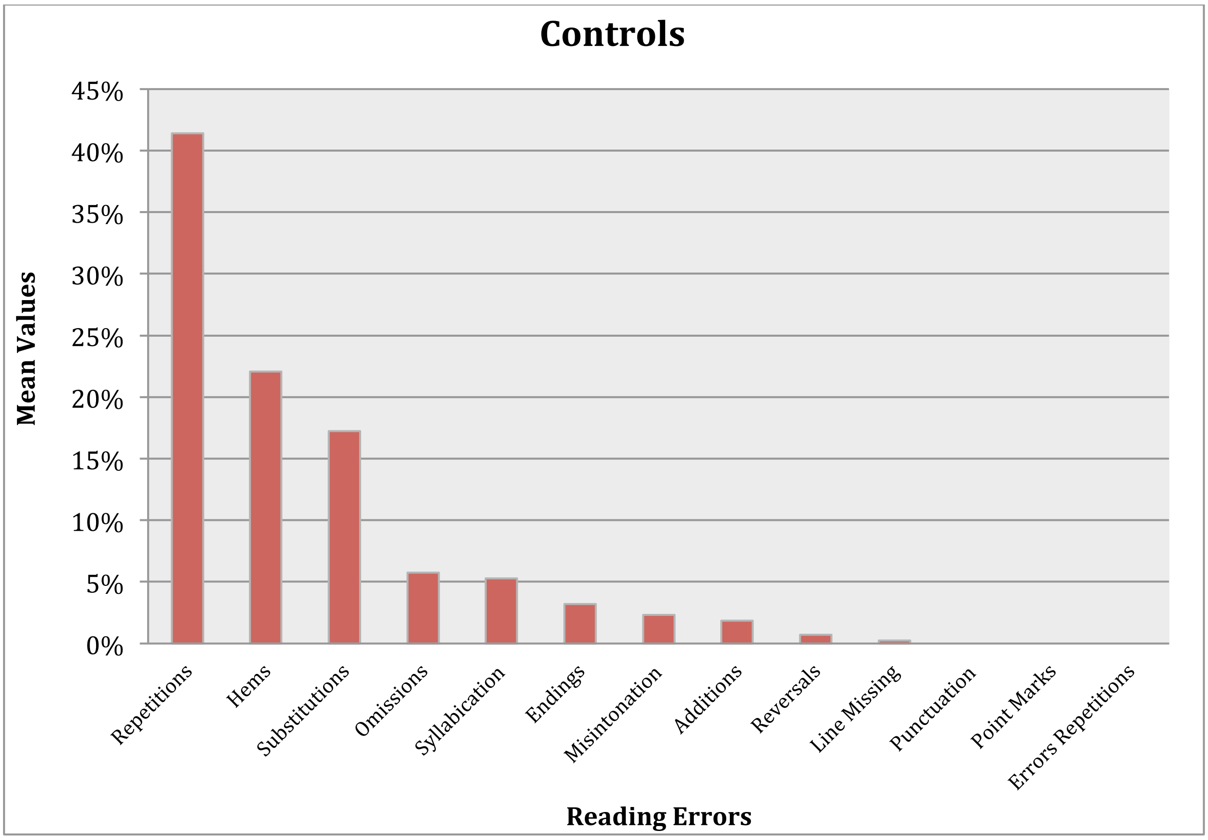


Figure 20(a). Mean values representing the more and less frequent errors of dyslexics made while reading the word list. It is obvious that their more frequent errors were Repetitions and Hems, which corresponded to 34.76% and 29.03% of the total errors, respectively, followed by far by Syllabication (15.26%). Conversely, their less frequent ones were Line Missing and Punctuation, both corresponding to 0% of the total errors, followed by Point Marks, which represented a percentage as small as 0.04%.

b) Controls



<u>Figure 20(b)</u>. Mean values representing the more and less frequent errors made by non-dyslexics in the word list. Their more frequent errors were Repetitions, which corresponded to 41.38% of the total errors, followed by Hems and Substitutions (22.07% and 17.24%, respectively). Conversely, the less frequent errors were Errors Repetitions, Point Marks and Punctuation, all corresponding to 0%, followed by Line Missing, which represented a percent as small as 0.23% of the total errors.

Table 19. Ranking Order of the Reading Errors made by Dyslexics & Controls in the List of Words

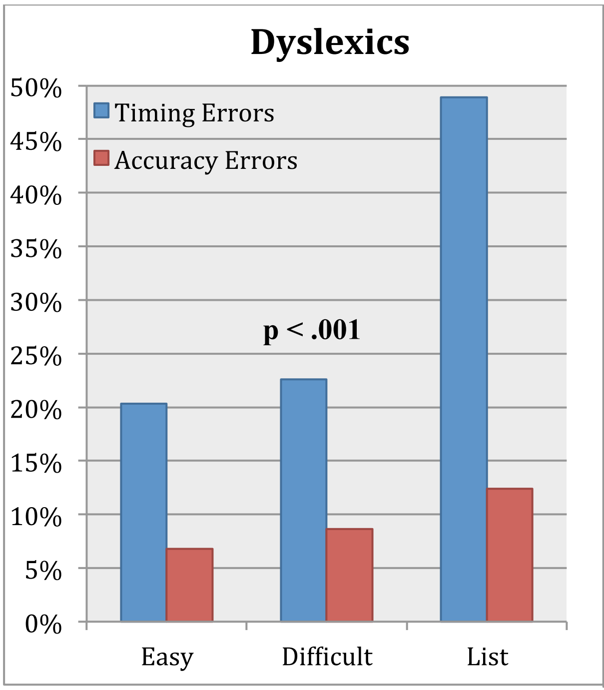
Dyslexics			Controls		
Repetitions	32.4	34.76%	Repetitions	6.4	41.38%
Hems	27.1	29.03%	Hems	3.4	22.07%
Syllabication	14.2	15.26%	Substitutions	2.7	17.24%
Substitutions	7.3	7.79%	Omissions	0.9	5.75%
Misintonation	3.6	3.84%	Syllabication	0.8	5.29%
Endings	3.3	3.55%	Endings	0.5	3.22%
Omissions	3.3	3.51%	Misintonation	0.4	2.30%
Errors Repetitions	1	1.03%	Additions	0.3	1.84%
Additions	0.8	0.91%	Reversals	0.1	0.69%
Reversals	0.3	0.29%	Line Missing	0.04	0.23%
Point Marks	0.04	0.04%	Punctuation	0	0%
Punctuation	0	0%	Point Marks	0	0%
Line Missing	0	0%	Errors Repetitions	0	0%
Total	**93.3**	**100%**	**Total**	**15.5**	**100%**

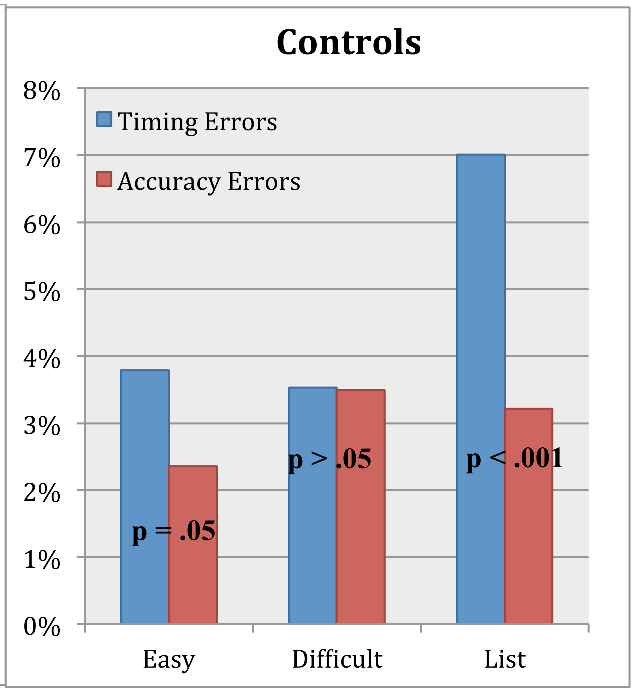
Looking at the above table, it is very interesting to observe that the ranking order of the reading errors made while reading the list of words is almost identical for both groups. In detail, Repetitions and Hems seem to be the most frequent errors made by both groups, significantly exceeding half of their total errors. Substitutions, Syllabications, Endings, Omissions and Misintonations follow in the ranking order. Conversely, Line Missing, Point Marks, Punctuation, Reversals, Errors Repetitions, and Additions are the less frequent ones for either group. It is noteworthy that in the List, compared to the other 2 reading materials, both groups show exactly the same pattern in terms of the kind and frequency of the reading errors they made.

Summary: Quality of Reading Errors

To sum up, it is concluded that both dyslexic University students and normal controls made similar reading errors in all 3 materials administered to them. The two most frequent categories were always identical (Repetitions & Hems) between groups. Minimum deviations existed, such as Syllabication errors, in the easy and difficult texts, which seemed to be more frequent in dyslexics, having a relatively high position in the ranking order, in contrast to non-dyslexics, for whom Syllabications were among the most infrequent errors. Nevertheless, this deviant pattern was not supported by the list of words, where the ranking order of the reading errors tended to be exactly the same for the 2 groups.

As obvious from the following figures, dyslexics made highly more **timing errors** *(= errors that reduce their reading speed, namely, Hems, Repetitions, and Syllabications),* whereas less **accuracy errors** *(= errors that negatively influence the accuracy of reading, such as Substitutions, Omissions, Misintonation, and Punctuation)* in all reading materials. On the other hand, controls made highly more timing errors only in the list of words, while barely significantly more in the easy material. In the difficult text, they made comparable timing and accuracy errors.





3.3.5. Reading Speed, Comprehension & Accuracy Correlations

The relationship among reading speed, comprehension and accuracy within each group was investigated. As discussed earlier, since only the reading speed variables were normal ($p > .05$), the Spearman's correlation coefficient seemed appropriate for the next step of the statistical analysis (Field, 2009, p.179). The results are presented per reading material for each group separately.

3.3.5.1. Easy Text

Table 20. Correlations among reading components (N = 26, Spearman's correlation coefficients)

Dyslexics	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	.303	–
Reading Errors	–.700**	–.109
Timing Errors	–.668**	–.126
Accuracy Errors	–.531**	–.070
Hems	–.605**	
Repetitions	–.661**	
Syllabication	–.323	
Substitutions	–.623**	
Omissions	–.101	
Punctuation	–.041	
Misintonation	–.332*	

$^{**}p < .01$ $^{*}p < .05$

Looking at the above table, in the easy material, there was a significant negative correlation for dyslexics between the total reading errors they made and their reading speed, $r_s = -.70$, p

(1-tailed) < .01. This finding suggests that as reading errors increase the speed of reading decreases. The subcategories of reading errors, timing and accuracy errors, were both significantly negatively correlated with the reading speed, $r_s = –.67$, p (1-tailed) < .01, and $r_s = –.53$, p (1-tailed) < .01, respectively. Among the timing errors, Repetitions and Hems were the most negatively correlated with reading speed (r_s= –.66, and r_s= –.61, p < .01, respectively), whereas among accuracy errors, Substitutions and Misintonation were mostly correlated with speed (r_s= –.62, p < .01, and r_s= –.33, p < .05). Reading comprehension did not significantly correlate with reading speed nor reading errors.

Table 21. Correlations among reading components (N = 28, Spearman's correlation coefficients)

Controls	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	–.465**	–
Reading Errors	–.266	–.055
Timing Errors	–.185	–.134
Accuracy Errors	–.243	.107
Hems	–.536**	
Repetitions	–.058	
Syllabication	.072	
Substitutions	–.032	
Omissions	–.021	
Punctuation	–.027	
Misintonation	–.173	

**p < .01

In the easy material, the reading speed of non-dyslexics significantly correlated with the level of reading comprehension, $r_s = –.47$, p (1-tailed) < .01. The negative correlation indicates that, as reading speed increases, the level of comprehension decreases. From all categories and subcategories of reading errors only Hems were significantly negatively correlated with reading speed, $r_s = -.54$, $p < .01$. Reading comprehension did not correlate with reading errors.

3.3.5.2. Difficult Text

Table 22. Correlations among reading components (N = 26, Spearman's correlation coefficients)

Dyslexics	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	.107	–
Reading Errors	$-.633^{**}$	–.128
Timing Errors	$-.676^{**}$	–.168
Accuracy Errors	$-.458^{**}$	–.148
Hems	$-.667^{**}$	
Repetitions	$-.678^{**}$	
Syllabication	$-.388^{*}$	
Substitutions	$-.369^{*}$	
Omissions	$-.412^{*}$	
Misintonation	–.105	
Punctuation	–.295	

$^{**}p < .01$ $^{*}p < .05$

As obvious from the previous table, the reading errors made by the dyslexic group were significantly correlated with their reading speed in the difficult material, $r_s = -.63$, p (1-tailed) < .01. The resulting negative correlation indicates that, as reading errors increase, the speed of reading decreases. The main subcategories of reading errors were both significantly negatively correlated with the reading speed, $r_s = -.68$, p (1-tailed) < .01 for timing errors, and

$r_s = -.46$, p (1-tailed) $< .01$ for accuracy errors. All categories of timing errors, Hems, Repetitions and Syllabication, were significantly negatively correlated with reading speed ($r_s = -.67$, $r_s = -.68$, $p < .01$, and $r_s = -.39$, $p < .05$, respectively). Among accuracy errors, only Substitutions and Omissions were significantly correlated with speed ($r_s = -.37$, and $r_s = -.41$, $p < .05$). Reading comprehension did not significantly correlate with reading speed nor with reading errors.

Table 23. Correlations among reading components (N = 28, Spearman's correlation coefficients)

Controls	Reading Speed	Reading Comprehension
Reading Speed	–	
Reading Comprehension	–.119	–
Reading Errors	$-.507^{**}$	.163
Timing Errors	$-.467^{**}$	.109
Accuracy Errors	–.315	.061
Hems	$-.529^{**}$	
Repetitions	$-.340^{*}$	
Syllabication	–.167	
Substitutions	–.311	
Omissions	–.035	
Misintonation	$-.440^{**}$	
Punctuation	–.071	

$^{**}p < .01$ $^{*}p < .05$

As obvious from table 23, there was a significant negative correlation between the amount of reading errors made by non-dyslexics and their reading speed in the difficult text, $r_s = -.51$, p (1-tailed) $< .01$, suggesting that, as reading errors increase, the reading speed decreases. From the main subcategories of reading errors, only timing errors were significantly correlated with reading speed, $r_s = -.47$, p (1-tailed) < .01. Among timing errors, only Hems and Repetitions significantly correlated with reading speed ($r_s = -.53$, $p < .01$, and $r_s = -.34$, $p < .05$, respectively), whereas from accuracy errors only Misintonation significantly correlated with speed, $r_s = -.44$, $p < .01$. Reading comprehension did not significantly correlate with reading speed nor with reading errors.

3.3.5.3. Word List

Table 24. Correlations among reading components (N = 26, Spearman's correlation coefficients)

Dyslexics	Reading Speed Total	Reading Speed 1΄	Reading Speed beyond 1΄
Reading Speed Total	–		
Reading Speed 1΄	.897**	–	
Reading Speed beyond 1΄	948**	.729**	–
Reading Errors	–.785**	–.597**	–.823**
Timing Errors	–.708**	–.455**	–.795**
Accuracy Errors	–.616**	–.512**	–.610**
Hems	–.573**		
Repetitions	–.651**		
Syllabication	–.560**		
Substitutions	–.437*		
Omissions	–.531**		
Misintonation	–.591**		

**p < .01

Looking at the table, the reading errors made by the dyslexic group were significantly negatively correlated with their total reading speed evaluated in the list of words, $r_s = -.79$, (1-tailed) $p < .01$. The negative correlation indicates that, as reading errors increase, the speed of reading decreases. The main subcategories of reading errors were both significantly negatively correlated with the reading speed, $r_s = -.71$, p (1-tailed) < .01 for timing errors, and $r_s = -.62$, p (1-tailed) < .01 for accuracy errors. All 3 categories of timing errors, Hems, Repetitions and Syllabication, were significantly negatively correlated with reading speed ($r_s = -.57$, $r_s = -.65$, $r_s = -.56$, $p < .01$, respectively). Similarly, all accuracy errors, Substitutions, Omissions and Misintonation, were significantly correlated with their reading speed ($r_s = -.44$, $p < .05$, $r_s = -.53$, and $r_s = -.59$, $p < .01$).

Table 25. Correlations among reading components (N = 28, Spearman's correlation coefficients)

Controls	Reading Speed Total	Reading Speed 1΄	Reading Speed beyond 1΄
Reading Speed Total	–		
Reading Speed 1΄	.942**	–	
Reading Speed beyond 1΄	.956**	.826**	–
Reading Errors	–.338*	–.234	–.376*
Timing Errors	–.432*	–.347*	–.435*
Accuracy Errors	–.116	–.018	–.197
Hems	–.528**		
Repetitions	–.212		
Syllabication	–.545**		
Substitutions	–.052		
Omissions	–.220		
Misintonation	–.389*		

**p < .01, *p < .05

Looking at the above table, the reading errors made by non-dyslexics in the word list were significantly negatively correlated with their total reading speed, $r_s = -.34$, (1-tailed) $p < .05$. From the main subcategories of reading errors only timing errors significantly negatively correlated with the reading speed, $r_s = -.43$, p (1-tailed) $< .05$. Among timing errors, Hems and Syllabication were significantly correlated with reading speed ($r_s = -.53$, $r_s = -.55$, $p < .01$, respectively), while only Misintonation from accuracy errors, $r_s = -.39$, $p < .05$.

3.3.6. Logistic Regression

H_1: Dyslexics will be discriminated on reading speed, errors, and comprehension from controls.

H_0: Dyslexics will not be discriminated on reading speed, errors, and comprehension from controls.

Logistic Regression Analysis seemed appropriate, in order to investigate whether we could predict which of the two groups (dyslexics or controls) a participant was likely to belong to, based on certain predictor variables (Field, 2009). Reading errors, speed and comprehension were the predictor variables and group membership was the outcome variable (Field, 2009). Logistic Regression is preferable to Discriminant Analysis, when there are only two categories of the dependent variable, as it is more robust in practice, while it is more flexible having less restrictive assumptions (Field, 2009; Tabachnick & Fidell, 1996), especially when normality is violated.

The logistic regression analyses conducted to predict group membership are presented below per reading material. The method used was the forward stepwise (Likelihood ratio, LR).

3.3.6.1. Easy Text

A logistic regression analysis was conducted, in order to predict the group that participants belong to using reading errors, speed and comprehension as predictors. The silent-reading speed was the predictor entered at step 1, because it had the highest value in the test statistic ($p < .001$). The aloud-reading speed was the second predictor entered at step 2, as it had the next highest score ($p < .001$). A test of the full model at both steps against a constant only model was statistically significant, indicating that predictors reliably distinguished between dyslexics and controls (Step 1: $\chi^2 = 52.92$, $p < .001$. Step 2: $\chi^2 = 66.80$, $p < .001$). R^2 at both steps indicated a strong relationship between prediction and grouping. The logistic regression model at both steps is tabulated below:

Table 26. Logistic Regression Model for the Easy Text

			95% CI for Odds Ratio		
		B (SE)	Lower	Odds Ratio	Upper
	Included				
Step 1	Constant	–18.12 (6.10)			
	Reading Speed Silent	0.13* (0.04)	1.05	1.14	1.24
Step 2	Constant	–150.69 (98.72)			
	Reading Speed Aloud	0.65 (0.42)	0.84	1.92	4.40
	Reading Speed Silent	0.40 (0.28)	0.87	1.50	2.58

Step 1: R^2 = .71 (Hosmer & Lemeshow), .63 (Cox & Snell), .83 (Nagelkerke). Model χ^2 = 52.92, p < .001. * p < .01
Step 2: R^2 = .89 (Hosmer & Lemeshow), .71 (Cox & Snell), .95 (Nagelkerke). Model χ^2 = 66.80, p < .001

Looking at the above table, the odds ratio being greater than 1 indicates that as reading speed increases, the odds of a participant being non-dyslexic increase as well. To be more precise, when reading speed is raised by 1 unit, participants are 1.14 more times at step 1 and 1.92 and 1.50 more times likely to be controls at step 2, respectively. The following table indicates how well the model predicts group membership at both steps:

Table 27. Classification table indicating group membership for the easy text

Classification Table

Observed			Predicted: GROUP: Dyslexics	Predicted: GROUP: Controls	Predicted: Percentage Correct
Step 1	GROUP	Dyslexics	24	2	92.3
		Controls	2	26	92.9
	Overall Percentage				**92.6**
Step 2	GROUP	Dyslexics	25	1	96.2
		Controls	1	27	96.4
	Overall Percentage				**96.3**

At step 1 (1 predictor included: silent-reading speed), the model correctly classifies 24 participants, who were dyslexics, while misclassifies 2 assigning them in the control group (it correctly classifies 92.3% of cases). The model also correctly classifies 26 participants in the control group, but misclassifies 2 others (it correctly classifies 92.9% of cases). Therefore, the overall accuracy of classification is the average of these values, namely **92.6%**.

Obviously, the model at step 1 is significantly predicting whether a participant is dyslexic or not. However, at step 2 (2 predictor variables included: silent & aloud reading speed), the model predicts the outcome better that it previously did. It correctly classifies 25 out of 26 dyslexics, misclassifying only 1 (96.2%), while similarly, it correctly predicts 27 participants, who were non-dyslexics, and misclassifies only 1 (96.4%). The overall accuracy of classification at this step is **96.3%**. This means that the model significantly predicts group membership based on only two variables, silent & aloud reading speed. Hence, **Reading Speed** was found to be the best predictor, in order to differentiate between dyslexics and non-dyslexics.

3.3.6.2. Difficult Text

A logistic regression analysis was conducted to predict the group in which participants belong to using reading errors, speed and comprehension as predictors. The aloud-reading speed was the predictor entered at step 1, as it had the highest score statistic ($p < .001$). The silent-reading speed was entered at step 2, as it had the next highest value ($p < .001$). A test of the full model at both steps against a constant only model was statistically significant, indicating that predictors reliably discriminated between dyslexics and non-dyslexics (Step 1: $\chi^2 = 57.71$, $p < .001$. Step 2: $\chi^2 = 66.54$, $p < .001$). R^2 at both steps indicated a strong relationship between prediction and grouping. The logistic regression model is tabulated below:

Table 28. Logistic Regression Model for the Difficult Text

			95% CI for Odds Ratio		
		B (SE)	Lower	Odds Ratio	Upper
	Included				
Step 1	Constant	–28.80 (10.30)			
	Reading Speed Aloud	0.20^{*} (0.07)	1.06	1.23	1.42
Step 2	Constant	–41.24 (17.55)			
	Reading Speed Aloud	0.19^{**} (0.09)	1.01	1.20	1.44
	Reading Speed Silent	0.10 (0.05)	0.99	1.10	1.22

Step 1: R^2 = .77 (Hosmer & Lemeshow), .66 (Cox & Snell), .88 (Nagelkerke). Model χ^2 = 57.71, p < .001. * p < .01.
Step 2: R^2 = .89 (Hosmer & Lemeshow), .71 (Cox & Snell), .95 (Nagelkerke). Model χ^2 = 66.54, p < .001. ** p < .05

Looking at the table, the odds ratio being greater than 1 indicates that as reading speed increases, the odds of a participant belonging in the control group increase as well. To be more precise, when reading speed is raised by 1 unit, participants are 1.23 more times likely to be controls at step 1 and 1.20 and 1.10 more times at step 2. The following table indicates how well the model predicts group membership at both steps.

Table 29. Classification table indicating group membership for the Difficult Text

Classification Table

Observed			Predicted		
			GROUP		Percentage Correct
			Dyslexics	Controls	
Step 1	GROUP	Dyslexics	25	1	96.2
		Controls	3	25	89.3
	Overall Percentage				**92.6**
Step 2	GROUP	Dyslexics	26	0	100.0
		Controls	1	27	96.4
	Overall Percentage				**98.1**

At step 1 (1 predictor: aloud reading speed), the model correctly classifies 25 participants who were dyslexics, while misclassifies 1 other (it correctly classifies 96.2% of cases). The model also correctly classifies 25 participants belonging in the control group, but misclassifies 3 others assigning them in the dyslexic group (it correctly classifies 89.3% of cases). The overall accuracy of classification is **92.6%**.

Indeed, the model at step 1 is significantly predicting whether a participant is dyslexic or not. At step 2 (inclusion of 2 predictors: aloud & silent reading speed), the model predicts the outcome better that it did at the previous step; the overall accuracy of classification rises from 92.6% to **98.1%**. Precisely, it correctly classifies all participants who were dyslexics (100% of cases), while also correctly classifies 27 participants who were non-dyslexics, misclassifying only 1 (96.4% of cases). This means that the model significantly predicts group membership based on only two variables, aloud & silent-reading speed. Similarly to the Easy text, **Reading Speed** was found to be the best predictor, in order to discriminate between dyslexics and controls.

3.3.6.3. List of Words

A logistic regression analysis was conducted to predict the group that participants belong to using timing errors and reading speed as predictors. The aloud-reading speed was the predictor entered at step 1, because it had the highest value in the test statistic ($p < .001$). Syllabication errors were the second predictor entered at step 2 ($p < .001$). A test of the full model at both steps against a constant only model was statistically significant, indicating that the predictors reliably distinguished between dyslexics and controls (Step 1: $\chi^2 = 45.69$, $p < .001$. Step 2: $\chi^2 = 52.01$, $p < .001$). R^2 at both steps indicated a moderately strong relationship between prediction and grouping. The logistic regression model at both steps is tabulated below:

Table 30. Logistic Regression Model for the Word List

			95% CI for Odds Ratio		
		B (SE)	Lower	Odds Ratio	Upper
	Included				
Step 1	Constant	–13.93 (4.33)			
	Reading Speed	0.24^{*} (0.07)	1.10	1.27	1.47
Step 2	Constant	–8.23 (5.24)			
	Syllabication	–0.45 (0.28)	0.37	0.64	1.11
	Reading Speed	0.17 (0.09)	1.00	1.18	1.39

Step 1: R^2 = .61 (Hosmer & Lemeshow), .57 (Cox & Snell), .76 (Nagelkerke). Model χ^2 = 45.69, p < .001. * p < .01.
Step 2: R^2 = .70 (Hosmer & Lemeshow), .62 (Cox & Snell), .83 (Nagelkerke). Model χ^2 = 52.01, p < .001.

Looking at the table, regarding reading speed, the odds ratio being greater than 1 indicates that as the speed of reading increases, the odds of a participant being control increase as well. Conversely, regarding Syllabications, the odds ratio being less than 1 indicates that as the percentage of Syllabications increases, the odds of a participant being control decrease. Precisely, when reading speed is raised by 1 unit, participants are 1.27 at step 1 and 1.18 at step 2 more times likely to belong to the control group. On the other hand, when Syllabications are raised by 1 unit, participants are 0.64 less times likely to be controls. The table below indicates how well the model predicts group membership at both steps.

Table 31. Classification table indicating group membership for the Word List

Classification Table

Observed			Predicted		
			GROUP		Percentage Correct
			Dyslexics	Controls	
Step 1	GROUP	Dyslexics	22	4	84.6
		Controls	4	24	85.7
	Overall Percentage				**85.2**
Step 2	GROUP	Dyslexics	22	4	84.6
		Controls	1	27	96.4
	Overall Percentage				**90.7**

At step 1 (inclusion of 1 predictor: aloud-reading speed), the model correctly classifies 22 participants who were dyslexics, while misclassifies 4 others (it correctly classifies 84.6% of cases). The model also correctly classifies 24 participants in the control group, but misclassifies 4 others assigning them in the dyslexic group (it correctly classifies 85.7% of cases). The overall accuracy of classification is **85.2%**.

It is obvious that the model at step 1 is significantly predicting whether a participant is dyslexic or not. However, at step 2 (2 predictor variables: reading speed & Syllabications), the model predicts the outcome better than it previously did. It correctly predicts 22 participants, who were dyslexics, misclassifying 4 just as before (84.6% accuracy), whereas it correctly classifies 27 participants in the control group, and misclassifies only 1 (96.4% accuracy). The overall accuracy of classification at this step is raised to **90.7%**. This means that the model can significantly predict group membership based on only two variables, Reading Speed & Syllabications. Hence, **reading speed** was actually found to be the best predictor, in order to discriminate between dyslexics and non-dyslexics, as Syllabications belong to timing errors, which reduce the speed of reading, without affecting accuracy.

A summary of the accuracy of classification in each reading material indicating how well the models predict group membership based on specific predictors is provided below:

Table 32. Classification accuracy throughout reading materials

Classification Accuracy	*Reading Material*		
Predictors	Easy Text	Difficult Text	Word List
Reading Speed	**96.3%**	**98.1%**	85.2%
Reading Speed & Timing Errors	Reading Speed 96.3%	Reading Speed 98.1%	**Speed & Syllabication 90.7%**
Timing Errors	Hems 90.7%	Hems & Repetitions 88.9%	Hems 85.2%
Accuracy Errors	Substitutions 81.5%	Substitutions & Misintonation 88.9%	Substitutions 81.5%
Total Errors	83.3%	90.7%	87%

Summing up, the main finding that came out from the Logistic Regression Analysis was that the **speed** of reading in context was the most powerful predictor, in order to predict which of the 2 groups a participant is more likely to belong to and could be suggested as an almost infallible criterion for "diagnosing" dyslexia in adults. However, in single word reading (no context), **reading speed** and **timing errors** was the best combination, in order to differentiate between dyslexics and controls. No other combination led to better classification. Finally, it is worth to mention that accuracy errors and total reading errors lead to lower accuracy of classification compared to reading speed and timing errors.

3.4. CONCLUSIONS

The main findings that came out of the statistical analysis are briefly reported here, while the conclusions will be in detail discussed at the last chapter of the thesis jointly for all the reading studies in order to provide a more comprehensive view of the results, instead of a fragmented and unconnected one.

From the **between-groups** analyses, the following findings emerged:

a) **Reading Speed:** As expected, adult dyslexic students read significantly more slowly compared to controls in all three reading materials *(easy text, difficult text, word list)* and irrespectively of reading condition (silent & aloud). Such a result was not surprising, as the slow reading speed is one of the main manifestations of developmental dyslexia (Pavlidis, 2013; Ziegler et al., 2003; Shaywitz, 1998). These findings are in line with the relevant literature, which confirms the speed deficit of adult dyslexics (Hatcher et al., 2002; Lehtola & Lehto, 2000; Bruck, 1990; Meyler & Breznitz, 2003, etc.).

b) **Reading Comprehension:** In the aloud condition, there were no significant differences between dyslexics and controls in the level of reading comprehension in any of the texts, while significant differences in the level of comprehension were found between groups in the silent condition. Such findings agree with the current literature, which suggests that dyslexics may or may not encounter comprehension difficulties, and if such difficulties are present, they may result from the dyslexics' decoding deficit (Vellutino et al., 2004; Lyon, Shaywitz, & Shaywitz, 2003). Besides, if dyslexics had a comprehension deficit, it should be evident in both aloud and silent reading. Thus, the mode of reading, aloud or silent, has a different impact on reading comprehension depending on the reader's proficiency, as it is discussed below.

c) **Reading Accuracy:** As predicted, adult dyslexic students were significantly less accurate than non-dyslexics in all three reading materials administered to them. They made significantly more reading errors in almost every reading category compared to controls. Inaccurate reading is among the most crucial features of dyslexia, even in adulthood (Critchley, 1981). Significant differences in the accuracy level between dyslexics and controls are also reported by the current literature (Felton et al., 1992; Snowling et al., 1997; Hatcher et al., 2002; Leinonen et al., 2001). However, most of the errors made by dyslexics were timing errors, errors that reduce reading speed, indicating that the slow reading speed is the main hurdle of dyslexic readers.

The speed deficit of dyslexics is further supported by the significant negative correlations found between timing errors and reading speed, suggesting that as the timing errors increase the speed of reading decreases, while for the control group less significant correlations were found between timing errors and speed. Finally, the Logistic Regression analyses conducted revealed that the reading speed in context could best differentiate between dyslexics and controls with the accuracy of classification reaching 98.1%, correctly classifying 100% of dyslexics but misclassifying only one non-dyslexic. This finding confirms Shaywitz et al. (1999), Shaywitz (1998), and Shaywitz & Shaywitz (2005) who argued that reading speed could be the most useful clinical criterion for distinguishing disabled from non-disabled readers in adulthood.

From the **within-groups** analyses, the following findings emerged:

a) **Reading Speed**: Albeit non-dyslexics read significantly faster in the silent condition, in line with Taylor and Connor (1982) who reported that proficient readers read faster silently, dyslexics read at the same rate in both aloud and silent condition. This finding amplifies the speed deficit of dyslexics, who, even when reading silently, a process that do not require so much effort in order to decode, they are still struggling to read, with their speed being stuck at very low levels. Comparing the speed of both groups in context and out of context, it is concluded that both groups were significantly slower in the list of words, indicating that both dyslexics and controls were affected by the lack of context and the structure of the word list. This comes in agreement with research evidence which points out that familiar words are read faster than unfamiliar (Defior et al., 2002; Leinonen et al., 2001; Wimmer & Goswami, 1994), and other research findings displaying that poor readers rely heavily on context for word recognition (Bruck, 1990; Ben-Dror et al., 1990; Shaywitz & Shaywitz, 2005). Interesting was the finding that non-dyslexics were similarly affected by the lack of context as far as it concerns reading speed.

b) **Reading Comprehension:** No significant differences were found in the level of reading comprehension between aloud and silent reading condition for either group. However, it is remarkable that an opposite pattern was shown. While non-dyslexics comprehended better silently, dyslexics tended to comprehend better aloud. This trend is in accordance with research evidence suggesting that proficient readers can go directly to meaning, whereas poor readers rely on aloud reading to extract meaning (Taylor & Connor, 1982; Miller & Smith, 1989). This explains why significant differences between dyslexics and controls were found only in the silent condition; when reading silently, whilst the reading comprehension of non-dyslexics increases, the comprehension of dyslexics decreases. Comparing the reading comprehension between the easy and difficult material, albeit no significant differences were found, there was a tendency for both groups to comprehend better the easier text.

c) **Reading Accuracy:** As expected, dyslexics were significantly less accurate in reading out of context, in contrast to non-dyslexics who made comparable reading errors in both reading in context and out of context. As discussed earlier, the error rate differences of dyslexics between text and list reading can be attributed to the lack of context and the structure of the word list. However, the reading accuracy of non-dyslexics is not affected by the lack of context in contrast to reading speed, as mentioned before. Support for these findings come from the research of Bruck (1990) and Lehtola and Lehto (2001).

A more detailed discussion of the results of the second research project will follow at the last chapter of the current thesis.

CHAPTER 4

DISCUSSION

In the present chapter, the results of the research will be thoroughly discussed in relation to the existing literature. The discussion of the results will follow the order of the two research projects presented in the previous chapters. The reading performance of teachers of Ancient Greek and 12th grade pupils will be discussed first, and then the discussion on the reading process of adult dyslexic students and normal controls will follow. At the end of this chapter, the results are going to be jointly discussed.

4.1. Discussion on the Reading Performance of Teachers & Pupils

The discussion on the reading performance of teachers of Ancient Greek and pupils of the 12th grade will follow the order of the reading components investigated: reading speed, comprehension and accuracy. First, the between-groups analysis will be discussed, followed by the within-groups analysis.

4.1.1. Between-Groups

The main findings that resulted from the comparisons conducted between teachers and pupils regarding reading speed, comprehension and accuracy were the following:

Main Findings

a) **Reading Speed:** Pupils of the 12th grade read significantly faster than the more experienced Greek language teachers in both Ancient and Modern Greek materials.
b) **Reading Comprehension:** There were no significant differences between teachers and pupils in the level of reading comprehension attained in either Ancient or Modern Greek. It is noteworthy, though, that pupils tended to comprehend slightly better than Greek language teachers.

c) **Reading Accuracy:** Pupils of the 12th grade made significantly more reading errors than the more experienced teachers of Ancient Greek in both Ancient and Modern Greek.

4.1.1.1. Reading Speed

As far as it concerns reading speed, the hypothesis set was that teachers of Ancient Greek would read faster than pupils of the 12th grade in both Ancient and Modern Greek. Intuitively, one would have expected that the far more experienced Greek language teachers would have been more familiar with the context and the structure of both Ancient and Modern Greek, because of their studies of 4 years minimum and their teaching experience, as well, for at least 5 years, as a main condition for their participation in the research was to teach for more than 5 years. Furthermore, teachers' rich vocabulary was expected to be an additional advantage for rapid word recognition and greater reading speed. Ouellette (2006) investigated the role of vocabulary in the reading skills of decoding, word recognition and reading comprehension and found that receptive and expressive vocabulary breadth *(how many words are known)* could predict decoding ability and visual word recognition, respectively. Similar research findings also support the relationship of reading ability with the above factors (Stanovich, 1986; Lewellen et al., 1993; Payne et al., 2012; Miller et al., 2006). As a result, teachers should have been faster and more proficient readers.

However, the results surprised us because the pupils, who were preparing for university, read significantly faster than the more experienced teachers in both Ancient and Modern Greek reading materials. In fact, teachers' reading speed was found to lag 12% and 14% behind pupils in Ancient and Modern Greek, respectively. It is reasonable, though, for someone to assume that the different goals the two groups had may have resulted in different reading performance in terms of reading speed (i.e. teachers may have laid more emphasis on accuracy, as supported by the less reading errors they made). An explanation for that comes from the kind of the reading errors made by both groups. It is noteworthy that pupils made significantly more timing errors *(errors that reduce the speed of reading like repetitions,* *syllabications, etc.),* as opposed to the teachers, who made comparable timing and accuracy errors. Taking into consideration the significantly more timing errors made by the pupils, they should read more slowly than teachers, as far as these errors are primarily responsible for the reduced speed of reading. However, despite the more timing errors of the pupils the teachers' reading speed was still slower, proving that the speed difference found between groups in favour of the pupils was original, because if pupils' reading speed was equated to their timing errors, the resulting speed would be even faster.

On the other hand, the results should have come to no surprise, because the relevant literature consistently shows that reading practice makes the reader faster, while even a few months lack of practice in reading, for example during summer vacation, has a profound negative effect on reading, as the reading speed of the same pupils slows considerably at the beginning of the next school year in comparison to their speed at the end of the previous school year, i.e. in June. To be more precise, from June to September, the reading speed is reduced far more in the slow readers than in the proficient readers. In slow readers, the speed reduction ranges from between 2-5 times (10%-30%) depending on the grade, whereas in more skilled readers the speed is reduced on average 10% (Pavlidis, 2013). In addition, Leinonen and colleagues (2001) concluded that extensive reading practice is related to the fast reading speed even for reading-disabled population.

This finding could be probably attributed to the greater practice of pupils in reading. All pupils participating in the current research were attending Ancient Greek classes and were oriented to Theoretical studies, whereas the main subject taught in their field was Ancient Greek for 5 hours per week. Besides, prerequisite for the pupils' participation was to have average or above average performance in Ancient and Modern Greek, and, thus, low achieving pupils were excluded from the research. Finally, this finding is reinforced by the fact that pupils were preparing themselves for the final exams, which would ensure their entry in higher education. It is noteworthy that testing took place from February to April, just a few months before their exams, namely within the period they intensify their efforts. All the aforementioned combined with the fact that teachers' practice in reading is limited in the teaching hours, which do not exceed 20 per week, in contrast to the pupils, who are obliged to deal with reading for at least half of their day, could possibly account for the superior performance of the latter in reading speed. Furthermore, it is worth mentioning that during the months the students read extensively for about 7 different disciplines, on the contrary, their teachers concentrate on a limited curriculum of one to few subjects and the exams they correct are of the same and at best of few pages materials. Finally, the complete lack of changes in the curriculum, which remains unchanged for so many years, along with the fact that the teachers continuously teach the same subjects should not be ignored, as they lead to "indifference" for further practice and development of their reading skills. Therefore, the students read far more intensively a variety of subjects and, hence, a great number of different words than the high school teachers, who each of them is specialised on a specific subject or area that remains constant throughout life, and, as a consequence, after a few years repetition they do not have to read as much as they would do during the first few years of teaching. The criterion for the participation of the teachers in this study was to have at least five years teaching experience, while it is noteworthy that the majority of them were far more experienced (see p. 59) and, therefore, they fit into the previously mentioned model.

4.1.1.2. Reading Comprehension

With regard to reading comprehension, it was hypothesised that teachers of Ancient Greek would attain higher level of reading comprehension than the 12th grade pupils in both Ancient and Modern Greek materials. Similarly to reading speed, the greater experience and exposure to print, familiarity with both languages and vocabulary size of teachers were expected to positively influence their performance in reading comprehension. There is plenty of research evidence confirming the relationship of the above factors with reading comprehension ability (Payne et al., 2012; Cunningham & Stanovich, 1997; McBride-Chang et al., 1993; Braze et al., 2007; Estévez Monzó & Calvo, 2002; Sénéchal et al., 2006; McNamara & Kintsch, 1996; Landi, 2010). Ouellette (2006), who investigated the role of vocabulary in the various reading skills, as discussed earlier, also found that the depth of vocabulary knowledge *(how well meanings of words are known)* predicts reading comprehension. This is in line with Nation (1993), who claims that *"good vocabulary knowledge enables good comprehension"* (p.115), and Stanovich (1986), who argues that the development of vocabulary knowledge facilitates reading comprehension, as well as it provides support for the Lexical Quality Hypothesis proposed by Perfetti and Hart (2002), who concluded that experience with words is critical for the development of reading skills.

However, results revealed that there was no significant difference between the 2 groups in the level of reading comprehension attained in either Ancient or Modern Greek, although there was a trend for pupils to comprehend slightly better, having 5% and 8% better comprehension in Ancient and Modern Greek, respectively, compared to the more experienced teachers. What made pupils faster readers, namely extensive daily practice as discussed earlier, was compensated for by the superior contextual knowledge and the richer vocabulary (word meaning) of the teachers, which are largely related with reading comprehension ability as reported before, resulting in similar level of reading comprehension by both groups.

Such a finding suggests that any difference reported in reading speed between groups was not guided by reading comprehension, as either reading faster (pupils) or more slowly (teachers), the reading comprehension remained approximately the same.

4.1.1.3. Reading Accuracy

Regarding reading accuracy, it was similarly hypothesised that pupils would make more reading errors than the far more experienced teachers of Ancient Greek. Indeed, results supported this hypothesis, and, as predicted, pupils made significantly more reading errors than teachers in both Ancient and Modern Greek reading materials. The reading errors categories, where significant differences between groups have been found in the Ancient Greek material, were: *Hems, Repetitions, Syllabication, Substitutions, Omissions, Misintonation, Endings, Pseudowords, Wrong Words, Timing, Accuracy & Total errors*. In the Modern Greek material: *Repetitions, Syllabication, Wrong Words, Timing & Total errors* significantly differentiated the two groups.

In fact, pupils made 64% more reading errors in total than Greek language teachers in Ancient Greek. Looking at the main subcategories, they made 70% more timing errors and 57% more accuracy errors than teachers. In Modern Greek, pupils made 38% more reading errors in total. Regarding the main subcategories, they made 48% more timing errors, while both groups made comparable accuracy errors. Obviously, the gap between teachers and pupils was considerably greater in Ancient Greek in the above categories of reading errors, whereas in Modern Greek the categories, where significant differences were found between groups, were limited. This is quite reasonable as Modern Greek is far more familiar for pupils, as well, because it is read and written not only in school but also in their daily life.

In the same way, as discussed earlier with regard to reading speed and comprehension, the greater familiarity with language context, the broader vocabulary and the greater experience of the teachers, who were more exposed to both Ancient and Modern Greek, lead to these findings, which are in line with the current literature (Perfetti & Hart, 2002; Ouellette, 2006; Lewellen, 1993; Cunningham & Stanovich, 1990; Acheson et al., 2008; Miller et al., 2006). For instance, Stanovich (1986) argued that more skilled readers could be more efficient in word decoding and, hence, they were able to use their cognitive resources for reading comprehension. Also, Lewellen and colleagues (1993) found college students with greater lexical familiarity being more efficient in language processing.

4.1.2. Within-Groups

The main findings that resulted from the comparisons conducted within each group regarding reading speed, comprehension and accuracy were the following:

Main Findings

a) **Reading Speed:** Both groups read significantly faster in Modern Greek.

b) **Reading Comprehension:** Both groups attained significantly higher level of reading comprehension in Modern Greek.

c) **Reading Accuracy:** Both groups made significantly more reading errors in Ancient Greek.

In the Introduction chapter (p.45), it was assumed that Modern Greek is more familiar for both teachers and pupils, read and spoken in everyday life, while Ancient Greek is unfamiliar, read only in school and for educational purposes. If the above hypothesis is true, then both groups should read more slowly and less accurately as well as attain lower level of comprehension in Ancient than in Modern Greek. Indeed, the results support the aforementioned hypothesis as both groups read much more slowly and with more errors and lower comprehension in Ancient Greek than in the same text translated in Modern Greek.

In detail, as far as it concerns reading speed, teachers were 23% slower in Ancient Greek in the aloud procedure and 31% slower in the silent condition compared to Modern Greek. In a similar way, pupils' reading speed was 25% slower in aloud reading and 30% in silent in Ancient compared to Modern Greek. Regarding reading comprehension, in Ancient Greek, teachers lagged 26% behind Modern Greek, while pupils' comprehension was 28% worse in Ancient compared to Modern Greek. Finally, in terms of reading accuracy, pupils were far more affected by the greater difficulty of the Ancient Greek material. They made 61% more reading errors in total, whereas with regard to the main subcategories they made 73% more accuracy and 54% more timing errors in Ancient than in Modern Greek. On the other hand, teachers made 33% more reading errors in total, 51% more accuracy and 22% more timing errors in Ancient Greek.

These findings can be easily explained taking into account the more complex structure of Ancient Greek, which has more complex syntax, uses a polytonic system, contains more grammatical rules, is characterised by more dense written word and utilizes subordinate clauses to a greater extent, as reported earlier (p. 44). Furthermore, both groups are more exposed to Modern Greek daily, more familiarised with the structure of the language; they have more contextual knowledge and richer vocabulary. Ample research evidence supports that all the aforementioned components are reciprocally related to reading ability (Stanovich, 1986; Miller et al., 2006; Payne et al., 2012; Ouellette, 2006; Lewellen, 1993; Perfetti & Hart, 2002; Sénéchal et al., 2006; Chateau & Jared, 2000).

It is worth mentioning that, in contrast to reading speed and comprehension, which were similarly affected in both teachers and pupils (see figures 9c in p. 101-102) by the reading material (Ancient and Modern Greek), with the group of pupils being steadily faster and slightly better comprehenders though, reading accuracy was far more severely affected within the pupils' groups, since they made 61% more reading errors in total, 73% more accuracy and 54% more timing errors in Ancient Greek, in contrast to teachers who made 33% more reading errors in total, 51% more accuracy and 22% more timing errors (see figures 12 in p. 113-114). Pupils' reading errors showed an abrupt increase from Modern to Ancient Greek. Such a finding proves the greater difficulty that pupils encountered in accurate word decoding in Ancient Greek, a rather more unfamiliar language to them.

4.1.3. Kind of reading errors

Another aim of the current study was to investigate the kind of reading errors made by both teachers of Ancient Greek and pupils of the 12th grade, in order to find out whether qualitative differences exist between groups as well. Looking at the ranking order of reading errors, a similar pattern is evident in both groups in all reading materials administered to them during the testing procedure. The two most frequent categories of reading errors were consistently Repetitions and Hems, whereas among the most infrequent ones Line Missing, Point Marks and Errors Repetitions were included.

Findings suggest that pupils made more Timing errors *(errors that reduce the speed of reading)*, while they made less Accuracy errors *(errors that negatively affect the accuracy of reading)* in both Ancient and Modern Greek materials. Precisely, pupils' Timing errors ranged from approximately 4% to 8%, whereas their accuracy errors ranged from 2% to 5%. On the other hand, teachers made a comparable amount of timing and accuracy errors in both Ancient and Modern Greek. In more detail, their Timing errors were consistently about 2%, while their Accuracy errors ranged from only 1% to 2%. It is noteworthy that even teachers made slightly more Timing errors but, as the rates for both Timing and Accuracy errors were quite low, no significant difference arose.

The low accuracy error rates of both groups are in line with Seymour and colleagues (2003) who concluded that in phonologically consistent languages, like Greek, adequate reading accuracy is relatively easily achieved. They report accuracy rates of Greek beginning readers that reach even 99%. In the current study, despite the demanding reading tasks, especially the Ancient Greek material, the maximum error rate did not exceed the extremely low percentage of 5% for pupils and 2% for teachers.

Comparing Ancient to Modern Greek, both groups made similar reading errors with the two most frequent categories being Repetitions and Hems, as aforementioned, leaving far behind the remaining errors categories, even though the errors in Ancient Greek were more in quantity. This is attributed to the phonological consistency of both languages and to their using the same alphabet, in spite of the differences in terms of grammar, syntax, intonation, and other features. Additionally, as mentioned in the Introduction chapter (p.36), Greek is a language with uninterrupted oral and written tradition that Greeks never stopped speaking, having as a result Ancient Greek being pronounced as Modern Greek. Hence, the similar pattern of reading errors indicates that similar reading strategies are applied in order to decode both Ancient and Modern Greek.

4.1.4. Correlations

The reading speed of teachers was significantly correlated with the reading comprehension ($r = .33$, $p < .05$) in the Ancient Greek material, indicating that as the reading speed increases, the comprehension increases as well. On the other hand, for the group of pupils, there was no significant correlation between reading speed and comprehension in Ancient Greek. These findings provide support for the greater familiarity of the teachers with Ancient Greek. When teachers encounter familiar words, it is easier for them to recognise, and, hence, their reading speed increases. And, as far as they have more domain specific knowledge, their reading comprehension increases as well. Conversely, pupils may read faster, but the lack of domain specific knowledge results in no significant correlation between their speed and comprehension.

With regard to the reading errors, there were positive but no significant correlations between teachers' reading speed and reading errors in Ancient Greek. This may suggest that teachers tried to slow down, in order not to lose accuracy. Within the group of pupils, there were significant negative correlations between the reading errors and the speed of reading (total reading errors: $r = –.34$, $p < .05$). The greater correlation was found between accuracy errors and reading speed ($r = –.39$, $p < .01$). This means that the difficulty pupils had in automatically recognising words made them lose reading speed. Besides, as aforementioned, pupils may read faster, but the lack of domain specific knowledge had as a result the increase of reading errors at the expense of reading speed. On the contrary, teachers who had domain specific knowledge made few errors, which were not found to negatively affect their reading speed.

In the Modern Greek material, a significant positive correlation was found between reading speed and comprehension, but only for the group of pupils ($r = 41$, $p < .01$). For the group of teachers, there was a positive but non-significant correlation between speed and comprehension. This means that as pupils' reading speed increases, the comprehension increases, as well. In Modern Greek, domain specific knowledge was similar for both groups. Thus, it seems plausible that the speed of reading, which is highly dependent on the easiness in word recognition, is the differentiating factor that enables higher comprehension, because more brain power is available for comprehension. Hence, the higher reading speed of pupils resulted in the significant correlation with comprehension.

Regarding reading accuracy, there were significant negative correlations between teachers' reading errors and reading speed (total reading errors: $r = -.50$, $p < .01$). Both timing and accuracy errors significantly correlated with reading speed, but the greater correlation was found with accuracy errors ($r = -.48$, $p < .01$). On the other hand, pupils' reading errors did not significantly correlate with reading speed. As mentioned before, reading speed depends on the easiness in word recognition. The lower speed of the teachers reflects a higher level of difficulty in word recognition, and it seems that it may be necessary for a higher speed to be reached in order to make less reading errors.

4.2. Discussion on the Reading Performance of Adult Dyslexic & Non-Dyslexic Students

The discussion on the reading performance of adult dyslexic university students and normal controls will follow the order of the reading components investigated: reading speed, comprehension and accuracy.

4.2.1. Reading Speed

The main findings that resulted from the comparisons conducted between dyslexic and controls and within each group regarding reading speed were the following:

Main Findings

a) Between-Groups:

- **Easy Text**: Adult dyslexic students read significantly more slowly than non-dyslexics in both aloud and silent reading processes.
- **Difficult Text**: Adult dyslexic students read significantly more slowly than non-dyslexics in both aloud and silent reading processes.
- **Word List**: Adult dyslexic students read significantly more slowly than non-dyslexics in a list of words of raising difficulty.

b) Within-Groups:

- **Aloud vs. Silent Reading:** Whilst non-dyslexics read significantly faster silently than aloud, dyslexics read at almost the same rate in both aloud and silent conditions.
- **Easy vs. Difficult Text:** Both groups read slightly faster the difficult text in both aloud and silent conditions.
- **Texts vs. List:** The reading speed of both groups was significantly slower in the list of words.

As far as the slow speed of reading is one of the main manifestations and the constitutional diagnostic criterion of developmental dyslexia (Brunswick, 2012; Pavlidis, 2013, 1990; Shaywitz, 1998; Critchley, 1981, etc.), it was hypothesised that adult dyslexic students would read significantly more slowly than non-dyslexics. As predicted, the reading speed of the dyslexic group was significantly slower compared to controls in all 3 reading materials administered to them during the testing procedure *(easy-difficult-word list)*. Indeed, in the easy reading material, dyslexics' reading speed was 32% slower than controls' in the aloud condition and reached 45% in the silent reading process. A similar pattern was observed in the difficult text. The reading speed of dyslexics was 34% slower in the aloud and 44% slower in the silent condition. It is noteworthy that the gap between dyslexics and controls is greater in the silent condition of both texts. Whilst non-dyslexics speed up, when reading silently, dyslexics are struggling to decode and their reading speed seems to be stuck at extremely low levels. This is further confirmed by the insignificant speed differences of dyslexics between aloud and silent reading; they read at almost the same rate aloud and silently, as opposed to non-dyslexics, who read significantly faster in the silent condition. This is in line with evidence suggesting that proficient readers read faster silently, as they go directly to meaning (Taylor & Connor, 1982). Furthermore, dyslexics have such a decoding problem that, even when reading an easier material, their reading speed did not improve at all. This is a major evidence for the speed deficit of dyslexics. Irrespective of whether reading aloud or silently, an easy or difficult text, their reading speed is always deficient compared to controls and remains at consistently low levels. This is in line with Pavlidis (2013) and Ziegler et al. (2003), who argue that the extremely slow reading speed is the main manifestation of dyslexia, which is evident irrespective of age, language, culture, or race.

In the list of words, although reading speed was reduced for either group, dyslexics were still 38% slower than normal controls, a percent in perfect agreement with those recorded in the 2 texts. Silent reading speed was not recorded in the list. However, 2 more speeds were evaluated, the speed attained in the 1st minute of reading *(defined as the number of words read in the 1st minute)* and the speed beyond the 1st minute *(defined as the number of words read after the 1st minute)*. In the 1st minute, dyslexics lagged 23% behind controls', whereas after the 1st minute the gap increased to 38% against the dyslexic group, a percent identical to the total speed of reading. This can be easily explained by the structure of the word list; it is of raising difficulty. It begins with simple, short and high frequency words and it proceeds to more complex, polysyllabic and low frequency words. As a result, word recognition gradually became more difficult for dyslexics, who were steadily left behind.

However, it could be hypothesised that dyslexics slow down, in order not to lose accuracy and comprehension. On the other hand, non-dyslexics speed up, and, thus, lower level of comprehension and more reading errors should be expected. Instead, the latter "run" faster, but they attain higher level of comprehension and they are more accurate, as will be discussed later in this chapter. This is another strong proof that dyslexics have a real speed deficit.

Such findings are in line with Bruck (1990) and Ben-Dror, Pollatsek & Scarpati (1991), who found that on all reading measures *(context, single word, low and high frequency words, etc.)* dyslexics' reading speed was significantly slower than controls. Speed deficits of adult dyslexics compared to controls were also reported by Hatcher et al. (2002) in English, Lehtola & Lehto (2000), Laasonen et al., 2012, and Leinonen et al. (2001) in the Finnish language, Miller-Shaul (2005) and Meyler & Breznitz (2003) in Hebrew-speaking adults, as well as by Wimmer (1993), Landerl et al. (1997) and Ziegler et al. (2003) in German, who, even though referring to children population, concluded that slow reading speed seems to be the main persistent deficit of dyslexics. Lehtola & Lehto (2000) similarly found that dyslexics' reading speed was 20% and 26% slower than controls' in context and nonword reading, respectively. These little lower percents of dyslexics' speed deficit reported by Lehtola & Lehto as compared to the outcomes of the current study may be due to the different reading materials used and level of difficulty or to a limitation in their sampling, as dyslexic participants did not have a formal diagnosis, but were selected based on teachers' judgments. As a result, it is possible that non-dyslexic individuals may have been included in their dyslexic group and vice versa.

Comparing the speed of both groups in the list to their speed in context reading, it is obvious that a significant decrease occurs. Dyslexics read approximately 60% more slowly in the list, whereas non-dyslexics read on average 57% more slowly in the list as compared to the 2 texts. This similar pattern displayed by both groups probably indicates that they are similarly affected by the lack of context and the structure of the word list (see figure 14d in p. 295). The raising difficulty of the words in the list forced even non-dyslexics to use decoding strategies instead of sight reading *(automatic recognition)*, in order to recognise rare and low frequency words, but at the expense of reading speed. This is in line with Ehri (2005), who suggested that sight word reading is used by skilled readers for familiar and high frequency words in contrast to decoding strategies, which seem to be more useful when dealing with unfamiliar and low frequency words. Even evidence from transparent orthographies, which could be read using grapheme-phoneme translation, provides support that, as readers become more skilled, they use sight reading rather than decoding, in order to achieve fast reading for meaning (Leinonen et al., 2001; Wimmer & Goswami, 1994; Defior et al., 2002). Leinonen et al. (2001) concluded that orthographic processing skills are used among normal readers to recognise familiar words, whereas unfamiliar ones have to be phonologically decoded. Defior et al. (2002) found that their participants read familiar words faster than unfamiliar, indicating that the former were probably read from memory. This influence of unfamiliar and rare words in the reading speed could be further confirmed herein by the abrupt speed reduction after the 1st minute of reading in the list, when low frequency and unfamiliar words were gradually encountered. Dyslexics' reading speed decreased by 45% after the 1st minute, while controls' reading speed decrease is estimated at 33%. As obvious, dyslexics' reading speed was far more affected than controls' as soon as they came upon more complex words.

Hence, once words become familiar and are held in memory, skilled readers do not rely on decoding. However, poor readers, like dyslexics, have difficulty in word recognition by direct visual access, even for high frequency words, and, they require more exposure to an unfamiliar word so as to visually recognise it (Meyler & Breznitz, 2003). As a result, they rely on spelling-sound conversion to a greater extent (Bruck, 1990); and, as dyslexics have poor decoding skills, this results in extremely slow reading speed, as suggested by the highly significant speed differences found between groups. In line with the literature, when decoding skills are deficient, higher-level sources of information, such as context, become essential; dyslexics rely heavily on context to help word recognition and, consequently, comprehension (Bruck, 1990; Ben-Dror, Pollatsek & Scarpati, 1990; Shaywitz, 1998; Shaywitz & Shaywitz, 2005). That is why, when reading the list of words their speed was reduced by more than half while their errors were doubled, as it will be discussed later in the current chapter. Similarly, controls showed significantly reduced speed of word recognition, although they did not make significantly more reading errors in the list. In support of the speed deficit of adult dyslexics in reading out of context, Miller-Shaul (2005), in her cross-sectional study, has found that the gap between dyslexics and controls that remains the most unchanged over the years is in the speed of single word reading.

However, the highly significant differences between context and single word recognition found in the current study are in contrast to Lehtola and Lehto (2000) and seem to be to a degree in contrast to Bruck (1990). Lehtola and Lehto (2000) found a significant correlation between the speed of context reading and the time needed to decode a pseudoword list *(varying in length and syllables)* and concluded that both context and word reading were similarly time-limited for dyslexics, something that was not the case herein. Bruck (1990) has found that controls were barely significantly affected by the lack of context, as indicated by the barely significant difference found in the speed of word recognition between the 2 conditions, while they made minimum errors, in contrast to dyslexics, who were severely affected. The different outcomes that resulted in this study suggesting that both dyslexics and controls are similarly affected by the lack of context could be attributed to the high level of difficulty of the word list used, which proceeds to considerably complex, long and low frequency words, forcing even non-dyslexics to slow down for a successful word recognition. Besides, there is evidence that all readers, including proficient ones, use context, in order to facilitate word recognition (Biemiller, 1970; Stanovich, Cunningham & Feeman, 1984). However, it is worthwhile to mention that non-dyslexics may be affected by the lack of context and the complex structure of the list with regard to the speed of reading, but this was not the case in terms of reading accuracy, as indicated by the comparable number of errors they made in both conditions. This discloses a potential strategy applied by non-dyslexics: they slow down, in order not to lose accuracy. Conversely, dyslexics are severely affected by the lack of context in both reading speed and accuracy; the extremely slow reading speed and the significant increase of their reading errors in and out of context environment reveal the real decoding problem of dyslexics. In any case though, there is no doubt that dyslexics' reading speed is severely more defective compared to controls.

4.2.2. Reading Comprehension

The main findings that resulted from the comparisons conducted between and within-groups in terms of reading comprehension were the following:

Main Findings

a) Between-Groups:

- **Aloud process**: There were no significant differences between dyslexics and controls in the level of reading comprehension attained in either the easy or difficult text.

- **Silent process**: Adult dyslexic students attained significantly lower level of reading comprehension than non-dyslexics in both the easier and difficult materials.

b) Within-Groups:

- **Aloud vs. Silent Reading**: There were no significant differences in the level of reading comprehension between aloud and silent processes for either group. However, an opposite pattern was displayed. Whilst non-dyslexics tended to comprehend better silently, there was a trend for dyslexics to comprehend better aloud.
- **Easy vs. Difficult Text**: There were no significant differences between the easy and difficult material in the level of comprehension that both groups attained. However, there was a trend for both groups to comprehend better the easier text.

In line with the current literature, as discussed earlier (p.190), which suggests that dyslexics may or may not have comprehension difficulties and conceptualise reading comprehension problems as secondary consequences that may result from their decoding deficit (Vellutino et al., 2004; Lyon, Shaywitz & Shaywitz, 2003; Shaywitz, 1998; Catts, Hogan & Fey, 2003; Shankweiler et al., 1999, etc.), adult dyslexics of the current study were found to have significantly worse reading comprehension than controls in both materials, but only in the silent condition, whereas there were no significant differences between groups in the aloud reading process, although dyslexics showed a tendency to comprehend worse. Even minor comprehension difficulties are totally understandable and expected for dyslexics, as, according to Ehri (2005), if the reader struggles to decode, his attention shifts from text to a specific word as to identify it, and this inevitably disrupts comprehension.

The outcomes regarding aloud reading comprehension are in line with Miller-Shaul (2005) and Meyler and Breznitz (2003), who did not find significant differences in the level of comprehension that dyslexics and non-dyslexics attained, as measured by multiple-choice questions after aloud text reading. However, results are in contrast to Ransby and Swanson (2003), who found significant differences in reading comprehension between adult dyslexics and age-matched controls, after reading aloud several passages of raising difficulty. It should be noted, though, that in the current research, the level of reading comprehension was not evaluated with multiple-choice questions, but with inferential-open questions. Thus, the possibility that the different type of questions brought some kind of influence on the outcomes cannot be neglected.

Findings with regard to silent reading comprehension seem to be in line with Simmons and Singleton (2000), who found significant differences between dyslexics and controls in answering inferential questions after silent reading of a relatively long passage. Similar results were reported by Ransby and Swanson (2003), who found significant comprehension differences between adult dyslexics and age-matched controls after silent passage reading, although measured by multiple-choice questions. Instead, results seem to be in contrast to Reid and colleagues (2007), who did not find significant differences in 2 silent reading comprehension tasks between dyslexics and controls. Neither Meyler and Breznitz (2003) found significant comprehension differences between dyslexic and non-dyslexic students after silent reading.

However, the different texts used in the different studies, the different length of the passages given, the different type of questions used for the evaluation of reading comprehension, the different mode of reading *(aloud or silently)* led to divergent results, which do not allow any generalisations of what really happens with the text understanding of adult dyslexics. Furthermore, whether they do or they do not find comprehension differences is possibly due to other factors known to determine reading comprehension, such as vocabulary or context, which may be sometimes very difficult for dyslexics. Besides, no research has ever evaluated both aloud and silent reading comprehension of dyslexics compared to non-dyslexics using the same reading materials, in order to find out whether any differences exist, and whether the mode of reading affects the level of comprehension. Hence, interest focuses on the outcomes of the current study having in mind that no generalisations could be easily made and that future research should address these limitations.

If dyslexics were characterised by a comprehension deficit, whatever the cause of it is, it should manifest itself in both aloud and silent reading. Or, according to the literature, if reading comprehension difficulties were the direct result of the decoding deficit, they should be evident in aloud reading as well. However, this was not the case here. In more detail, in the aloud condition, dyslexics performed 17% and 26% worse than controls in the easy and difficult reading material, respectively, percents that were not rendered significant, though. On the other hand, in the silent reading condition, the former group attained 57% and 56% lower level of comprehension than controls in the easier and difficult text, respectively. This huge difference between the 2 conditions allows the assumption that dyslexics have not a real comprehension problem and that the mode of reading *(aloud or silent)* probably has an impact on reading comprehension.

Therefore, comparing the reading comprehension of both groups in the aloud and silent conditions, an opposite pattern is evident. Even though the comprehension differences between aloud and silent reading were not significant for any of the groups, dyslexics display a trend to comprehend better aloud, whereas non-dyslexics tend to comprehend better silently in both reading materials (easy & difficult). Precisely, the dyslexic group shows 32% and 25% better comprehension in the aloud reading condition for the easy and the difficult text, respectively. Conversely, non-dyslexics exhibit 25% and 21% better reading comprehension in the easier and difficult material, respectively, but in favour of silent reading. This opposite pattern possibly explains the significant comprehension differences found between dyslexics and controls but only in the silent reading mode. When reading silently, whereas the reading comprehension of non-dyslexics increases, the comprehension of dyslexics decrease, and, as a result, the gap between them grows.

This finding is in line with research evidence suggesting that the mode of reading *(aloud or silent)* has different impact on reading comprehension depending on the reader's proficiency. According to Goodman's model (1968), *"readers recode print to speech and decode spoken input in meaning"*. As readers become more proficient, they *"are able to go directly from print to meaning by passing the oral stage"* (as cited in Taylor & Connor, 1982). The human brain can perform simultaneously only one main task and a secondary one. In aloud reading, the brain has to devote "workforce" apart from that required for the reading process also to synchronise and control the centres that convert the silent-inner speech into aloud one. On the contrary, in silent reading, all brain power is devoted to decoding and to the understanding of the text, hence, more brain power is available for reading comprehension which is expected to increase in silent than in oral reading (Pavlidis, 2013).

Conversely, poor readers rely on oral reading to extract meaning from text (Taylor & Connor, 1982). Research has shown that poor readers may benefit more than skilled from aloud reading in terms of comprehension, because they hear themselves read and, therefore, they do not lose attention and concentration (Kragler, 1995; Miller & Smith, 1989; Levin, 1979). Miller & Smith (1989) found that poor readers perform better in comprehension when reading aloud, as opposed to average readers, who comprehend better when reading silently, because they do not need to allocate a portion of their cognitive workspace to tasks such as accurate decoding, pronunciation, intonation and other tasks that limit the resources available for comprehension.

This evidence provides an adequate explanation for the increased reading comprehension of adult dyslexics in the aloud process in contrast to controls. However, there is an additional problem with silent reading comprehension of dyslexics. There is no way to ascertain if they read the whole text. Research data suggests that reading-impaired students, when reading silently, often do not read the whole text, as they must devote much effort to read, but they scan the passage before answering the questions (Freeland et al., 2000). Or, it is possible for dyslexics to lose attention when reading silently. Taking into account that dyslexia often co-occurs with Attention Deficit Hyperactivity Disorder (ADHD), this seems a very plausible explanation (Pavlidis, 2013; Germano, Gagliano & Curatolo, 2010; Knivsberg et al., 1999; Gilger, Pennington & DeFries, 1992).

Finally, comparing the level of reading comprehension attained by each group between the easy and the difficult reading materials, results revealed that there were no significant differences for either group. However, both groups tended to comprehend better the easy text irrespective of whether reading aloud or silently. That is, dyslexics comprehended 20% and 12% better the easier text in the aloud and silent condition, respectively. Similarly, non-dyslexics attained 10% (aloud) and 15% (silent) better reading comprehension in the easy material. This probably suggests that reading comprehension, in contrast to reading speed, tends to be affected by text difficulty for both disabled and non-disabled readers. If reading speed were also affected, we would expect that both groups would read faster the easier material, a fact that was not the case herein.

4.2.3. Reading Accuracy

The main findings that resulted from the comparisons conducted between and within-groups in terms of reading accuracy were the following:

Main Findings

a) Between-Groups: Adult dyslexic students were significantly less accurate than non-dyslexics in all reading materials administered to them during the testing procedure.

b) Within-Groups (Texts vs. List): Dyslexics were significantly less accurate in the list of words, in contrast to non-dyslexics, who made comparable reading errors in all 3 reading materials.

As far as inaccurate reading *(reading with many errors)* is, along with reading speed, among the most crucial manifestations of developmental dyslexia even in adulthood

(Critchley, 1981), it was hypothesised that adult dyslexic university students would make significantly more reading errors while reading than their non-dyslexic peers. Indeed, as predicted, adult dyslexics were significantly less accurate compared to controls in all three reading materials administered to them during the testing procedure *(easy-difficult-word list)*. The reading errors categories where significant differences have been found between groups in the easy passage were: *Hems, Repetitions, Syllabication, Substitutions, Misintonation, Endings, Errors Repetitions, Pseudowords, Corrected & Non-Corrected Errors, Wrong Words, Timing Errors, Accuracy Errors*, and *Total Errors*. In the difficult reading material, due to the greater level of difficulty, more reading errors categories significantly differentiated between dyslexics and controls, namely: *Hems, Repetitions, Syllabication, Substitutions, Omissions, Misintonation, Endings, Errors Repetitions, Pseudowords, Corrected & Non-Corrected Errors, Wrong Words, Timing Errors, Accuracy Errors,* and *Total Errors*. A similar pattern was observed in the list of words: *Hems, Repetitions, Syllabication, Substitutions, Omissions, Additions, Misintonation, Endings, Errors Repetitions, Pseudowords, Corrected & Non-Corrected Errors, Wrong Words, Timing Errors, Accuracy Errors,* and *Total Errors* significantly differentiated between the 2 groups.

In detail, in the easy reading material, dyslexics made 77% more reading errors in total than controls. Looking at the main subcategories, they made 81% more Timing and 65% more Accuracy errors than non-dyslexics. The case was pretty similar in the difficult reading material. The dyslexic group was 78% less accurate than the control group. The former group made 84% more Timing and 60% more Accuracy errors than the latter. Finally, an almost identical pattern was observed in the list of words. Dyslexics were 83% less accurate than normal controls. In particular, they made 86% more Timing and 74% more Accuracy errors than their non-dyslexic peers. It is obvious that the gap between dyslexics and controls is greater in Timing errors. This is also in support of the speed deficit of dyslexics, as Timing errors include Hems, Repetitions, and Syllabication, which are responsible for the slowdown of the reading speed. Besides, approximately 80% of dyslexics' total reading errors were timing errors compared to 68% of controls.

Significant differences in the accuracy level between adult dyslexics and controls have also been reported by Bruck (1990), who found higher error rates in her dyslexic group in comparison to age-matched students on all measures. Similarly, Hatcher et al. (2002) found significant differences in accuracy levels of dyslexics and controls on single word and passage reading. Significantly inaccurate reading of dyslexics compared to non-dyslexics was also reported by Felton et al. (1990), Snowling et al. (1997), Hanley (1997), Ramus et al. (2003) and Miller-Shaul (2005), who found significant differences between groups on text, word and/or nonword reading. Dyslexic students participating in the study of Lehtola & Lehto (2001) made 15.7% reading errors in a list of words compared to non-dyslexics, who made only 6.3%. The error percents reported for both groups in context reading were very low, namely 3% for dyslexics and 0.9% for controls (insignificant difference). However, this was not the case here, as significant differences between groups were found for both context and out of context reading. The different level of difficulty of the reading materials used and/or the more sensitive tool for the recording of reading errors, as it is discussed below, may account for this difference. Or, as mentioned before, Lehtola and Lehto's sampling fell into a key limitation. Dyslexics did not have a formal diagnosis, and, therefore, it is possible that non-dyslexics may have been included in the group. This limitation could account for such an insignificant difference between dyslexics and controls. Two more studies in the Finnish language provide support for the reading accuracy differences between dyslexics and controls (Leinonen et al., 2001; Laasonen et al., 2012). Leinonen et al. (2001), in particular, suggested that decoding accuracy could best discriminate between dyslexics and non-dyslexics.

Comparing the reading accuracy of both groups in the list of words to their accuracy in context reading (easy & difficult passages), a different image emerges. Dyslexics made

56% and 49% more reading errors in the list compared to the easy and difficult material, respectively, whereas they were only 14% less accurate in the difficult text compared to the easy one. On the other hand, non-dyslexics made 41% and 33% more reading errors in the list compared to the easy and difficult passage, respectively, while they were as little as 12% less accurate in the difficult material compared to the easy. An almost identical pattern was evident for dyslexics with regard to timing errors. They made 58% and 54% more timing errors in the list compared to the easy and difficult material, respectively, while they made only 10% more timing errors in the difficult compared to the easy text. Controls made 46% and 50% more timing errors in comparison to the easy and difficult passage, but they made 6% less timing errors in the difficult material in comparison to the easy. Finally, in terms of accuracy errors, dyslexics made 45% and 30% more accuracy errors in the list, as compared to the easy and difficult text, respectively, whereas their accuracy errors were 22% more in the difficult text compared to the easy. On the other hand, controls made 27% more accuracy errors in the list compared to the easy text, but they made 8% less accuracy errors in the list compared to the difficult text (see figures 17b in p. 311-312).

Generally, an increase in the number of total reading errors made by both groups is observed in the list of words as opposed to reading in context. Reading accuracy seems to be affected by the lack of context. As discussed earlier (see reading speed above), this error rate differences between materials can be attributed to the lack of context and the structure of the word list, which is of raising difficulty starting from simple and high frequency words and proceeding to unfamiliar and long words. Consequently, word recognition becomes more difficult, decoding strategies are applied, the speed of reading is slowing down, and the number of errors is increasing. This is also in line with Ben-Dror et al. (1991), who found that dyslexics show a regularity effect as well as they rely more on context to help word identification. However, this increase in the number of errors was found significant only for the dyslexic group, indicating that dyslexics are far more affected by the lack of context with regard to reading accuracy than controls. The errors of dyslexics were doubled in the list of word in contrast to non-dyslexics, who did not made significantly more reading errors in the list, although a slight increase was also inevitably evident. It is worthwhile to mention that, in contrast to reading speed (see p.356), which was found to be affected to the same extent in dyslexics and controls by the lack of context, reading accuracy is far more severely affected within the dyslexic group.

This is in line with Bruck (1990), who found that the control group made minimum errors in both context and single word reading in contrast to dyslexics, who were significantly facilitated by context environment. Support for the increase of dyslexics' reading errors when reading out of context also comes from the study of Lehtola and Lehto (2001). Their dyslexic participants made 3% of reading errors in the text compared to 15.7% in the word list, demonstrating a considerable increase. The higher percents of reading errors reported in the current study though, reaching 30% in context and exceeding 60% in the word list, are probably due to the different reading materials and level of difficulty, mainly of the word list, which was progressing to very unfamiliar and low frequency words. Besides, as aforementioned, in the current study a very sensitive and detailed instrument for the recording of reading errors was used, and, thus, a thorough categorisation and analysis of the errors has been made, possibly resulting in higher error rates. To be more precise, each mistaken word was not considered as one reading error, as it is the case in most studies including Lehtola and Lehto's, but all different errors made in a single word were taken into account and were counted in the total amount of errors made. Comparing, hence, these percents with the number of mistaken words reported in the current study, although still higher, the difference is somehow reduced *(19% for context and 27% for single word reading)*.

Regarding the comparison between the easy and difficult reading materials, there was no significant increase in the number of errors made for either group, even though both dyslexics and controls made slightly more reading errors in the difficult passage *(14% and*

12%, respectively). This probably means that reading accuracy is not considerably affected by text difficulty for either disabled or non-disabled readers. If reading accuracy were affected, it would be expected that both groups should make significantly more reading errors in the difficult material.

4.2.4. Kind of reading errors

Another main aim of the present research was to investigate the kind of reading errors that dyslexics and non-dyslexics have made, in order to find out whether the 2 groups qualitatively differ as well. Looking at the ranking order of the various categories, it is concluded that both groups made similar reading errors, with minor deviations, in all 3 materials administered to them. The 2 most frequent categories were always identical between groups, namely Repetitions and Hems, usually representing more than half of the errors that both groups have made. On the other hand, Line Missing, Point Marks and Errors Repetitions were among the least frequent reading errors made. Findings suggest that both groups made more Timing errors *(errors than reduce the speed of reading)*, whereas they made less Accuracy errors *(errors that negatively affect the accuracy of reading)* in all 3 materials. Precisely, dyslexics' timing errors ranged from 20% up to 49%, whereas their accuracy errors ranged from 7% to 12%. Controls' timing errors ranged from 4% up to 7% and accuracy errors from 2% to 3%. The more Hems and Repetitions made by dyslexics could be thought as a strategy employed, in order to gain some time for word recognition and compensate for their decoding difficulty.

The occurrence of more timing errors and the low accuracy error rates are in line with Seymour et al. (2003), Ziegler et al. (2003), Wimmer (1993) and Landerl et al. (1997), who concluded that in shallow orthographies, including the Greek one, adequate reading accuracy is easily achieved even by disabled readers, while speed remains their major difficulty. Seymour et al. (2003), for instance, report accuracy rates of Greek beginning readers that reach 99%. In the current study, despite the demanding reading tasks, even dyslexics, attained high accuracy levels, as indicated by the maximum error rate of 12% in the list of words.

Investigating the proportion of timing errors out of the total reading errors, it is estimated that, within the dyslexic group, 75%, 72% and 78% of their total errors were timing errors in the easy text, the difficult and the word list, respectively. In the control group, 62%, 51% and 68% of the errors were timing following the order of the 3 reading materials. It is obvious, therefore, that dyslexics are more prone to timing errors than normal controls. Such findings support previous outcomes with regard to reading speed, which was found to be deficient and significantly lower in dyslexics compared to controls. The increased timing errors led to the reduced reading speed of dyslexics, whereas this was not the case for controls, whose percents of total reading errors were very low, barely exceeding 10% in the list of words, while their timing errors did not exceed 7%. This is also supported by the significant negative correlations found in the dyslexic group between timing errors and reading speed, as it is discussed in the following section.

4.2.5. Further Analyses

Further analyses conducted *(correlations and logistic regression)* provided further support for the speed deficit of adult dyslexic university students as compared to normal controls.

4.2.5.1. Correlations

The reading speed of dyslexics was negatively correlated with their reading errors in all reading materials (easy text: $r = -.70$, $p < .01$; difficult text: $r = -.63$, $p < .01$; word list: $r = -.79$, $p < .01$). Thus, the slower the reading speed, the more the reading errors made. Hence, as aforementioned, the slower reading speed of dyslexics does not mean less reading errors, as someone would expect, revealing their true decoding deficit. On the other hand, the reading speed of controls was either insignificantly correlated with their reading errors or less significantly correlated. These findings are in line with Lehtola & Lehto (2000) as well as with Hatcher et al. (2002), who also found significant negative correlations between reading errors and reading speed of dyslexics ($r = -.46$ and $r = -.56$, respectively).

The significant negative correlations of dyslexics' timing errors with the speed of reading (easy text: $r = -.67$, $p < .01$; difficult text: $r = -.68$; word list: $-.71$, $p < .01$) and the significant positive correlations found between timing errors and total reading errors (easy text: $r = .95$, $p < .01$; difficult text: $.92$, $p < .01$; word list: $.91$, $p < .01$) provided further support for their speed deficit. As timing errors *(mainly Hems and Repetitions)* increase, the speed of reading decreases, while, as timing errors increase, the total amount of reading errors increases as well. This latter indicates that timing errors mainly contribute to the total amount of reading errors, as indicated by the very large correlation coefficients.

For controls, outcomes slightly deviated from this pattern. Although, similarly to dyslexics, timing errors mainly contributed to the total amount of errors, as shown by the significant correlations between timing errors and total errors (easy text: $r = .95$, $p < .01$; difficult text: $r = .93$, $p < .01$; word list: $r = .96$, $p < .01$), less significant correlations were found between timing errors and reading speed (easy text: $r = -.18$, ns; difficult text: $r = -.47$, $p < .01$; word list: $r = -.43$, $p < .05$). This means that their reading speed is not affected as much as dyslexics' by the timing errors made during reading.

Regarding accuracy errors, there were significant negative correlations between accuracy errors and reading speed but only for dyslexics (easy text: $r = -.53$, $p < .01$; difficult text: $r = -.46$, $p < .01$; word list: $r = -.62$, $p < .01$). As dyslexics' accuracy errors increase, the speed of reading decreases. These significant correlations found suggest that the difficulty dyslexics had in automatically recognising words made them lose reading speed as well. Especially in case of co-occurrence of dyslexia and ADHD, automatic word recognition is hindered further more.

Finally, the reading comprehension of dyslexics was not significantly correlated with their reading speed. Despite their extremely slow reading speed, their level of comprehension was not significantly affected. However, the existence of positive correlation between comprehension and speed, although not significant, indicates that as reading speed increases, reading comprehension increases as well. This is consistent with the assumption that any comprehension difficulties of dyslexics are due to their decoding deficit, whereas they have no comprehension deficit. Conversely, non-dyslexics' negative correlation between reading speed and reading comprehension, although significant only for the easy material, indicates that as reading speed increases, the reading comprehension tend to decrease. These findings are in line with Bell (2001), who suggests that comprehension is attained when reading neither too slow nor too fast. Dyslexics and controls show the opposite pattern: dyslexics may lose comprehension, because they read too slowly, whereas controls may lose comprehension, because they sometimes read so fast. Rightly Bell (2001) claims that slow readers are more likely to read with little comprehension due to the inability of the memory to retain large amount of information for a long time, while the development of reading speed may be at the expense of reading comprehension.

4.2.5.2. Logistic Regression

The main findings that resulted from the logistic regression analyses conducted, in order to investigate which variables (reading speed, accuracy, and/or comprehension) provided the most sensitive predictors of group membership were the following:

Main Findings

a) **Reading speed** can almost perfectly discriminate between dyslexics and controls.
b) **Reading accuracy** can less accurately discriminate between dyslexics and controls.
c) **Reading comprehension** cannot discriminate between dyslexics and controls.

Based on the previous findings, it was hypothesised that the speed of reading could possibly be the most accurate predictor of group membership. Indeed, results from the logistic regression analyses conducted clearly confirmed this hypothesis. In the first set of analyses (easy text), group membership was best predicted from reading speed alone *(aloud and silent reading speed)*. Reading speed tests accurately classified **96.3%** of the total cases (96.2% of dyslexics and 96.4% of controls). In the second set of analyses (difficult text), group membership was also best predicted from reading speed only *(aloud & silent)*. The classification accuracy reached **98.1%**, which was rendered the best among all analyses conducted, correctly classifying 100% of dyslexics and 96.4% of controls. In the third set of analyses (word list), group membership was best predicted by a combination of reading speed and timing errors *(errors that are responsible for the reduction of reading speed, and, as such, are considered as a measure of reading speed as well)*. Reading speed and Syllabication errors correctly classified **90.7%** of the total cases (84.6% of dyslexics and 96.4% of controls). Irrespective of adding other variables and making other possible combinations, the classification accuracy did not further increase.

The findings of the logistic regression analyses suggested that the classification of university students into the dyslexic and the control group could be successfully done using only one test, the evaluation of reading speed. The best classification resulted from their performance in reading speed on the difficult material (accuracy **98.1%**: 100% of dyslexics & 96.4% of controls). This model misclassified only one non-dyslexic participant assigning him in the dyslexic group (participant's ID number 27). Wondering why the certain participant was wrongly classified led me to look more carefully at his reading speed performance. Indeed, a closer look indicated that his reading speed was always within the lower speed limits of the control group being at least 1 SD below the group mean. Besides, his reading speed profile was more similar to dyslexics'. Namely, instead of his slow reading speed, he read at almost the same rate in both aloud and silent conditions (see Appendix 12).

Dropping him out of the analysis, the classification accuracy reached **100%**, correctly classifying all cases. This might suggest that the specific participant was undiagnosed dyslexic and, because of his ignorance, he was accidentally included in the control group. It is a matter of fact that almost 80% of dyslexics remain undiagnosed throughout their lives (Pavlidis, Tzivinikou & Evaggelinou, 1997). Such accurate results give us confidence that reading speed is the best predictor of dyslexia in adulthood. Thus, a short assessment of reading speed in context environment would be sufficient to “diagnose” dyslexia in adult population. Of course, a full dyslexia assessment is required and cannot be replaced by any screening procedure. For full diagnosis, though, it is essential to gather further information, such as IQ, spelling abilities, and other essential information.

Besides, the fact that such a high-achieving dyslexic population, namely university students, was selected, although not representative of the whole adult population of dyslexics, it was essential to identify the pure deficits that characterise adult dyslexia. The few dyslexics that enter university are probably of higher intelligence, more privileged socio-economically and have usually received better support regarding reading. Hence, if the very slow reading speed is the main manifestation of dyslexia in such a high-achieving population, it is doubtful that things would be different in other dyslexic adults.

It is noteworthy that the accuracy of classification based on the reading speed alone is somewhat reduced in the list of words (85.2%) compared to the other 2 reading materials. This is probably due to the lack of context. As discussed earlier, the lack of context made not only dyslexics, but also controls to slow down for successful word recognition making their discrimination more difficult. Due to the lack of context in the list, dyslexics made significantly more reading errors, in contrast to non-dyslexics, who did not make significantly more reading errors. Hence, it was assumed that the inclusion of reading errors *(timing errors, in particular)* could possibly better discriminate the 2 groups, as indeed it did. It is a matter of fact though that the model including reading speed and timing errors (Syllabication) had somehow reduced classification accuracy for dyslexics (84.6%). This may be attributed to the high heterogeneity of dyslexics with regard to syllabication errors, which ranged from only

0.67% up to 46.67% (M = 9.49%, SD = 10.23), in contrast to controls, whose syllabication errors ranged from 0% to 4%.

These findings seem to be in line with Shaywitz et al. (1999), Shaywitz (1998), and Shaywitz & Shaywitz (2005), who suggested that reading rate may be the most useful clinical criterion for differentiating disabled from non-disabled readers in early adulthood, as their decoding skills will never be fluent nor automatic. This is also consistent with Bruck (1990) and Ben-Dror, Pollatsek & Scarpati (1991), who concluded that the most prominent feature of adult dyslexia is slow word recognition, while inaccuracy in reading does not manifest itself to the same extent as in children. In full accordance with the findings of the present study, Bruck (1990) proposed the speed of word recognition as a main criterion for the identification of dyslexia in adult population. Furthermore, these findings totally confirm Ziegler and colleagues (2003), who claimed that in all languages dyslexics exhibit a persistent reading speed deficit compared to either age-matched or reading level-matched normal readers.

Further support is provided by the results reported by Miller-Shaul (2005), who found that the gap between dyslexics and controls that remains the most unchanged over the years is the speed of single word reading, as indicated by the large effect sizes. However, her finding that the gap between dyslexics and controls with regard to reading speed in context tends to decrease with age *(as indicated by the effect sizes: 1.31 for children and 0.52 for adults)* making the differentiation between groups more difficult, was not confirmed by the results of the current study, as the speed of reading in context was found to be the best predictor of dyslexia in adults. A potential explanation for this divergence could be that the adult sample of Miller-Shaul included compensated dyslexics, and, hence, they could probably more easily use context as a tool to help the speed of word recognition. This could possibly account for the reduced effect size in adults' reading speed in context as opposed to their reading speed out of context.

High accuracy of classification was also reported by Hatcher, Snowling & Griffiths (2002), who found that dyslexic students could be discriminated from non-dyslexics with 95.9% accuracy using 4 tests: spelling, nonword reading, short-term memory and writing speed. Using only literacy measures *(reading, spelling and nonword reading)*, they resulted in 91.8% *(78% of dyslexics and 98% of controls)* classification accuracy. In the second case, however, the classification accuracy for dyslexics was relatively low and the total accuracy was mainly influenced by the control group. Similarly, accurate classification (94%) was also reported by Decker (1989) using reading recognition, spelling, letter naming and speed of nonwords matching as predictors. Despite the high accuracy of Hatcher, Snowling & Griffiths (2002) and Decker (1989), the current study resulted in even higher classification accuracy (**98.1%**) based on only one test, the evaluation of reading speed. Besides, the evaluation of reading speed is easier and less time consuming compared to a test battery that includes reading, spelling, as well as cognitive, phonological and other abilities. In addition, it does not need any special skills for someone to administer a reading speed test; anyone is able to do with ease.

The outcomes of the logistic regression analysis are not in line with Snowling et al. (1997), Felton et al. (1990) and Hanley (1997), who recommended accuracy of nonword reading and phonological measures as the best tests with predictive value for the identification of dyslexia in adults. Even though in the present study the sample was not evaluated on phonological measures or nonword reading, the almost perfect accuracy of classification using reading speed alone renders it rather pointless. Findings of the current study are neither consistent with Leinonen et al. (2001), who concluded that decoding accuracy could mainly differentiate between dyslexics and non-dyslexics as well as between different dyslexic subgroups.

Furthermore, Nicolson and Fawcett (1997) proposed a 30-minute screening test for adult dyslexia evaluating reading and spelling skills, rapid naming, phonemic segmentation, verbal fluency, and other skills. Based on the outcomes of the current research, an accurate screening of great value could be made evaluating only the speed of context reading, after having been validated for a larger sample though. Nicolson & Fawcett's Adult Dyslexia Screening Test satisfactorily discriminated between dyslexic and non-dyslexic students (hit rate 94%) compared to an objective diagnostic system for adult dyslexia. The hit rates of the various subtests included in their screening test ranged from 63% up to 100%, with the lower rates being associated with rapid naming and digit span and the higher with reading speed (94%) and spelling (100%). Such results provide further support for the significance of reading speed in differentiating between dyslexic and non-dyslexics as opposed to phonological measures.

The significance of reading speed is also reinforced by the findings regarding reading accuracy. None combination of error variables has led to better classification accuracy. Indicatively, accuracy errors correctly classified 81.5% of the total cases in the easy text and the list and 88.9% in the difficult (for more details see p.337). Finally, with regard to reading comprehension, findings revealed that it cannot accurately discriminate between dyslexics and controls providing further support for the assumption that dyslexics have not a comprehension deficit, but their comprehension difficulties are direct consequences of their reading problem.

4.3. Conclusions – Recommendations

The present study highlights some very important findings on the reading performance in the Greek language as performed by individuals of multiple educational levels, from pupils to students, both normal achieving and dyslexics, to teachers. The connecting link between the two studies is how the reading process is expressed in a phonologically consistent language (Greek) from advanced and highly educated individuals to dyslexics in Ancient and/or Modern Greek.

The findings of this thesis show that the reading process in the phonologically consistent Greek language is influenced in a different way and degree in terms of speed, accuracy and comprehension by different factors, such as familiarity with language structure or biological-constitutional factors. The results of this study elucidate both the theoretical as well as the practical-applied aspects of reading.

In terms of theory, the results of the comparison between Greek language teachers and 12th grade pupils show that daily extensive practice in reading is more important at least for the reading speed than familiarity, experience and knowledge, as the 12th graders, who read daily extensively, held significantly higher reading speed than the far more experienced teachers. On the contrary, the higher level of domain specific knowledge and familiarity of the teachers influenced more reading accuracy than daily practice of 12th graders did. This is confirmed by the more reading errors made by the 12th grade pupils in both Ancient and Modern Greek.

These findings have also significant practical applications, as they may lead to new teaching methods that will focus on reading practice, which is a neglected area in more advanced grades, and on developing higher reading abilities. In more advanced grades, the teaching of the Greek language is mainly focused on grammatical and syntactic processing of the text as well as on developing the written expression of the students. After the end of primary school, reading no longer exists as an attempt-practice to improve reading speed and accuracy, while it is rather a personal matter. Therefore, it must be emphasised to students how important it is to read daily either for educational purposes or even for personal enjoyment. Daily reading practice increases the speed of reading and, as a result, students will need less time to study and, hence, they will have more leisure time available. Besides, according to Mathew effect the more one reads, the higher the reading proficiency becomes (Stanovich, 1986). Thus, teachers should provide more time and continuously encourage their students to read, in order to become more proficient readers. However, this holds true not only for pupils but also for teachers, who were found to lag behind pupils, at least in terms of reading speed. Teachers should also be motivated to develop their reading skills. Revision of the curriculum and assigning different subjects to them would engage teachers to more extensive reading, in order to meet instructional requirements.

From a theoretical point of view, this study also provides a comparison of the level of difficulty between Ancient and Modern Greek. Language structure and familiarity with text were found to play a vital role in the reading process, as expressed by the greater speed, higher comprehension and less reading errors of both teachers and pupils in Modern Greek, which is more familiar for both groups, read and spoken in everyday life in contrast to Ancient Greek, used only for educational purposes.

Such findings are important not only for teachers who teach but also for pupils who learn Ancient and Modern Greek, as they may lead to new approaches, teaching methods and learning strategies for both languages focusing on the individual strengths and weaknesses of both groups. Furthermore, the comparison between the two languages determined that their existent differences hindered the reading efficiency in Ancient Greek, suggesting that reading instruction should focus on learners' further familiarisation with the language structure. Besides, if we know the differences between the two languages, we can be more aware of the expectations of the students' progress, namely how quickly and easily they will acquire the two languages. It is finally noteworthy that, with regard to Ancient Greek, instruction focuses on learning the grammatical and the syntactic features of the language as well as translation skills, while it almost entirely ignores reading as a means to acquire reading fluency. A review of the teaching goals as to incorporate reading practice in Ancient Greek would be really useful for both teachers and pupils.

Furthermore, the results show that biological-constitutional factors significantly negatively affect the reading process. The findings confirm that, even in adulthood, dyslexic students still encounter severe difficulties and perform significantly worse in reading compared to normal controls matched for age, sex and socio-educational level. Dyslexic students were not able to read as accurately as controls, while their worse performance was related to reading speed. Their difficulties were also evident in reading comprehension, but to a lesser extent.

The data were separately analysed in terms of accuracy and speed. Accuracy by itself was proved to be a worse differentiating factor than speed of reading and when accuracy and speed were combined, even then, accuracy not only did not contribute to a better differentiation between the 2 groups but also deteriorated-reduced the discriminating ability of reading speed. Reading speed is not highly associated with phonological awareness, but accuracy in many cases is. The fact that reading speed was proven to be the only and the best differentiating factor between dyslexics and normal reading adult by itself constitutes a major contribution towards an objective diagnosis of dyslexia. Secondly, in terms of theory, the results of this study, namely the diagnostic significance of reading speed goes contrary to the phonological theory and supports the theory put forward by Prof. Pavlidis (Pavlidis, 2013).

These findings have also significant implications for treatment, because they show that the debilitating factor of dyslexics throughout life is reading speed and, therefore, the treatment of dyslexia should also concentrate on improving reading speed and, thus, it will ameliorate the negative effects of dyslexia. This is not a hypothetical suggestion, but a real and doable one, as it is proven among others by the results of the studies of Hatzifilippidou (2004) and Hatzifilippidou & Pavlidis (2005). However, it needs to be clarified that by improving the major debilitating factor of dyslexics (reading speed) it does not mean that all the other problems that are caused by dyslexia will be also equally ameliorated. Further research will show what else needs to be improved in parallel to the improvement of reading speed, in order to reduce even more the known negative phycho-socio-educational effects of dyslexia.

This study emphasises a number of ongoing concerns regarding the education of dyslexic individuals. Although awareness has increased and support services have been established for dyslexics in higher education in the last decade (Gilroy & Miles, 1996), there is continuous need to become more aware and provide support relevant to the individualised needs of these students. In Greece, there is little provision for dyslexic students in higher education, while it is limited to oral examination allowances. This means that there is ample opportunity for improvement of the facilities provided to dyslexics within higher education institutions. The finding that dyslexics need significantly more time than controls to read a passage provides ample support for such a provision within higher education institutions, in order for dyslexic students to complete their studies successfully and on time.

The findings of the current study highlight the importance of the reading speed not only for normal achieving population, as discussed before, but mainly for disabled readers, as it is the area of greatest concern for dyslexic students, because reading is significantly impaired in dyslexics compared to non-dyslexics. However, reading speed is a highly essential skill for both high school and University students, in order to deal with the large volume of material they have to study across academic semesters. Therefore, dyslexics, in particular, must be supported, in order to develop their reading skills. The provision of extra time seems to be the most essential accommodation for them. In the absence of time pressure, they can have all the time needed to decode each single word and use the context, as to extract meaning from text (Shaywitz, 1998). Tape recorders or recorded books, tutoring, support groups, access to syllabi and lecture notes instead of bulky books, as well as reduced curriculum and adaptive technology *(e.g. electronic readers)*, could be additional aid for them. Such provisions would definitely help dyslexic students to complete their studies successfully and on time.

Dyslexics must be equally and effectively treated across their studies in higher education. Because of the society's ignorance, dyslexics do not have the support they need either at home or even school or later university and they are often treated unfairly. Support must be perceived as satisfaction of their right for equal educational opportunities. Because, according to Hurst (1994): *"when disabled people enter higher education they are taking up an opportunity to increase their knowledge, to develop their social skills, to obtain good qualifications and to expose themselves to debate and discussion. It is an important experience for empowerment"* (p.141).

Finally, this study highlights a number of issues of diagnostic significance. Reading speed in context was found to be the best predictor of dyslexia in adulthood with an almost perfect classification accuracy of dyslexics and controls and it could be definitely used for the assessment of dyslexia in adulthood. It is noteworthy, though, that oral reading texts have not been widely used for the identification of dyslexia, probably because of the context facilitation. However, it is an advantage of using such tasks, because they imitate normal reading conditions (Leinonen et al., 2001). Thus, the accurate and on time diagnosis will contribute in the development of individualised treatment methods that will socially, psychologically as well as educationally improve adult dyslexic students.

The results of the dyslexia study clearly indicate that the diagnostic battery for the assessment of reading should always include the measurement of reading speed. As it is proven by the international literature irrespective of language, culture, race or socio-economic background, the most robust and trustworthy indicator of reading ability is reading speed. Further research should concentrate on developing effective methods of treatment that address the improvement of reading speed especially in the early grades. This is an achievable aim as it is proven by the corresponding use of Pavlidis method (Hatzifilippidou & Pavlidis, 2005; Hatzifilippidou, Pavlidis & Evans, 2005).

According to the present study, the following suggestions could be put forward in relation to the reading process in the phonologically consistent Greek language:

- Emphasise the importance of daily extensive reading practice, particularly for the improvement of reading speed.
- Emphasise the significance of domain specific knowledge and familiarity with print for reading.
- Rise awareness of dyslexia within higher education.
- Inform dyslexic students for their rights and responsibilities within higher education institutions.
- Provide facilities, such as extra time, extended deadlines, etc., for dyslexics within higher education.
- Provide guidelines and assessments based on reading speed in context for the identification of dyslexia in higher education.
- Highlight the importance of reading speed measurements in a diagnostic battery for adult dyslexia.

4.4. Limitations – Suggestions for further research

The present study highlights some very important findings on the reading process in the Greek language as performed by teachers and pupils as well as by adult dyslexic and non-dyslexic students. There are, however, some limitations that should be addressed in future research.

Primarily, the number of participants within each group was not very large, and, hence, present results should be replicated with a larger number of participants. Furthermore, within the teachers' group, there was an expanded age range that might have resulted in heterogeneity of the sample. With regard to university students, either dyslexics or non-dyslexics, they were studying in different faculties *(from Technological Institutions to Polytechnic and Medical schools, from undergraduate to PhD students)* and might have different literacy levels. Hence, it would be useful for future research to match participants for areas of study *(similar scientific fields)*.

A second limitation is the lack of Greek literature. There is no systematic research, studies or publications in the specific area of interest in Greece to compare my findings with, while most data remain at a theoretical level. The reading performance of Greek language teachers and 12th grade pupils as well as of dyslexic and non-dyslexic students was never investigated in Greek.

Another limitation lies in the lack of information about the possible remediation that several dyslexic students may have benefited from. So, there may be included in the sample both dyslexics that received reading treatment and others that did not. Further studies should take into consideration the treatment factor. Besides, the great heterogeneity of dyslexic population makes it difficult to include dyslexics equally severely affected and who fulfill all the inclusion criteria. That is why the reading performance of dyslexics was heterogeneous mainly in terms of reading errors.

Additionally, the conclusions drawn are limited by the cross-sectional nature of the data. Ideally, particularly dyslexic participants should have been followed longitudinally, since the first grades until University, in order to observe the whole development of their reading skills.

Finally, it is a well-established fact that dyslexics have a major problem in word recognition, which they compensate by relying on context and meaning. However, when they read a very difficult text like the ones used in the present study, they lose the support they get from context and understanding, because, as aforementioned, it was very difficult for them to understand with many infrequent words and concepts.

Future research should address the aforementioned limitations, as they may have reduced the probabilities of finding more significant results. In addition, a follow-up study could assess the reliability of the present data and the practical use of the current findings. Finally, similar studies in phonologically inconsistent languages like English would be really useful.

Concluding, hopefully the present study may become the basis for further research in the Greek language *(phonologically consistent language)*, so that the reading process will be fully investigated, especially for individuals who encounter learning difficulties and dyslexia in particular.

APPENDIX 1

The History of Learning Disabilities

The origins of the field of Learning Disabilities date back at the beginning of the 19^{th} century. Lerner & Johns (2008) divided the history of Learning Disabilities into 4 historical phases: a) the *Foundation Phase* (1800-1930), emphasizing on basic scientific research related to the brain, which became the basis of the field of LD, b) the *Transition Phase* (1930-1960), during which the scientific research of the brain was applied to the clinical study of children, c) the *Integration Phase* (1960-1980), when learning disabilities were recognised and implemented in schools, and d) the *New Directions Phase* (1980-present), emphasising on the incorporation of new concepts and directions into the field, such as inclusion reinforcement. It is remarkable to mention that it was during the Transition Phase, when Alfred Strauss and Heinz Werner (1940) suggested a neurological etiology of Learning Disabilities (Kavale & Forness, 2003; Winzer, 1993), something than greatly influenced the field since then.

Looking at the above phases of the history of Learning Disabilities, two comments could be made: Primarily, as at the early phases schools had no educational programmes for learning-disabled children, parents turned to physicians and psychologists for help. Hence, the field of Learning Disabilities was perceived within a medical frame at first and professionals viewed children from the point of their own discipline using medical terms *(such as brain damage, brain dysfunction, neurological impairment, perceptual handicap, etc.)* to describe their learning problems. Secondly, the perception of Learning Disabilities as a concern of education is relatively recent. In fact, it was only in 1963 when Kirk suggested the term “learning disability” as a term focusing on children’s educational problems rather than having medical implications, meaning that the actual history of Learning Disabilities as perceived today is relatively brief, counting only five decades. This term was better and widely accepted by parents, teachers as well as pupils themselves (Hallahan, Kauffman & Pullen, 2009; Heward, 2009; Lerner & Johns, 2008; 2011; Kavale & Forness, 2003; Winzer, 1993). Besides, only in 1975, Learning Disabilities were included in IDEA as a distinct category of Special Education (Heward, 2009).

From another point of view, Hallahan and Mercer (2001) suggested a different categorisation of the history of Learning Disabilities resulting in the following 5 chronological periods: a) the *European Foundation Period* (1800-1920), during which European researchers investigated the relationship between brain injury and behaviours, while at the same time interest developed about reading disorders, b) the *U.S. Foundation Period* (1920-1960), when researchers moved beyond observing and explaining disabilities, and remediation became their focus developing identification and assessment tools as well as remedial interventions, c) the *Emergent Period* (1960-1975), when the term "Learning Disabilities" emerged into the public domain and efforts for a meaningful as well as comprehensive definition have been made, d) the *Solidification Period* (1975-1985), in which the field of learning disabilities solidified both definition and identification regulations, and finally e) the *Turbulent Period* (1985-2000), during which the rapid increase in the size of learning-disabled population caused new turbulence, mainly because of lack of consensus among professionals (Hallahan & Mock, 2003).

Even though the history of Learning Disabilities as an educational concern seems to be brief, the specific field still remains complex. Controversial issues, considerable confusion and disagreement exist not only among professionals but also among parents regarding the definition of the term. Finally, as Heward (2009) stated, *"learning disabilities has brought out both the worst and the best that special education has to offer"* (p.173).

APPENDIX 2

Kottalos

According to the original text of the mime, Kottalos, as most dyslexics do, encountered difficulties in writing: *"His wretched tablet that I'm worn out waxing every month lies abandoned by the bed post close against the wall, except when he glares at it as it as though it were Hades and writes nothing any good and wipes it clean"* (translated by Fowler, 1990). Furthermore, he had severe problems with reading: *"He can't recognize the letter a, not even if one shouts it five times to him. His father the day before yesterday was teaching him to spell the name Maron, and this fine scholar wrote the throw Simon"* (translated by Fowler, 1990). However, Kottalos was a charismatic boy with high intelligence: *"He knows his festive sevenths and twentieths better than the astrologists. He can calculate the holidays even in his sleep"* (translated by Fowler, 1990). His intelligence though was in contrast to the continuous school failure, something known to characterise the majority of dyslexics (e.g. Lyon, Shaywitz & Swaywitz, 2003; Pavlidis, 1990; Critchley, 1978, etc.). Thus, his mother, Mitrotima, convinced for his laziness, asked his teacher to punish him hoping that he would become more diligent: *"Lampriskos, the dear Muses allow you enjoyment of life upon condition that you cudgel this boy across the back until his wicked soul just hovers upon his lips"* (translated by Fowler, 1990).

APPENDIX 3

THE UNIVERSITY OF NORTHAMPTON

Participants' Information Sheet

Research Title:

"Quantitative and qualitative differences in the reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students"

Purpose of the study:

The aim of the present study is to find out whether any differences exist a) in reading Ancient and Modern Greek texts between teachers of Ancient Greek and pupils of the 12th grade and b) in reading Modern Greek texts between adult dyslexic university students and age, sex and socio-educational level matched normal controls.

The present study constitutes a part of our research in learning difficulties, while will also constitutes the base of **Sofia's Rapti** postgraduate studies (Ph.D).

Description of the research:

The participants will be evaluated in reading accuracy and speed as well as in reading comprehension. They will be given Ancient and/or Modern Greek texts of varying difficulty and will be asked to read. They will also have to answer in reading comprehension questions to evaluate their level of comprehension. Especially for the group of dyslexics, they will also be given a list of 150 words of raising difficulty and will be asked to read them.

All participants will be tape recorded while reading for further analysis of the reading errors ***(only with their written consent).***

What are the risks?

There are no risks for the participant if he/she decides to participate in the research.

Duration:

The total time that each participant will be occupied will be approximately 20 – 25 minutes. Every test will be accomplished **only with the written consent of each participant.**

Utility of the research:

For the participant: The results of the research will help the participant to find out any difficulties that he/she may have in the areas tested and to choose the appropriate methods of treatment (especially for dyslexic students).

For the society: The results of the proposed study will prove important for the society as they may lead to new approaches and teaching methods for learning Ancient and Modern Greek, as there will be a comparison of the level of difficulty between the two languages. These new approaches and methods may be more effective and useful for both teachers, who teach Ancient and Modern Greek and pupils, who learn Ancient and Modern Greek.

Furthermore, in our society, any deviation of the ideal is often rejected or excluded. Pupils that face learning difficulties and dyslexia are usually treated unfairly. Because of ignorance they do not have the support they need neither at home nor at school or later at university. The aim of the present study is to fill in the gaps in our knowledge about adult dyslexics, so that they will be treated fairly and effectively. The correct and on time diagnosis will lead in the development of programmes, which will improve them in social, psychological and educational level through individualised treatment methods.

What will happen to the information?

The information given will be stored in a locked filing cabinet. The identity of each participant will remain anonymous throughout the research process and in the report. We will do this by assigning a number for each one. From then on each participant will be known only by his number. Once the research is completed, personal information will be destroyed. When writing any report of the study, it will not be possible for anyone who participated in the study to be identified.

The information collected will be for research purposes only and will not be given to any other party.

The **results** are **completely confidential** and will not be given to anyone else except for the participant himself, if he wishes so.

Not sure about participating?

If one does not want to participate, that is fine; He/She has the right not to participate.

Each participant has the right to freely withdraw from the study at anytime, without any warning or penalty. He has just to let us know when he is ready to stop. **He can also withdraw his material from the research at anytime.**

Contact details of the researcher:

Name: Sofia Rapti

Address: 4 Karagatsi Street, 41221, Larissa, Greece

Tel: (0030) 2410 – 235108, **mobile**: (0030) 6978776464

e-mail: sofia.rapti@northampton.ac.uk *or* ssrapti@yahoo.gr

Who has checked this research?

If you need further information or assurances you could also contact someone of the supervisory team:

Supervisors:

1) **Prof. Philip Garner**, Professor of Education (University of Northampton, United Kingdom), **tel**: (0044) 01604 892418, **e-mail**: Philip.Garner@northampton.ac.uk
2) **Prof. George Th. Pavlidis**, Professor of Learning Difficulties (University of Macedonia, Thessaloniki, Greece), **tel**: (0030) 2310 – 891333-4, **e-mail**: pavlidis@uom.gr

Thank you very much for your interest and support. If you would like to participate in the research, please complete the consent form and contact the researcher.

Thank you very much for your well-intentioned cooperation.

Respectfully Yours,

Sofia Rapti

APPENDIX 4

THE UNIVERSITY OF NORTHAMPTON

Consent form

Participation in the research:

“Quantitative and qualitative differences in the reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students”

The undersigned ....……………………………………..........................., after having read and understood the description as well as the aim and utility of the research titled: ***“Quantitative and qualitative differences in the reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students”*** that Sofia Rapti carries out in the frame of her postgraduate studies (Ph.D), I declare that:

- I consent to participate under the condition that I will be occupied for minimum time and I will have the right to freely withdraw at anytime, without any warning or penalty.
- I consent to be recorded while reading under the condition that I will have the right to withdraw my material from the research at anytime.
- I consent that my material will be retained with the researcher after the completion of the research under the condition that it will be kept anonymous and confidential and I will have the right to withdraw my material at anytime.

Larissa …./…./201…

The undersigned

(signature)

APPENDIX 5

THE UNIVERSITY OF NORTHAMPTON

Consent form

Participation in the research:

"Quantitative and qualitative differences in the reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students"

The undersigned ....…………………………………..........................., after having read and understood the description as well as the aim and utility of the research titled: ***"Quantitative and qualitative differences in the reading performance between Greek language teachers & 12th grade pupils and between adult dyslexic & non-dyslexic students"*** that Sofia Rapti carries out in the frame of her postgraduate studies (Ph.D), I declare that:

- I consent that my son/daughter ………………………………………………...
participates under the condition that will be occupied for minimum time and will have the right to freely withdraw at anytime, without any warning or penalty.
- I consent him/her to be recorded while reading under the condition that he/she will have the right to withdraw his/her material from the research at anytime.
- I consent that his/her material will be retained with the researcher after the completion of the research under the condition that it will be kept anonymous and confidential and he/she will have the right to withdraw his/her material at anytime.

Larissa …./…./201…

The undersigned

(signature)

APPENDIX 6

QUESTIONNAIRE

CONFIDENTIAL PERSONAL DATA

George Th. Pavlidis

Professor of Learning Difficulties, University of Macedonia

Lifelong Member and Vice-president of the International Academy of Learning Problems Research

DATE: …. /….. /**201…**

Please answer accurately and honestly, all the Questions

Only *honest* answers will benefit our collaboration

FULL NAME………………………………………………………………………………

FATHER'S NAME…………………………………………………………………………..

Profession……………………………………….. **Specialisation** ……………………….....

PARENTS PROFESSION: FATHER…………………… **MOTHER**………….............

AGE:.…………………………… **DATE OF BIRTH**: …………. /…………../19…………

Address: ……………………………………………………….. **Number**……….........

District……………………………**City**……………………...**Post Code**……………………

Tel.: Home……………………..**Office**……………...**Mobile phone**………………….........

FAX………………………………**E-MAIL**..

STUDIES

High school …………. School Certificate mark ……………..

- **DEGREE:** ………………………………...**Specialisation** ……………………………

  Year of studies…………

- **POSTGRADUATE STUDIES**:

  ……………………………………………**Specialisation** ………………………..

Further Education *(relative seminars, further education etc.)* - **Describe** briefly:

…………………………………………………………………………………….

…………………………………………………………………………………….

…………………………………………………………………………………….

ATTENTION DEFICIT [0 – 10]: **0 = NONE** **10 = VERY HIGH**

VERY LOW LOW AVERAGE HIGH VERY HIGH

READING COMPREHENSION [0 – 10]: **0 = NONE** **10 = EXCELLENT**

VERY LOW LOW NORMAL HIGH EXCELLENT

READING SPEED [0 – 10]: **0 = NONE** **10 = EXCELLENT**

VERY SLOW SLOW NORMAL FAST VERY FAST

READING ACCURACY [0 – 10]: **0 = NONE** **10 = EXCELLENT**

VERY LOW LOW NORMAL GOOD EXCELLENT

EXTRA-CURRICULAR READING [0 – 10]: **0 = NONE** **10 = EVERY DAY**

VERY RARELY RARELY REGULARLY OFTEN EVERY DAY

ORTHOGRAPHY IS [0 – 10]: **0 = VERY BAD** **10 = EXCELLENT**

VERY BAD BAD AVERAGE PRETTY GOOD EXCELLENT

Fill in 3 of your **most Important Learning Difficulties:**

1……………………………………..

2………………………………………………………………….

3………………………………………………………………….

Do you have a **Diagnosis**? YES NO **If YES:**

Diagnosed by:

....

When and which was your diagnosis?

....

Your comments *(if you wish)***:**

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

APPENDIX 7

READING PASSAGE 1

(Ancient Greek)

[301] ἔστιν οὖν δικαστῶν νοῦν ἐχόντων τοὺς μὲν τῶν τοιούτων λόγων αἰτίους γιγνομένους ἀποκτείνειν ὡς μεγάλην αἰσχύνην τῇ πόλει περιποιοῦντας, τοὺς δὲ τῶν ἐπαίνων τῶν λεγομένων περὶ αὐτῆς μέρος τι συμβαλλομένους τιμᾶν μᾶλλον ἢ τοὺς ἀθλητὰς τοὺς ἐν τοῖς στεφανίταις ἀγῶσιν νικῶντας· [302] πολὺ γὰρ καλλίω δόξαν ἐκείνων κτώμενοι τῇ πόλει τυγχάνουσι καὶ μᾶλλον ἁρμόττουσαν. περὶ μὲν γὰρ τὴν τῶν σωμάτων ἀγωνίαν πολλοὺς τοὺς ἀμφισβητοῦντας ἔχομεν, περὶ δὲ τὴν παιδείαν ἅπαντες ἂν ἡμᾶς πρωτεύειν προκρίνειαν. χρὴ δὲ τοὺς καὶ μικρὰ λογίζεσθαι δυναμένους τοὺς ἐν τοῖς τοιούτοις τῶν ἔργων διαφέροντας, ἐν οἷς ἡ πόλις εὐδοκιμεῖ, τιμῶντας φαίνεσθαι, καὶ μὴ φθονερῶς ἔχειν, μηδ᾽ ἐναντία τοῖς ἄλλοις Ἕλλησιν γιγνώσκειν περὶ αὐτῶν. [303] ὧν ὑμῖν οὐδὲν πώποτ᾽ ἐμέλησεν, ἀλλὰ τοσοῦτον διημαρτήκατε τοῦ συμφέροντος, ὥσθ᾽ ἥδιον ἔχετε, δι᾽ οὓς ἀκούετε κακῶς ἢ δι᾽ οὓς ἐπαινεῖσθε, καὶ δημοτικωτέρους εἶναι νομίζετε τοὺς τοῦ μισεῖσθαι τὴν πόλιν ὑπὸ πολλῶν αἰτίους ὄντας ἢ τοὺς ἅπαντας, οἷς πεπλησιάκασιν, εὖ διακεῖσθαι πρὸς αὐτὴν πεποιηκότας. [304] ἢν οὖν σωφρονῆτε, τῆς μὲν ταραχῆς παύσεσθε ταύτης, οὐχ οὕτω δ᾽ ὥσπερ νῦν οἱ μὲν τραχέως, οἱ δ᾽ ὀλιγώρως διακείσεσθε πρὸς τὴν φιλοσοφίαν, ἀλλ᾽ ὑπολαβόντες κάλλιστον εἶναι καὶ σπουδαιότατον τῶν ἐπιτηδευμάτων τὴν τῆς ψυχῆς ἐπιμέλειαν, προτρέψετε τῶν νεωτέρων τοὺς βίον ἱκανὸν κεκτημένους καὶ σχολὴν ἄγειν δυναμένους ἐπὶ τὴν παιδείαν καὶ τὴν ἄσκησιν τὴν τοιαύτην, [305] καὶ τοὺς μὲν πονεῖν ἐθέλοντας καὶ παρασκευάζειν σφᾶς αὐτοὺς χρησίμους τῇ πόλει περὶ πολλοῦ ποιήσεσθε, τοὺς δὲ καταβεβλημένως ζῶντας καὶ μηδενὸς ἄλλου φροντίζοντας, πλὴν ὅπως ἀσελγῶς ἀπολαύσονται τῶν καταλειφθέντων, τούτους δὲ μισήσετε καὶ προδότας νομιεῖτε καὶ τῆς πόλεως καὶ τῆς τῶν προγόνων δόξης· μόλις γάρ, ἢν οὕτως ὑμᾶς αἴσθωνται πρὸς ἑκατέρους

αὐτῶν διακειμένους, ἐθελήσουσιν οἱ νεώτεροι καταφρονήσαντες τῆς ῥαθυμίας προσέχειν σφίσιν αὐτοῖς καὶ τῇ φιλοσοφίᾳ τὸν νοῦν.

READING PASSAGE 2

(Modern Greek)

Είναι καθήκον των σωφρόνων δικαστών να καταδικάζουν σε θάνατο τους ανθρώπους που γίνονται αιτία να λέγονται τέτοια, γιατί ντροπιάζουν πολύ την πόλη και να ανταμείβουν εκείνους που συμβάλλουν στον εγκωμιασμό της τιμώντας τους περισσότερο απ’ ό,τι τους αθλητές που νικούν στους αγώνες και τους στεφανώνουν, γιατί προσφέρουν στην πόλη δόξα μεγαλύτερη και αντάξιά της. Αν στους αθλητικούς αγώνες έχουμε πολλούς αντιπάλους, στις παιδαγωγικές μεθόδους όλοι θα μπορούσαν να αναγνωρίσουν ότι κατέχουμε την πρώτη θέση. Επίσης, όποιοι διαθέτουν απλώς λίγη λογική, πρέπει να εκτιμούν τους ανθρώπους που διαπρέπουν στα έργα, τα οποία προσδίδουν τιμή στην πόλη μας και όχι να τους φθονούν και να έχουν γι’ αυτούς *αντ*ίθετη άποψη απ’ ότι οι άλλοι Έλληνες. Εσείς όμως δεν ενδιαφερθήκατε ποτέ για όλα αυτά, αλλά παραβλέψατε τόσοπολύ το συμφέρον σας, ώστε δείχνετε μεγαλύτερη εύνοια για τους ανθρώπους που σας δυσφημούν, παρά για εκείνους που σας επαινούν και θεωρείτε ότιεκείνοι που επισύρουν εναντίον της πόλης μας το μίσος πολλών ανθρώπων, αγαπούν περισσότερο τη δημοκρατία απ’ ό,τι εκείνοι που κάνουν όσους συναντούν, να τρέφουν φιλικά αισθήματα για την πόλη.

Αν λοιπόν είστε συνετοί, θα σταματήσετε αυτήν την αναστάτωση και δεν θα διάκεισθε, όπως τώρα, άλλοι μεν εχθρικά προς τη φιλοσοφία και άλλοι με αδιαφορία. Αν πεισθείτε ότι η καλλιέργεια της ψυχής αποτελεί την ωραιότερη και σπουδαιότερη ενασχόληση, θα προτρέψετε τους νέους που διαθέτουν αρκετή περιουσία και τα μέσα να ζουν άνετα, να στραφούν προς αυτές τις σπουδές και ασκήσεις και θα δείξετε τη συμπάθειά σας σε εκείνους που θα θελήσουν να κουραστούν και να γίνουν χρήσιμοι στην πόλη, ενώ εκείνους που ζουν κατά τρόπο χυδαίο, χωρίς να ενδιαφέρονται για τίποτα άλλο, εκτός από το να απολαύσουν κατά τρόπο σκανδαλώδη την περιουσία που έχουν κληρονομήσει, τούτους θα τους μισήσετε και θα τους θεωρήσετε προδότες και της πατρίδας τους και της δόξας των προγόνων. Γιατί, βλέποντάς σας οι νέοι να έχετε αυτά τα αισθήματα απέναντι στους μεν και τους δε, θα θελήσουν περιφρονώντας τη ραθυμία να ενδιαφερθούν και για τον εαυτό τους και για τη φιλοσοφία.

(Περί αντιδόσεως, 301-305)

Translation in English

It is the duty of the sensible judges to condemn to death people that become the cause of such things being told, because they dishonor the city, and to reward those people who contribute to its encomium by honoring them more than the athletes that win the games, because they offer to the city more glory. If we have many opponents in the athletic games, everyone could recognise that we occupy the first place in the educational methods. Moreover, people that have just a little sense must appreciate the people that excel in actions, which offer honor to the city, and not to envy them or have a more opposite opinion about them than the other Greeks. However, you have never cared about all these, but you discounted your benefit so much as to show more favour to people who defame you than to those that praise you, and you think that those, who attract the hate of many people against the city, love more the democracy than those who make other people entertain friendly feelings for the city.

Thus, if you are sensible, you will stop this confusion and you will be neither ill-disposed towards the philosophy nor careless as you are now. If you will be convinced that the culture of the mind constitutes the major occupation, you will urge young people who have enough money and the means for a comfortable living, to turn to these studies and exercises and you will show your liking to those that will want to work hard for the city, while you will hate those that vulgarly live and have no other interest than misspending their fortune, and you will consider them as betrayers of their country and of the glory of the ancestors. That's because, when the young people see you having these feelings, they will be interested either in themselves or the philosophy, condemning the leisureliness.

(Isocrates, peri antidoseos)

READING COMPREHENSION

(Translated in English)

Answer the questions below:

READING COMPREHENSION QUESTIONS	TRUE	FALSE
1. The duty of the sensible judges is to reward those people that contribute to the encomium of the city.		
2. The athletes that win the games must be less honored than people that contribute to the encomium of the city.		
3. In the educational methods, everyone could recognise that the Athenians did not occupy the first place.		
4. The Athenians have the same opinion with the other Greeks about the people who honor the city.		
5. The Athenians, according to the orator, show more favor to those that praise them.		
6. The Athenians are ill-disposed and careless towards the philosophy.		
7. The young people prefer the philosophy than a comfortable living.		

APPENDIX 8

READING PASSAGE 1

1st half

Είναι καθήκον των σωφρόνων δικαστών να καταδικάζουν σε θάνατο τους ανθρώπους που γίνονται αιτία να λέγονται τέτοια, γιατί ντροπιάζουν πολύ την πόλη και να ανταμείβουν εκείνους που συμβάλλουν στον εγκωμιασμό της τιμώντας τους περισσότερο απ' ότι τους αθλητές που νικούν στους αγώνες και τους στεφανώνουν, γιατί προσφέρουν στην πόλη δόξα μεγαλύτερη και αντάξιά της. Αν στους αθλητικούς αγώνες έχουμε πολλούς αντιπάλους, στις παιδαγωγικές μεθόδους όλοι θα μπορούσαν να αναγνωρίσουν ότι κατέχουμε την πρώτη θέση.

Translation in English

It is the duty of the sensible judges to condemn to death people that become the cause of such things being told, because they dishonor the city, and to reward those people who contribute to its encomium by honoring them more than the athletes that win the games, because they offer to the city more glory. If we have many opponents in the athletic games, everyone could recognise that we occupy the first place in the educational methods.

Reading Comprehension Questions

(Translated in English)

1. Whose duty is to reward those, who contribute to the encomium of the city?

………………………………………………………………………………………….

2. More than whom people that contribute to the encomium of the city must be rewarded?

………………………………………………………………………………………….

3. Why these people must be more rewarded?

………………………………………………………………………………………….

4. In which field Athenians have many opponents?

………………………………………………………………………………………….

5. In which field Athenians occupy the first position?

………………………………………………………………………………………….

READING PASSAGE 1

2nd half

Όποιοι διαθέτουν λίγη λογική, πρέπει να εκτιμούν τους ανθρώπους που διαπρέπουν στα έργα, τα οποία προσδίδουν τιμή στην πόλη μας και όχι να τους φθονούν και να έχουν γι' αυτούς αντίθετη άποψη απ' ότι οι άλλοι Έλληνες. Εσείς όμως δεν ενδιαφερθήκατε ποτέ για όλα αυτά, αλλά παραβλέψατε τόσο πολύ το συμφέρον σας, ώστε δείχνετε μεγαλύτερη εύνοια για τους ανθρώπους που σας δυσφημούν, παρά για εκείνους που σας επαινούν και θεωρείτε ότι εκείνοι που επισύρουν εναντίον της πόλης μας το μίσος πολλών ανθρώπων, αγαπούν περισσότερο τη δημοκρατία απ' ότι εκείνοι που κάνουν όσους συναντούν, να τρέφουν φιλικά αισθήματα για την πόλη.

Translation in English

People that have just a little sense must appreciate the people that excel in actions, which offer honor to the city, and not to envy them or have a more opposite opinion about them than the other Greeks. However, you have never cared about all these, but you discounted your benefit so much as to show more favour to people who defame you than to those that praise you, and you think that those, who attract the hate of many people against the city, love more the democracy than those who make other people entertain friendly feelings for the city.

READING COMPREHENSION QUESTIONS

Translated in English

1. Which people must appreciate those who offer honor of the city?

…………………………………………………………………………….

2. Which is the attitude of those people towards the people who honor the city?

…………………………………………………………………………….

3. Which is the opinion of the Athenians compared with the opinion of the other Greeks concerning the people who honor the city?

…………………………………………………………………………….

4. To whom the Athenians show more favour?

…………………………………………………………………………….

5. Which people, according to the opinion of the Athenians, love more the democracy?

…………………………………………………………………………….

READING PASSAGE 2

1st half

Όσο για τους λόγους που διάφοροι είπαν είτε όταν σκόπευαν ν' αρχίσουν τον πόλεμο είτε αφού μπήκαν πια σ' αυτόν, δύσκολο για μένα ήταν να συγκρατήσω στη μνήμη μου ίδια κι απαράλλαχτα τα ειπωμένα, τόσο εκείνα που ο ίδιος άκουσα όσο κι εκείνα που μου ανακοίνωναν άλλοι από κάπου αλλού· όπως όμως νόμιζα πως ο καθένας τους θα μιλούσε προσφορότερα για τα κάθε φορά επίκαιρα ζητήματα, μένοντας όσο το δυνατό πιο κοντά στη γενική ιδέα του πραγματικά ειπωμένου, έτσι έγραψα τους λόγους. Τις πράξεις, όμως, που στη διάρκεια του πολέμου έγιναν, δεν έκρινα άξιο να τις γράψω βασισμένος στις πληροφορίες του πρώτου τυχόντα ούτε όπως εγώ νόμιζα, αλλά αφού ερεύνησα με κάθε δυνατή ακρίβεια για την καθεμιά, τόσο για εκείνες που ο ίδιος ήμουν παρών και για εκείνες που μάθαινα από τους άλλους.

Translation in English

Concerning the reasons that many people said either when they intended to begin the war or when they had already got into the war, it was hard for me to keep consistent in my memory all these that have been said, either those that I heard myself or those that I have been told by others. As I thought that everyone would talk appropriately for the current affairs, staying as close as possible to the general idea of the truth that is how I wrote my speeches. However, concerning the acts happened during the war, I didn't think that it could be appropriate to write them according to accidental information of someone or according to my opinion, but to write them down after researches about every act, either for those I was present or those I was informed by others.

READING COMPREHENSION QUESTIONS

1. Which words it was hard for Thucydides to keep consistent in his memory?

……………………………………………………………………………….

2. What did he care for when talking about the current affairs?

……………………………………………………………………………….

3. On which information Thucydides was never based when writing?

……………………………………………………………………………….

4. Which element was characterising the research of Thucydides?

……………………………………………………………………………….

5. Which facts Thucydides was equally investigating?

……………………………………………………………………………….

READING PASSAGE 2

2nd half

Η εξακρίβωση γινόταν δύσκολα, γιατί οι αυτόπτες μάρτυρες του κάθε περιστατικού δεν έλεγαν τα ίδια για το ίδιο, αλλά καθένας ανάλογα με τη συμπάθειά του για τη μια ή για την άλλη μερίδα ή καταπώς θυμόταν. Κι όσο στο να ακούει κανείς την αφήγησή μου, επειδή λείπει απ' αυτή το μυθικό, ίσως θα φανεί λιγότερο ευχάριστη· όσοι όμως θα θελήσουν να γνωρίσουν με ακρίβεια αυτά που έγιναν κι εκείνα που, σύμφωνα με την ανθρώπινη φύση, θα γίνουν κάποτε ξανά τέτοια ή παρόμοια, αυτοί να κρίνουν το έργο μου ωφέλιμο θα μου είναι αρκετό. Το έργο έχει γραφτεί πιο πολύ σαν μελέτημα παντοτινό παρά σαν ανάγνωσμα της στιγμής για να τ' ακούν ευχάριστα.

Translation in English

The verification was difficult, because the eye-witnesses of a certain case didn't say the same things for the same act, but everyone was narrating the facts according to his liking for the one or the other side or as he remembered. And, concerning my narration, it would be less agreeable, as there is no mythical element. However, I would be content enough if my narration would be concerned useful by people who want to learn either the exact facts happened or these that will happen in the future, according to the human nature. This narration was written more as an age-long thesis than as a casual reading in order to amuse the readers.

READING COMPREHENSION QUESTIONS

1. Which was the problem caused by the fact that the eye-witnesses of a certain incident didn't say the same?

……………………………………………………………………………….

2. What was influencing the words of the eye-witnesses?

……………………………………………………………………………….

3. Which element was excluded from the narration of Thucydides?

……………………………………………………………………………….

4. What does the mythical element offer to a story?

……………………………………………………………………………….

5. As what the narration of Thucydides was written?

……………………………………………………………………………….

LIST OF WORDS

Τι με να θα οι αχ γη της ζω πως τρως ποια αυτή μπει ποιοι ψηλά ντύνω φτύνω φταίει ντέφι πλοίο άλμα κλάμα κρότος αιτία δωρεά βαθμό στεγνός έκπληξη εκτροπή τροφή ευχή βιβλίο ηλικία πρώτον θρηνώ κουνέλι ψήνομαι μπροστά κείμενο αυγούλα άνδρας ύφασμα κριτικός θεϊκός κληρικός γρήγορος τσαγκάρη περίμενα τρακτέρ σύστημα γραμμικός ξεσκίζουν έγκλημα εκπέμπω πρεσβεία επιφάνεια αγρυπνία υπόσχομαι περπατώ πειθώ δωρητής επείγων κουλτούρα σημείωμα παράξενος ψιχουλάκι θυμωμένος υπαρχηγός αρχοντικό αποτελείται κρυφογελώ ανακάτεψαν αποφασίσανε ποδόσφαιρο κουβεντιάζουν σκαθαράκι φροντίζουνε ανυπόμονος σαρκοφάγος ουσιαστικά οικογένεια περιεχόμενο αδεξιότητα οιδίποδας μεγαλόσωμη εξακολούθησε σπιρτοκουτάκι πλειοψηφία εξαπατήθηκε αναχώρηση ιδιωματικός λιμνοθάλασσα ανεμοδαρμένο ραδιενέργεια ηλεκτρισμός σημαιοφόρος διασχίζοντας παραμεθόριος ανεμόπτερο βρικόλακας αρχιτέκτονας σκελετωμένο λαρυγγισμούς μεγαλειότατος χαρακτηριστικό εργοστασιάρχες απολαυστικός εγκαταλείφτηκε απογευματινός κρεβατοκάμαρα χειμωνιάτικες δημοσιογράφοι πρωτοποριακός προειδοποίηση τραβολογούσανε εγκαταστάθηκαν κατασκευαστικός συμπαρασταθείτε στρατοκρατούμενος ισχύων ξέσκεπη μαγγάνιο νεραντζούλα εύπλαστος εστιάζοντας αρτεσιανός ηττοπαθής κοσμογονία αισχρολογία ανατολίτικα στρογγυλωπός παραμονεύανε καμπανοκρουσία δωδεκαδάκτυλος διαπεραστικότητα οικειοποιούμαι ψυχαναλυτικές ανελκυστήρας παιζοκλαψούριζαν ξεμπροστιασμένος πλείστος ζενίθ οίστρος διαύγεια ευκρίνεια εύσπλαχνος ευρεσιτεχνία ορμώμενος αναποφασιστικότητα.

TRANSLATION IN ENGLISH

What, **with**, **to** *(e.g. do,)* **will**, **the** *(plural),* **ah**, **earth**, **of the** *(feminine),* **live**, **that**, *(you)* **eat**, **who** *(feminine)*, **she**, *(to)* **get in**, **who** *(masculine plural)*, **high** *(adverb)*, *(I)* **dress**, *(I)* **spit**, **is responsible**, **tambourine**, **ship**, **jump** *(noun)*, **cry** *(noun)*, **knock** *(noun)*, **cause**, **donation**, **grade**, **dry** *(adjective)*, **surprise**, **diversion**, **food**, **wish** *(noun)*, **book**, **age**, **firstly**, *(I)* **grieve**, **rabbit**, *(I)* **am baked**, **in front**, **text**, **little dawn**, **man**, **fabric**, **critical**, **divine**, **cleric**, **quick**, **cobbler**, *(I)* **was waiting**, **tractor**, **system**, **linear**, *(they)* **tear**, **crime**, *(I)* **transmit**, **embassy**, **surface**, **vigil**, *(I)* **promise**, *(I)* **walk**, **persuasion**, **donator**, **urgent**, **culture**, **note**, **strange**, **little crumb**, **angry**, **second-in-command**, **mansion**, **consists of**, *(I)* **snigger**, *(they)* **mixed**, *(they)* **decided**, **football**, *(they)* **discuss**, **little beetle**, *(they)* **take care**, **impatient**, **flesh-eating**, **nouns**, **family**, **content**, **awkwardness**, **Oedipus**, **big** *(feminine)*, *(he/she/it)* **continued**, **little matchbox**, **majority**, *(he/she/it)* **was cheated**, **departure**, **idiomatic**, **lagoon**, **wind-swept** *(neutral)*, **radiation**, **electricity**, **flag-bearer**, **crossing**, **border** *(adjective)*, **glider**, **vampire**, **architect**, **skinny** *(neutral),* **vocalisations**, **His majesty**, **characteristic**, **factory owners**, **enjoyable**, *(he/she/it)* **was abandoned**, **afternoon** *(adjective)*, **bedroom**, **winter** *(adjective)*, **journalists**, **pioneer**, **warning**, *(they)* **were manhandling**, *(they)* **were established**, **constructive**, **stand by** *(imperative)*, **stratocracied** *(participle)*, **being in force** *(participle)*, **roofless** *(feminine)*, **manganese**, **little sour orange** *(feminine)*, **malleable**, **focusing** *(participle)*, **artesian**, **defeatist**, **cosmogony**, **smut**, **oriental**, **round**, *(they)* **were lurking**, **bell-ringing**, **twelve-fingered**, **sharpness**, *(I)* **usurp**, **psychoanalytical** *(plural)*, **lift**, *(they)* **were pulling**, **exposed** *(participle)*, **most** *(adjective)*, **peak**, **inspiration**, **clarity**, **lucidity**, **compassionate**, **invention**, **dashing** *(participle)*, **hesitancy**.

APPENDIX 9

TEACHERS & PUPILS: READING SPEED & COMPREHENSION SCORING SHEET

PARTICIPANT CODE: ______________________________

GROUP: ______________________________

AGE: ______________________________

SEX: male □ female □

ANCIENT GREEK PASSAGE

- READING SPEED:

ALOUD *(words/min):* ______________________________

SILENT *(words/min):* ______________________________

- READING COMPREHENSION ***(questions)****:*

1. TRUE □ - FALSE □
2. TRUE □ - FALSE □
3. TRUE □ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □
6. TRUE □ - FALSE □
7. TRUE □ - FALSE □

MODERN GREEK PASSAGE

- READING SPEED:

ALOUD *(words/min):* ____

SILENT *(words/min):* ____

- READING COMPREHENSION ***(questions)***:

1. TRUE □ - FALSE □
2. TRUE □ - FALSE □
3. TRUE □ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □
6. TRUE □ - FALSE □
7. TRUE □ - FALSE □

DYSLEXICS & CONTROLS: READING SPEED & COMPREHENSION SCORING SHEET

PARTICIPANT CODE: ______________________________

GROUP: ______________________________

AGE: ______________________________

SEX: male □ female □

PASSAGE 1 (1st HALF)

- READING SPEED:

ALOUD *(words/min)*: ______________________________

OR

SILENT *(words/min)*: ______________________________

- READING COMPREHENSION ***(questions)***:

1. TRUE □ - FALSE □
2. TRUE □ - FALSE □
3. TRUE□ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □

PASSAGE 1 (2nd HALF)

- READING SPEED:

ALOUD *(words/min)*: ______________________________

OR

SILENT *(words/min)*: ______________________________

- READING COMPREHENSION ***(questions)***:

1. TRUE □ - FALSE □
2. TRUE □ - FALSE □
3. TRUE □ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □

PASSAGE 2 (1st HALF)

- READING SPEED:

ALOUD *(words/min)*: ____

OR

SILENT *(words/min)*: ____

- READING COMPREHENSION *(questions)*:

1. TRUE □ - FALSE □
2. TRUE □ - FALSE □
3. TRUE □ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □

PASSAGE 2 (2nd HALF)

- READING SPEED:

ALOUD *(words/min)*: ____

OR

SILENT *(words/min)*: ____

- READING COMPREHENSION *(questions)*:

1. TRUE □ - FALSE □

2. TRUE □ - FALSE □
3. TRUE □ - FALSE □
4. TRUE □ - FALSE □
5. TRUE □ - FALSE □

LIST OF WORDS

- READING SPEED:

TOTAL: ____

1´: ____

BEYOND 1´: ____

APPENDIX 10

‘‘THE READING ERRORS ANALYSIS INSTRUMENT’’

Developed by Prof. George Th. Pavlidis in 2005

CATEGORIES OF READING ERRORS –

GUIDELINES FOR THE CORRECTION OF READING ERRORS

(Translated in English)

On the scoring sheet:

Filling in personal information about the participant: The initials of the examiner's name, the date of testing and the participant's personal information, which are already recorded in the tape or CD that includes his/her reading performance *(participant's name - code, age, sex, date of examination, title of the text or number of word list, etc.)* are filled in on the scoring sheet.

Errors Recording: The reading errors are primarily recorded on the testing sheet by filling in the error codes next to the words of the text or the word list according to the categories of reading errors, which are described in detail below. After the errors being recorded on the testing sheet, they are transcribed on the scoring sheet, which includes all the reading errors categories and subcategories.

Notice*: Any difficulty in speech articulation will not be considered as an error during correction.*

CATEGORIES OF READING ERRORS – CODES OF ERRORS

The main categories of reading errors included in the **"Reading Errors Analysis Instrument"** are 13. All categories of reading errors along with their several subcategories as well as their codes[*] are indicated in table 1 below. The "χ" factor, which appears in front of the error code, shows how many times an error is made in a single word *(e.g. for one hem → 1 K is recorded, while for two hems → 2 K are recorded, etc)*. However, for some error categories, the "χ" factor is usually equivalent to the number 1, and thus will optionally be recorded before the error code, but will be counted as 1 in the total sum of reading errors, e.g. 1 ΓΑ *(1 Letters Reversal)*, 1 Π *(1 Misintonation)*, 1 Χ Σ *(1 Line Missing)*, 1 Α Στ *(1 Punctuation Substitution)*. Moreover, in several subcategories the "ψ" factor is recorded *(in Substitutions of "ψ" Letters, Syllables or Words → the "ψ" factor shows how many Letters, Syllables or Words are substituted)*, e.g. 1 Α 1 Γ *(1 Substitution of 1 Letter)*, 2 Α 2 Γ *(2 Substitutions of 2 Letters),* etc.

***<u>Notice</u>**: When the "χ" or "ψ" factors are equivalent to 1, they will be optionally recorded, but will undoubtedly be counted in the total sum of reading errors, e.g. 1 ΑΓ (1 Letter Substitution) → 1 Α 1 Γ (1 Substitution of 1 Letter). *The error codes are given in Greek.*

<u>Table 1</u>. Reading Errors: Categories & Codes

Error Categories	**Error Codes**
1. HEMS	χ **Κ**
2. REGULAR REPETITIONS	χ **ΚΕ**
2a. Letter Repetition	χ **Ε**ψ **Γ**
2b. Syllable Repetition	χ **Ε** ψ **Σ**
2c. Word Repetition	χ **Ε** ψ **Λ**
3. SYLLABICATION	χ **Σ**
4. SUBSTITUTIONS	χ **ΑΚ**
4a. Letter Substitution	χ **Α** ψ **Γ**
4b. Syllable Substitution	χ **Α** ψ **Σ**
4c. Word Substitution	χ **Α** ψ **Λ**
5. REVERSALS	χ **ΑΣ**

5a. Letters Reversal	(1) **Γ Α**
5b. Syllables Reversal	(1) **Σ Α**
5c. Words Reversal	(1) **Λ Α**
6. OMISSIONS	χ –
6a. Letter Omission	χ – **Γ**
6b. Syllable Omission	χ – **Σ**
6c. Word Omission	χ – **Λ**
7. ADDITIONS	χ +
7a. Letter Addition	χ + **Γ**
7b. Syllable Addition	χ + **Σ**
7c. Word Addition	χ + **Λ**
8. MISINTONATION	(1) **Π**
9. ENDINGS	χ **ΚΑ**
10. PUNCTUATION ERRORS	χ **ΣΤ**
10a. Punctuation Substitution	(1) **Α Στ**
10b. Punctuation Omission	(1) **– Στ**
10c. Punctuation Addition	(1) **+ Στ**
11. POINT MARKS	(1) **ΟΣ**
12. LINE MISSING	(1) **ΧΣ**
13. REPETITIONS OF ERRORS	χ **ΛΕ**
13a. SUBSTITUTION REPETITIONS	
- **Letter Substitution Repetition**	χ **Ε Α Γ**
- **Syllable Substitution Repetition**	χ **Ε Α Σ**
- **Word Substitution Repetition**	χ **Ε Α Λ**
13b. REVERSALS REPETITIONS	
- **Letters Reversal Repetition**	χ **Ε Γ Α**
- **Syllables Reversal Repetition**	χ **Ε Σ Α**

- **Words Reversal Repetition**	**χ Ε Λ Α**
13c. OMISSION REPETITIONS	
- **Letter Omission Repetition**	**χ Ε – Γ**
- **Syllable Omission Repetition**	**χ Ε – Σ**
- **Word Omission Repetition**	**χ Ε – Λ**
13d. ADDITIONS REPETITIONS	
- **Letter Addition Repetition**	**χ Ε + Γ**
- **Syllable Addition Repetition**	**χ Ε + Σ**
- **Word Addition Repetition**	**χ Ε + Λ**
13e. MISINTONATION REPETITIONS	**χ Ε Π**
13f. ENDINGS REPETITIONS	**χ Ε ΚΑ**
13g. PUNCTUATION REPETITIONS	
- **Punctuation Substitution Repetition**	**χ Ε Α Στ**
- **Punctuation Omission Repetition**	**χ Ε – Στ**
- **Punctuation Addition Repetition**	**χ Ε + Στ**
13h. POINT MARKS REPETITIONS	**χ Ε ΟΣ**

Furthermore, it is important for three (3) special categories of reading errors, which show the reading ability as well, to be detected along with the main categories of reading errors. These 3 special categories of reading errors are the following:

a) Pseudo-Words *or* **Non-Words** ***(code χ ΨΛ)***

b) Corrected errors ***(code χ Δ)***

c) Non-corrected errors ***(code χ ΜΔ)***

The first 2 of the above special categories of reading errors, the Non-Words or Pseudo-Words and the Corrected Errors, will be marked along with all the other categories, but they will not be counted in the total sum of reading errors *(these two categories are not counted in the total sum of reading errors, because their existence requires the pre-existence of another error as* *well in the same word and thus, they cannot account as an error)*. The Non Corrected Errors, is not necessary to be marked along with the other reading errors, because they can be easily calculated in the end by subtracting the total sum of the Corrected Errors from the total sum of all the reading errors except for Regular Repetitions *(category 2)* and Repetitions of Errors *(category 13) – the Corrected and Non Corrected Errors concern all the kinds of reading errors except for Repetitions.*

READING ERRORS CATEGORIES

DETAILED DESCRIPTION OF ALL CATEGORIES – CODES – CORRECTION CRITERIA – EXAMPLES

All categories of reading errors along with their several subcategories are described below, while representative examples for each category are given. Moreover, detailed advice is given for the correction of the reading errors by the examiner.

I. SPECIAL CATEGORIES OF READING ERRORS

A. NON – WORDS or PSEUDO – WORDS *(code χ ΨΛ)*

Pseudo-Words or Non-Words are the *"words"* without meaning that the participant incorrectly reads after making one or more reading errors *(apart from Hems, Syllabication and Regular or Error Repetitions)*.

e.g. "αμ**ό**σως" instead of "αμ**έ**σως" *(= immediately)* → the letter **"ε"** of the word "αμέσως" is substituted by the letter **"ο"** → 1 Substitution of 1 Letter *(1 Α 1 Γ)* / the word **"αμόσως"** is meaningless → **1 Pseudo-Word** *(1 ΨΛ)*

"oject" instead of "o**b**ject" → the letter **"b"** of the word "object" is omitted → 1 Letter Omission *(1 – Γ)* / the word **"oject"** is meaningless → **1 Pseudo-Word** *(1 ΨΛ)*

However, as a participant may read more than one Pseudo-Words for a normal word, the total number of Pseudo-Words read is necessary to be recorded *(1 ΨΛ, 2 ΨΛ, etc.)*.

B. CORRECTED ERRORS *(code χ Δ)*

A Corrected Error is recorded, when the participant corrects an error that he made while reading a word *(except for Regular Repetitions and Repetitions of Errors)*. The total number of Corrected Errors in a single word is recorded.

e.g. "**ο**μέ – **α**μέσως" *(= immediately)* → the syllable **"α"** of the word "αμέσως" is substituted by the syllable **"ο"** → 1 Substitution of 1 Syllable *(1 Α 1 Σ)* / the substitution error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)* / the syllable **"με"** is repeated → 1 Repetition of 1 Syllable *(1 Ε 1 Σ)*

"oj – "o**b**ject" → the letter **"b"** of the word "object" is omitted → 1 Letter Omission *(1 – Γ)* / the omission error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)* / the letters **"o"** and **"j"** are repeated → 2 Repetitions of 2 Letters *(2 Ε 2 Γ)*

C. NON – CORRECTED ERRORS *(code χ ΜΔ)*

A Non-Corrected Error is an error that is not afterwards corrected by the participant. Non-Corrected Errors are not necessarily recorded along with the other categories of reading errors, as they can be easily calculated as described before.

II. CATEGORIES OF READING ERRORS

All the main categories of reading errors along with their several subcategories are described in detail below:

1. HEM *(code χ Κ)*

A hem is recorded in the following cases:

a) when the participant characteristically says **"εεε…"** *(= hem)* either before or in the middle of a word e.g. “Στο δρόμο για το **(εεε…)** σχολείο” *(= In the way to the* ***heeem…*** *school)* → **1 Hem** is recorded before the word “σχολείο” *(1 K)*

b) when the participant, trying to read a word, ***“drags”*** a letter either in the beginning or in the middle of a word

τώ**ρρρ**ρα *(= now)* → the participant *“drags”* the letter **“ρ”** in the middle of the word “τώρα” → **1 Hem** *(1 K)*

c) when the participant makes a **pause** between two words or sentences

e.g. “Στο δρόμο για το **(pause)** σχολείο” *[= In the way to the* ***(pause)*** *school]* → the participant makes a pause between the words “το” *(= the)* and “σχολείο” *(= school)* → **1 Hem** *(1 K)*

d) when the participant makes a **pause** in the middle of a word

e.g. “γρή **(pause)** γορος” *(= quick)* → the participant makes a pause in the middle of the word “γρήγορος” → **1 Hem** *(1 K)*

e) in combination with a Letter Repetition error as it will be explained below *(see Letter Repetition)*

2. REGULAR REPETITIONS ***(code χ KE)***

These are the total sum of all letter, syllable or word regular repetitions made by the participant. This category may exist independently, without other categories of reading errors, while the error repetitions *(repetitions of errors)* are always followed by other categories of reading errors, as it will be described further down in the present chapter *(see Category 13 of reading errors)*.

2a. Letter Repetition ***(code χ Ε ψ Γ)***

A Letter Repetition is recorded, when a letter of a word is repeated. Each letter may be repeated more than once. Thus, the sum of repetitions made by the participant will be recorded as well as the sum of letters repeated.

e.g. "**γ** – γρήγορος" *(= quick)* → the letter **"γ"** of the word "γρήγορος" is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)*

"**γ** – **γ** – γρήγορος" *(= quick)* → the letter **"γ"** of the word "γρήγορος" is repeated twice → **2 Repetitions of 1 Letter** *(2 Ε 1 Γ)*

"**t** – today" → the letter **"t"** of the word "today" is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)*

<u>Notice</u>*: i) When a double letter consonant is repeated, then a Letter Repetition error is recorded.*

*e.g. "**μπ** - μπάλα" (= ball) → the double letter consonant **"μπ"** of the word "μπάλα" is repeated → **1 Repetition of 1 Letter** (1 Ε 1 Γ)*

ii) When a double letter vowel (following a consonant) is repeated, then a Letter Repetition error is recorded.

*e.g. "κατ**οι** – οικία" (= residence) → the double letter vowel **"οι"** of the word "κατοικία" is repeated → **1 Repetition of 1 Letter** (1 Ε 1 Γ)*

Frequently, a <u>Letter Repetition</u> error is confused with a <u>Hem</u>. Consequently, it is necessary to distinguish between the 2 categories of reading errors:

1) A <u>Hem</u> is recorded when the participant ***"drags"*** a letter either in the beginning or in the middle of a word.

e.g. "**γγγ**γρήγορος" or "γρ**ηηη**ήγορος" *(= quick)* → in the first example the participant ***"drags"*** the letter **"γ"** in the beginning of the word "γρήγορος", while in the second one the letter **"η"** in the middle of the word "γρήγορος" → **1 Hem** is recorded *(1 K)*

2) A Letter Repetition is recorded when the participant **clearly** repeats a letter, a vowel or a consonant, either in the beginning or in the middle of a word *(the participant stops a little before repeating the letter)*.

e.g. "**γ** – γρήγορος" *(= quick)* → the participant repeats the letter **"γ"** in the beginning of the word "γρήγορος" *(he stops a little before repeating the letter)* → **1 Repetition of 1 Letter** *(1 E 1 Γ)*

3) A Letter Repetition in combination with a Hem is recorded:

a) when the participant **repeats** a letter or letters of a word and at the same time makes a **pause** between the letter repetitions.

e.g. "**γ (pause) γ (pause)** γρήγορος" *(= quick)* → the letter **"γ"** of the word "γρήγορος" is repeated twice → **2 Repetitions of 1 Letter** *(2 E 1 Γ)* / the participant makes 2 pauses between the repetitions of the letter **"γ"** → **2 Hems** *(2 K)*

b) when the participant reads:

e.g. "**θρррρ** - θρανίο" *(= desk)* → the letters **"θ"** and **"ρ"** of the word "θρανίο" are repeated → **2 Repetitions of 2 Letters** *(2 E 2 Γ)* / the participant ***"drags"*** the letter **"ρ"** in the middle of the word "θρανίο" → **1 Hem** *(1 K)*

2b. Repetition of adjacent Syllables *(code χ E ψ Σ)*

A Repetition of adjacent Syllables error is recorded, when consecutive syllables of a word are repeated. The sum of repetitions as well as the number of adjacent syllables repeated is accordingly recorded.

e.g. "**τώ**– τώρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is repeated → **1 Repetition of 1 Syllable** *(1 Ε 1 Σ)*

"**αμέ** – αμέσως"*(= immediately)* → the syllables **"α"** and **"μέ"** of the word "αμέσως" are repeated → **1 Repetition of 2 Adjacent Syllables** *(1 Ε 2 Σ)*

"**α** – **αμέ** – αμέσως" *(= immediately)* → the syllable **"α"** of the word "αμέσως" is repeated → **1 Repetition of 1 Syllable** *(1 Ε 1 Σ)* / the consecutive syllables **"α"** and **"μέ"** of the word "αμέσως" are repeated → **1 Repetition of 2 Adjacent Syllables** *(1 Ε 2 Σ)*

"**αποφα** - αποφασίζω" *(= I decide)* → the consecutive syllables **"α"**, **"πο"** and **"φα"** of the word "αποφασίζω" are repeated → **1 Repetition of 3 Adjacent Syllables** *(1 Ε 3 Σ),* etc.

<u>Notice:</u> *When one letter of a vowel combination ("**αυ**" or "**ευ**") is repeated, a Syllable Repetition error is recorded.*

*e.g. "**ε** – **εύ**κολος" (= easy) → the letter **"ε"** of the vowel combination **"ευ"** is repeated →* ***1 Repetition of 1 Syllable*** *(1 Ε 1 Σ)*

2c. Word Repetition *(code χ Ε ψ Λ)*

A Word Repetition error is recorded, when a word of a sentence is repeated. Each word may be repeated more than once. Thus, the total sum of word repetitions is recorded as well as the number of words repeated.

e.g. "**τώρα** – τώρα" *(= now)* → the word **"τώρα"** is repeated → **1 Repetition of 1 Word** *(1 Ε 1 Λ)*

"**today** – today" → the word **"today"** is repeated → **1 Repetition of 1 Word** *(1 Ε 1 Λ)*

3. SYLLABICATION *(code χΣ)*

A Syllabication error is recorded, when the participant reads either slowly or regularly, emphasising each syllable separately *(syllable-by-syllable reading)*. For each pair of syllables separated by the participant the examiner notes down 1 Syllabication error.

e.g. "τώρα" *(= now)* → **1 Syllabication** *(1 Σ)*

"αποφασίζω" *(= I decide)* → **2 Syllabications** *(2 Σ)*

It is generally accepted that the evaluation of the Syllabication is quite subjective. Thus, when marking the specific errors, the examiner must take into account the pupil's grade. The lower the grade, the more lenient the marking must be regarding Syllabication errors. Respectively, the higher the grade, the stricter the marking must be. Consequently, as the current research concern pupils of the 12th grade and adult population, the marking was rigorous concerning their Syllabication errors.

Moreover, **Syllabication** is a quite imperceptible error and is often confused with **slow reading**. It is necessary though to clarify the differences between syllabication and slow reading.

Specifically, a Syllabication error is recorded when the participant clearly *"cuts"* the syllables in a word *(syllable segmentation)* and reads without colouring the voice. On the contrary, when the participant while reading *"breaks"* somehow the syllables, but has a stable and continuous tone in the voice, then it is not considered as syllabication but as slow reading *(and it is not considered an error at all)*.

4. SUBSTITUTIONS *(code χ ΑΚ)*

These are the total sum of all letter, syllable and word substitutions made by the participant.

4a. Letter Substitution *(code χ Α ψ Γ)*

A Letter Substitution is recorded, when a letter of a word is substituted by another letter or letters. Each letter of a word may be substituted more than once. Thus, the sum of letter substitutions is recorded as well as the number of letters substituted.

e.g. "τ**έ**ρα" instead of "τ**ώ**ρα" *(= now)* → the letter **"ώ"** of the word "τώρα" is substituted by the letter **"έ"** → **1 Substitution of 1 Letter** *(1 Α 1 Γ)* / the word **"τέρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)* "**π**έζω" instead of "**παί**ζω" *(= I play)* → the double letter vowel **"αι"** of the word "παίζω" is substituted by the letter **"ε"** *(any double letter is considered as one letter)* → **1 Substitution of 1 Letter** *(1 Α 1 Γ)* / the word **"πέζω"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"t**a**day" instead of "t**o**day" → the letter **"o"** of the word "today" is substituted by the letter **"a"** → **1 Substitution of 1 Letter** *(1 Α 1 Γ)* / the word **"taday"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

4b. Syllable Substitution *(code χ Α ψ Σ)*

A Syllable Substitution error is recorded, when a syllable of a word is substituted by another syllable or syllables. A single syllable of a word may be substituted more than once. Thus, the sum of syllable substitutions as well as the number of syllables substituted is recorded.

e.g. "**κέ**ρα" instead of "**τώ**ρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is substituted by the syllable **"κέ"** → **1 Substitution of 1 Syllable** *(1 Α 1 Σ)* / the word **"κέρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"**κί** – **τώ**ρα" instead of "τώρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is substituted by the syllable **"κί"** → **1 Substitution of 1 Syllable** *(1 Α 1 Σ)* / the Syllable Substitution error is afterwards corrected by the participant → 1 Corrected Error *(1 Δ)*

Notice: *When a single vowel constitutes a syllable on its own, then its substitution is perceived as a syllable substitution and not as a letter substitution error.*

*e.g. "**ο-**μέσως" instead of "**α-**μέσως" (= immediately) → the syllable **"α"** of the word "αμέσως" is substituted by the syllable **"ο"** → **1 Substitution of 1 Syllable** (1 Α 1 Σ) / the word **"ομέσως"** is meaningless → 1 Pseudo-Word (1ΨΛ)*

4c. Word Substitution *(code χ Α ψ Λ)*

A Word Substitution error is recorded, when a word of a sentence is substituted by another word. Each word of a sentence may be substituted more than once. Thus, the sum of word substitutions as well as the number of the words substituted is accordingly recorded.

e.g. **“μέρα”** *(= day)* instead of **“τώρα”** *(= now)* → the word **“τώρα”** is substituted by the word **“μέρα”** → **1 Substitution of 1 Word** *(1 Α 1 Λ)*

“play” instead of **“day”** → the word **“day”** is substituted by the word **“play”** → **1 Substitution of 1 Word** *(1 Α 1 Λ)*

Notice: *As reasonable, a Word Substitution error is recorded, when the participant reads a completely different word – e.g.* ***“όλα”*** *(= all) instead of* ***“αλλά”*** *(= but) /* ***“που”*** *(= that) instead of* ***“του”*** *(= his). Furthermore, the same error is recorded, when the participant reads a similar, relative or derivative word but with a different meaning – e.g.* ***“ψαράς”*** *(= fisherman) instead of* ***“ψάρια”*** *(= fish) /* ***“μαθαίνω”*** *(= I learn) instead of* ***“μαθητής”*** *(= learner).*

However, when the participant makes an error in the ending of a word changing it with another existing ending *(namely changing the person, the tense or the voice for verbs and the gender, the number or the case for nouns, adjectives etc.)* and reads a regular word, then an Ending error is recorded and not a Word Substitution error *(see Ending errors below)*.

e.g. “πήγ-**α**” *(= I went)* instead of “πήγ-**ε**” *(= he went)* → the ending **“ε”** *(3rd singular person)* is substituted by the ending **“α”** *(1st singular person)* → **1 Ending error** is recorded.

5. REVERSALS *(code χ ΑΣ)*

These are the total sum of letters, syllables and words reversals made by the participant. A two letters or syllables reversal usually takes place once in a word as well as a two words reversal in a sentence.

5a. Letters Reversal *(code 1 ΓΑ)*

A Letter Reversal error is recorded, when two consecutive letters of a word are reversed by the participant in their order of reading. A Letters Reversal usually takes place once in a word.

e.g. "αγ**ρ**εί" instead of "α**ρ**γεί" *(= he is late)* → the letters **"ρ"** and **"γ"** of the word "αργεί" are reversed in their order of reading → **1 Letters Reversal** *(1 ΓΑ)* / the word **"αγρεί"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"av**io**d" instead of "av**oi**d" → the letters **"o"** and **"i"** of the word "avoid" are reversed in their order of reading → **1 Letters Reversal** *(1 ΓΑ)* / the word **"aviod"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

5b. Syllables Reversal *(code 1 ΣΑ)*

A Syllables Reversal error is recorded, when two adjacent syllables of a word are reversed by the participant in their order of reading. This error usually takes place once in a single word.

e.g. **"μάδε"** instead of **"δέμα"** *(= package)* → the syllables **"δε"** and **"μα"** of the word "δέμα" are reversed in their order of reading → **1 Syllables Reversal** *(1 ΣΑ)* / the word **"μάδε"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

5c. Words Reversal *(code 1 ΛΑ)*

A Words Reversal error is recorded, when two consecutive words of a sentence are reversed by the participant in order of reading. This error usually takes place once in a sentence.

e.g. "**πάμε τώρα**" instead of "**τώρα πάμε**" *(= let's go now)* → the words **"τώρα"** and **"πάμε"** are reversed in their order of reading → **1 Words Reversal** *(1 ΛΑ)*

"**blue colour**" instead of "**colour blue**" → the words **"colour"** and **"blue"** are reversed in their order of reading → **1 Words Reversal** *(1 ΛΑ)*

6. OMISSIONS *(code χ –)*

These are the total sum of letter, syllable and word omissions made by the participant.

6a. Letter Omission ***(code χ – Γ)***

A Letter Omission error is recorded, when one letter or more of a word are omitted *(including a single letter of a diphthong or a letter of either a double consonant or vowel or a letter of the vowel combinations "αυ" and "ευ")*. The total sum of letter omissions in a word is recorded.

e.g. "τ_ρα" instead of "τ**ώ**ρα" *(= now)* → the letter **"ω"** of the word "τώρα" is omitted → **1 Letter Omission** *(1 – Γ)* / the word **"τ_ρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"eveni_g" instead of "eveni**n**g" → the letter **"n"** of the word "evening" is omitted → **1 Letter Omission** *(1 – Γ)* / the word **"eveni_g"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

Notice*: When the participant omits a single letter of a double letter vowel (αι, ει etc.) or a double letter consonant (μπ, ντ, γκ etc.), a letter of a diphthong (αϊ, αη, οϊetc.) or a letter of a vowel combination (αυ, ευ), then a Letter Omission error is recorded as well.*

e.g. "ε_κόνα" instead of "ε**ι**κόνα" *(= image)* → the letter **"ι"** of the double letter vowel **"ει"** is omitted → **1 Letter Omission** *(1 – Γ)* / the word **"ε_κόνα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"_πάλα" instead of "**μ**πάλα" *(= ball)* → the letter **"μ"** of the double letter consonant **"μπ"** is omitted → **1 Letter Omission** *(1 – Γ)* / the word **"_πάλα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

Attention: When the participant does not finish a word and the last letter he reads is not an irrelevant one but the following letter he should read, then a Letter Omission error is recorded and not a Letter Substitution error.

e.g. "αμέ**ω**-αμέσως" instead of "**αμέσως**" *(= immediately)* → the letter **"σ"** of the word "αμέσως" is omitted *(it is not perceived as a substitution of the letter* ***"σ"*** *by the letter* ***"ω"****, because the letter* ***"ω"*** *is the following letter that the participant should read)* → **1 Letter Omission** (1 – Γ) / the syllables **"α"** and **"μέ"** of the word "αμέσως" are repeated → 1

Repetition of 2 Syllables (1 Ε 2 Σ) / the Letter Omission error is afterwards corrected by the participant → 1 Corrected Error (1 Δ)

6b. Syllable Omission ***(code χ – Σ)***

A Syllable Omission error is recorded, when a syllable or syllables of a word are omitted. The total sum of syllable omissions in a word is recorded.

e.g. "**__**ρα" instead of "**τώ**ρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is omitted → **1 Syllable Omission** *(1 – Σ)* / the word **"__ρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

6c. Word Omission ***(code χ – Λ)***

A Word Omission error is recorded, when a word or words of a sentence *(or a word list)* are omitted. The sum of words omitted is recorded. Thus, if one word of a sentence is omitted → **1 Word Omission** is recorded *(1 – Λ)*, if two words of a sentence are omitted → **2 Word Omissions** are recorded *(2 – Λ)*, etc.

7. ADDITIONS ***(code χ +)***

These are the total sum of different letters, syllables and words added by the participant.

7a. LetterAddition ***(code χ + Γ)***

A Letter Addition error is recorded, when a different letter or letters are added in a word. The sum of letter additions in a word is recorded.

e.g. "τώ**τ**ρα" instead of "τώρα" *(= now)* → the letter **"τ"** is added in the middle of the word "τώρα" → **1 Letter Addition** *(1 + Γ)* / the word **"τώτρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"tod**r**ay" instead of "today" → the letter **"r"** is added in the middle of the word "today" → **1 Letter Addition** *(1 + Γ)* / the word **"todray"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

7b. Syllable Addition *(code χ + Σ)*

A Syllable Addition error is recorded, when a different syllable or syllables are added in a word. The total sum of syllables added in a word is recorded.

e.g. "τώ**πα**ρα" instead of "τώρα" *(= now)* → the syllable **"πα"** is added in the middle of the word "τώρα" → **1 Syllable Addition** *(1 + Σ)* / the word **"τώπαρα"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

7c. Word Addition *(code χ + Λ)*

A Word Addition error is recorded, when a different word or words are added in a sentence. The total sum of word additions in a sentence is recorded. Thus, for one word added in a sentence → **1 Word Addition** is recorded *(1 + Λ)*, for two words added in a sentence → **2 Word Additions** are recorded *(2 + Λ)*, etc.

8. MISINTONATION *(code 1 Π)*

A Misintonation error is recorded, when the participant "misintonates" a word. Only one misintonation error may be recorded for a single word.

e.g. "αμεσ**ώ**ς" instead of "αμ**έ**σως" *(= immediately)* → the intonation mark is incorrectly located, while reading, in the third instead of the second syllable of the word **"αμέσως"** → **1 Misintonation** *(1 Π)*

<u>**Attention**</u>: a) The Misintonation error is not recorded <u>before the participant having read the whole word</u>. When, for example, the participant reads "υποσχ**ό** – υπ**ό**σχομαι" *(= I promise)*, we do not record a Misintonation error *(because he "misintonates" before reading the whole word),* but only the Syllable Repetition errors *(the syllables **"υ"**, **"πό"** and **"σχο"** are repeated → 1 Repetition of 3 Syllables → 1 Ε 3 Σ).*

b) The participant often reads as stressing a single word <u>twice</u>. In that case, only <u>one Misintonation</u> error is recorded.

9. ENDINGS *(code χ KA)*

As aforementioned, when the participant substitutes the ending of a word with another existing ending and reads another regular word *(similar)*, changing the person, the tense or the voice *(for verbs),* and changing the gender, the number or the case *(for nouns, adjectives, etc.)*, then an Ending error is recorded.

It is possible to have many errors of endings substituted by other existing *(valid)* endings in a single word. Thus, the total sum of ending substitutions made by the participant is recorded.

e.g. "πήγ-**ε**" *(= **he** went)* instead of "πήγ-**α**" *(= **I** went)* → the ending **"-α"** *(1st singular person)* is substituted by the ending **"-ε"** *(3rd singular person)* → **1 Ending** Substitution *(1 KA)*

"κάποι-**ος**" *(= someone)* instead of "κάποι-**ο**" *(= something)* → the ending **"-ο"** *(neutral gender)* is replaced by the ending **"-ος"** *(masculine gender)* → **1 Ending** Substitution *(1 KA)*

Notice: *The error made by the participant in the ending of a word (substitution, omission or addition), having as a result to read a Pseudo-Word (instead of the regular word), it is not recorded as an Ending error but as the specific error made (substitution, addition or omission).*

e.g. "αμέσω**_**" instead of "αμέσως" *(= immediately)* → the letter **"ς"** of the word "αμέσως" is omitted → **1 Letter Omission** *(1 – Γ)* / the word **"αμέσω"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

"άργησας" instead of "άργησα" *(= I am late)* → the letter **"ς"** is added in the end of the word "άργησα" → **1 Letter Addition** *(1 + Γ)* / the word **"άργησας"** is meaningless → 1 Pseudo-Word *(1 ΨΛ)*

10. PUNCTUATION *(code 1 ΣΤ)*

Punctuation errors are the total sum of substitutions, omissions and additions of punctuation marks made by the participant. For each sentence, only one punctuation error may be recorded.

10a. Punctuation Substitution *(code 1 ΑΣτ)*

A Punctuation Substitution error is recorded, when the participant replaces any punctuation mark with another.

e.g. when the participant, while reading, substitutes a **full stop** with a **question mark** or vice versa → **1 Punctuation Substitution** is recorded *(1 ΑΣτ)*

10b. Punctuation Omission *(code 1 – Στ)*

A Punctuation Omission error is recorded, when the participant omits any punctuation mark. If, for example, the participant does not stop in front of a **comma**, then a **Punctuation Omission** error is recorded. The same error is recorded, if the participant does not stop in front of a **full stop**, etc.

10c. Punctuation Addition *(code 1 + Στ)*

A Punctuation Addition error is recorded, when the participant adds, while reading, a punctuation mark that doesn't exist in the sentence.

e.g. when the participant adds a **comma**, while reading, that does not exist → **1 Punctuation Addition** is recorded *(1 + Στ)*

11. POINT MARKS *(code 1 ΟΣ)*

A Point Mark error is recorded, when the participant, while reading, does not take into account point marks *(apostrophe, dieresis, disjunction etc.)*. For each word only one point mark error may be recorded.

e.g. "**το** απόγευμα" instead of "**τ'** απόγευμα" *(= the afternoon)* → the participant, while reading, does not take into account the apostrophe → **1 Point Mark** *(1 ΟΣ)*

"it **is**" instead of "it**'** **s**" → the participant does not take into account the apostrophe → **1 Point Mark** *(1 ΟΣ)*

"**αι**τός" instead of "**αϊ**τός" *(= eagle)* → the participant, while reading, does not take into account the dieresis ***(αϊ)*** → **1 Point Mark** *(1 ΟΣ)*

12. LINE MISSING *(code ΧΣ)*

A Line Missing error is recorded, when the participant misses a whole line and reads the previous or the next one.

Notice: *All the errors made by the participant while reading the wrong line are not recorded.*

13. REPETITIONS OF ERRORS *(code χ Λ Ε)*

This category of reading errors follows 8 of the aforementioned categories. Repetitions of Errors are the total sum of the repetitions of substitutions, reversals, additions, omissions, misintonation, endings, punctuation and point marks errors *(including their subcategories)*.

Notice: An error may be repeated more than once. Thus, the total sum of repetitions made for each reading error is separately recorded.

13a. REPETITIONS OF SUBSTITUTIONS *(code χ Ε ΑΚ)*

These are the total sum of the repetitions of letter, syllable and word substitutions made by the participant.

- **Letter Substitution Repetition *(code χΕΑΓ)***

A Letter Substitution Repetition error is recorded, when the substitution of a letter by another one is repeated.

e.g. "τ**έ** – τ**έ**ρα" instead of "τ**ώ**ρα" *(= now)* → the letter **"ω"** of the word "τώρα" is substituted by the letter **"ε"** → **1 Substitution of 1 Letter** *(1 Α 1 Γ)* / the Letter Substitution error is repeated by the participant → **1 Letter Substitution Repetition** *(1 Ε ΑΓ)* / the letter **"τ"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the word **"τέρα"** is meaningless → 1 **Pseudo-Word** *(1 ΨΛ)*

"t**a** – t**a**day" instead of "t**o**day" → the letter **"o"** of the word "today" is substituted by the letter **"a"** → **1 Substitution of 1 Letter** *(1 Α 1 Γ)* / the Letter Substitution error is repeated → **1 Letter Substitution Repetition** *(1 Ε ΑΓ)* / the letter **"t"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the word **"taday"** is meaningless → **1 Pseudo-Word** *(1 ΨΛ)*

- **Syllable Substitution Repetition *(code χ Ε ΑΣ)***

A Syllable Substitution Repetition error is recorded, when the substitution of a syllable by another one is repeated.

e.g. "**κέ – κέ – τώ**ρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is substituted by the syllable **"κέ"** → **1 Substitution of 1 Syllable** *(1 Α 1 Σ)* / the Syllable Substitution error is repeated by the participant → **1 Syllable Substitution Repetition** *(1 Ε ΑΣ)* / the Syllable Substitution error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)*

- **Word Substitution Repetition *(code χ Ε ΑΛ)***

A Word Substitution Repetition error is recorded, when the substitution of a word by another one is repeated.

e.g. "**χώρα – χώρα**" *(= country)* instead of "**τώρα**" *(= now)* → the word **"τώρα"** *(= now)* is substituted by the word **"χώρα"** *(= country)* → **1 Substitution of 1 Word** *(1 Α 1 Λ)* / the Word Substitution error is repeated → **1 Word Substitution Repetition** *(1 Ε ΑΛ)*

"**play – play**" instead of "**day**" → the word **"day"** is substituted by the word **"play"** → **1 Substitution of 1 Word** *(1 Α 1 Λ)* / the Word Substitution error is repeated → **1 Word Substitution Repetition** *(1 Ε ΑΛ)*

13b. REPETITIONS OF REVERSALS ***(code χ Ε ΑΣ)***

These are the total sum of the repetitions of letters, syllables and words reversals made by the participant.

- **Letters Reversal Repetition** ***(code χΕΓΑ)***

A Letters Reversal Repetition error is recorded, when the reversal of two adjacent letters of a word is repeated.

e.g. "α**γρ**εί – α**γρ**εί" instead of "α**ργ**εί" *(= he is late)* → the letters **"ρ"** and **"γ"** of the word "αργεί" are reversed in their order of reading → **1 Letters Reversal** *(1 ΓΑ)* / the Letters Reversal error is repeated by the participant → **1 Letters Reversal Repetition** *(1 ΕΓΑ)* / the syllable **"α"** is repeated → **1 Repetition of 1 Syllable** *(1 Ε 1 Σ)* / the letter **"ει"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the word **"αγρεί"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)*

"av**io**d – av**io**d" instead of "av**oi**d" → the letters **"o"** and **"i"** of the word "avoid" are reversed in their order of reading → **1 Letters Reversal** *(1 ΓΑ)* / the Letters Reversal error is repeated by the participant → **1 Letters Reversal Repetition** *(1 Ε ΓΑ)* / the letter **"a"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the letter **"v"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the letter **"d"** is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)* / the word **"aviod"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)*

- **Syllables Reversal Repetition** ***(code χ Ε ΣΑ)***

A Syllables Reversal Repetition error is recorded, when the reversal of two adjacent syllables of a word is repeated.

e.g. "**μάδε**–**μάδε**" instead of "**δέμα**" *(= package)* → the syllables **"δέ"** and **"μα"** of the word "δέμα" are reversed in their order of reading → **1 Syllables Reversal** *(1 ΣΑ)* / the Syllables Reversal error is repeated → **1 Syllables Reversal Repetition** *(1 Ε ΣΑ)* / the word **"μάδε"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)*

- **Words Reversal Repetition** ***(code χ Ε ΛΑ)***

A Words Reversal Repetition error is recorded, when the reversal of two consecutive words of a sentence is repeated.

e.g. "**πάμε τώρα – πάμε τώρα**" instead of "**τώρα πάμε**" *(= let's go now)* → the words **"τώρα"** and **"πάμε"** of the sentence "τώρα πάμε" are reversed in their order of reading → **1 Words Reversal** *(1 ΛΑ)* / the Words Reversal error is repeated by the participant → **1 Words Reversal Repetition** *(1 Ε ΛΑ)*

13c. REPETITIONS OF OMISSIONS ***(code χ Ε –)***

These are the total sum of the repetitions of letter, syllable and word omissions made by the participant.

- **Letter Omission Repetition** ***(code χ Ε – Γ)***

A Letter Omission Repetition error is recorded, when the omission of a single letter, a letter of a double vowel or a double consonant, a letter of a diphthong or a letter of the vowel combinations *"αυ"* and *"ευ"* is repeated.

e.g."**τ_ρα – τ_ρα** –τ**ώ**ρα" *(= now)* → the letter **"ώ"** of the word "τώρα" is omitted → **1 Letter Omission** *(1 – Γ)* / the Letter Omission error is repeated → **1 Letter Omission Repetition** *(1 Ε – Γ)* / the letter **"τ"** of the word "τώρα" is repeated twice → **2 Repetitions of 1 Letter** *(2 Ε 1 Γ)* / the syllable **"ρα"** of the word "τώρα" is repeated twice → **2 Repetitions of 1 Syllable** *(2 Ε 1 Σ)* / the word **"τρα"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)* / the Letter Omission error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)*

"**eveni_g – eveni_g**" instead of "eveni**n**g" → the letter **"n"** of the word "evening" is omitted → **1 Letter Omission** *(1 – Γ)* / the Letter Omission error is repeated → **1 Letter Omission Repetition** *(1 Ε – Γ)* / the letters **"e"**, **"v"**, **"e"**, **"n"**, **"i"** and **"g"** of the word **"evening"** are repeated → **6 Repetitions of 6 Letters** *(6 Ε 6 Γ)* / the word **"evenig"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)*

- **Syllable Omission Repetition** ***(code χ E – Σ)***

A Syllable Omission Repetition error is recorded, when the omission of a syllable of a word is repeated.

e.g. "**__ρα – __ρα**" instead of "**τώ**ρα" *(= now)* → the syllable **"τώ"** of the word "τώρα" is omitted → **1 Syllable Omission** *(1 – Σ)* / the Syllable Omission error is repeated → **1 Syllable Omission Repetition** *(1 E – Σ)* / the syllable **"ρα"** of the word "τώρα" is repeated → **1 Repetition of 1 Syllable** *(1 E 1 Σ)* / the word **"ρα"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)*

- **Word Omission Repetition** ***(code χ E – Λ)***

A Word Omission Repetition error is recorded, when the omission of a word of a sentence is repeated.

e.g. If one Word Omission error is repeated → **1 Word Omission Repetition** is recorded *(1 E – Λ),* if one Word Omission error is repeated twice → **2 Word Omission Repetitions** are recorded *(2 E – Λ)*, etc.

13d. REPETITIONS OF ADDITIONS ***(code χ E +)***

These are the total sum of the repetitions of letter, syllable and word additions made by the participant.

- **Letter Addition Repetition** ***(code χ E + Γ)***

A Letter Addition Repetition error is recorded, when the addition of a different letter in a word is repeated.

e.g. "τώ**τ**ρα – τώ**τ**ρα – τώρα" *(= now)* → the letter **"τ"** is added in the middle of the word "τώρα" → **1 Letter Addition** *(1 + Γ)* / the Letter Addition error is repeated → **1 Letter Addition Repetition** *(1 E + Γ)* / the syllable **"τώ"** of the word "τώρα" is repeated twice → **2 Repetitions of 1 Syllable** *(2 E 1 Σ)* / the syllable **"ρα"** of the word "τώρα" is repeated twice

→ **2 Repetitions of 1 Syllable** *(2 Ε 1 Σ)* / the word **"τώτρα"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)* / the Letter Addition error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)*

"bar**g** – bar**g** – bar**g**" instead of "bag" → the letter **"r"** is added in the word "bag" → **1 Letter Addition** *(1 + Γ)* / the Letter Addition error is repeated twice → **2 Letter Addition Repetitions** *(2 Ε + Γ)* / the letter **"b"** of the word "bag" is repeated twice → **2 Repetitions of 1 Letter** *(2 Ε 1 Γ)* / the letter **"a"** is repeated twice → **2 Repetitions of 1 Letter** *(2 Ε 1 Γ)* / the letter **"g"** of the word "bag" is repeated twice → **2 Repetitions of 1 Letter** *(2 Ε 1 Γ)* / the word **"barg"** is meaningless → **3 Pseudo-Words** *(3 ΨΛ)*

- **Syllable Addition Repetition *(code χ Ε + Σ)***

A Syllable Addition Repetition error is recorded, when the addition of a different syllable in a word is repeated.

e.g. "τώ**πα**ρα – τώ**πα**ρα – τώρα" *(= now)* → the syllable **"πα"** is added in the middle of the word "τώρα" → **1 Syllable Addition** *(1 + Γ)* / the Syllable Addition error is repeated → **1 Syllable Addition Repetition** *(1 Ε + Γ)* / the syllable **"τώ"** of the word "τώρα" is repeated twice → **2 Repetitions of 1 Syllable** *(2 Ε 1 Σ)* / the syllable **"ρα"** of the word "τώρα" is repeated twice → **2 Repetitions of 1 Syllable** *(2 Ε 1 Σ)* / the word **"τώπαρα"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)* / the Syllable Addition error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)*

- **Word Addition Repetition *(code χ + Λ)***

A Word Addition Repetition error is recorded, when the addition of a different word in a sentence is repeated.

e.g. If 1 Word Addition error is repeated → **1 Word Addition Repetition** is recorded *(1 Ε + Λ),* if 1 Word Addition error is repeated twice → **2 Word Addition Repetitions** are recorded *(2 Ε + Λ)*, etc.

13e. REPETITIONS OF MISINTONATION ***(code χ Ε Π)***

A Misintonation Repetition error is recorded, when the participant repeats the misintonation of a word.

e.g. "αμεσ**ώ**ς – αμεσ**ώ**ς – αμ**έ**σως" *(= immediately)* → the intonation mark is incorrectly located in the third instead of the second syllable of the word "αμέσως" → **1 Misintonation** *(1 Π)* / the Misintonation error is repeated → **1 Misintonation Repetition** *(1 ΕΠ)* / the word **"αμεσώς"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)* / the Misintonation error is afterwards corrected by the participant → **1 Corrected Error** *(1 Δ)*

13f. REPETITIONS OF ENDINGS ***(code χ Ε ΚΑ)***

An Ending Repetition error is recorded, when the substitution of an ending of a word with another existing ending is repeated.

e.g. "πήγ-**ε** – πήγ-**ε**" *(= he went)* instead of "πήγ-**αν**" *(= they went)* → the ending **"-αν"** *(3rd plural person)* is substituted by the ending **"-ε"** *(3rd singular person)* → **1 Ending Substitution** *(1 ΚΑ)* / the Ending Substitution error is repeated by the participant → **1 Ending Repetition** *(1 ΕΚΑ)* / the syllable **"πή"** of the word "πήγαν" is repeated → **1 Repetition of 1 Syllable** *(1 Ε 1 Σ)* / the letter **"γ"** of the word "πήγαν" is repeated → **1 Repetition of 1 Letter** *(1 Ε 1 Γ)*

"play-**ed** – play-**ed**" instead of "play-**s**" → the ending **"-s"** *(present tense)* is substituted by the ending **"-ed"** *(past tense)* → **1 Ending Substitution** *(1 ΚΑ)* / the Ending Substitution error is repeated by the participant → **1 Ending Repetition** *(1 ΕΚΑ)* / the letters **"p"**, **"l"**, **"a"** and **"y"** are repeated → **4 Repetitions of 4 Letters** *(4 Ε 4 Γ)*

13g. REPETITIONS OF PUNCTUATION ***(code χ Ε Στ)***

These are the total sum of the repetitions of punctuation substitutions, omissions or additions made by the participant.

- **Punctuation Substitution Repetition** ***(code χ Ε Α Στ)***

A Punctuation Substitution Repetition error is recorded, when the substitution of a punctuation mark with another one is repeated.

e.g. if the substitution of a question mark (?) with a full stop (.) is repeated while reading → **1 Punctuation Substitution Repetition** is recorded *(1 ΕΑΣτ)*

- **Punctuation Omission Repetition** ***(code χ Ε – Στ)***

A Punctuation Omission Repetition error is recorded, when the omission of a punctuation mark is repeated.

e.g. if the omission of a question mark (?) is repeated while reading → **1 Punctuation Omission Repetition** is recorded *(1 Ε – Στ)*

- **Punctuation Addition Repetition** ***(code χ Ε + Στ)***

A Punctuation Addition Repetition error is recorded, when the addition of a punctuation mark is repeated.

e.g. if the addition of a question mark (?) is repeated while reading → **1 Punctuation Addition Repetition** is recorded *(1 Ε + Στ)*

13h. REPETITIONS OF POINT MARKS ***(code χ Ε ΟΣ)***

A Point Mark Repetition error is recorded, when a point mark error *(the participant does not take into account point marks, e.g. apostrophe, dieresis, etc.)* is repeated.

e.g. "**αιτός** – **αι**τός" instead of "**αϊ**τός" *(= eagle)* → the participant does not take into account the dieresis ***(αϊ)*** → **1 Point Mark** *(1 ΟΣ)* / the Point Mark error is repeated → **1 Point Mark Repetition** *(1 Ε ΟΣ)* / the letters **"α"** and **"ι"** of the word "αϊτός" are repeated → **2 Repetitions of 2 Letters** *(2 Ε 2 Γ)* / the syllable **"τός"** of the word "αϊτός" is repeated → **1 Repetition of 1 Syllable** *(1 Ε 1 Σ)* / the word **"αιτός"** is meaningless → **2 Pseudo-Words** *(2 ΨΛ)* "it **is – it is**" instead of "it**'s**" → the participant does not take into account the apostrophe → **1 Point Mark** *(1 ΟΣ)* / the Point Mark error is repeated → **1 Point Mark Repetition** *(1 Ε ΟΣ)* / the word **"it"** is repeated → **1 Repetition of 1 Word** *(1 Ε 1 Λ)* / the letter **"s"** is repeated → **1 Repetition of 1 Letter***(1 Ε 1 Γ)*

FILLING IN THE TABLE WITH THE READING ERRORS CATEGORIES

After having recorded in detail all the reading errors on the testing sheet and all of them having been transcribed on the scoring sheet, the total sum of incorrect words *(words where at least one reading error has been made by the participant)* is counted and filled in the corresponding cell of the scoring sheet. Then, the percentage of wrong words is calculated and recorded. The sum of correct words is also counted by subtracting the sum of incorrect words from all the words read and their percentage is calculated. The total sum of errors for each subcategory of reading errors is afterwards estimated – *e.g. 5 Repetitions of 3 Letters (5 Ε 3 Γ)* – and recorded in the corresponding cell of the scoring sheet. In order to calculate the total sum of reading errors, the errors of all categories are added *(except for Corrected Errors and Pseudo-Words)*. Then, the percentage of the total errors is calculated *(% of errors = # of errors x 100 / # of words of the text or the list)*. Finally, the sum of Non-Corrected errors is estimated by subtracting the sum of Corrected Errors from the total number of errors, but without regular repetitions and repetitions of errors being included *(reading errors categories 2 & 13)*. Thus, the percentage of Non-Corrected errors is also calculated.

APPENDIX 11

SCORING SHEET FOR READING ERRORS (TEACHERS OF ANCIENT GREEK & PUPILS OF THE 12th GRADE)

PARTICIPANT CODE:	
AGE:	
SEX:	
GROUP:	

READING ERRORS CATEGORIES	CODES	PASSAGE 1 *(ANCIENT GREEK)*		PASSAGE 1 *(MODERN GREEK)*	
1. HEM	χ Κ				
2. REGULAR REPETITIONS	χ Κ Ε		TOTAL		TOTAL
2a. Letter Repetition	χ Ε ψ Γ				
2b. Repetition of Adjacent Syllables	χ Ε ψ Σ				
2c. Word Repetition	χ Ε ψ Λ				
3. SYLLABICATION	χ Σ				
4. SUBSTITUTIONS	χ ΑΚ		TOTAL		TOTAL
4a. Letter Substitution	χ Α ψ Γ				
4b. Syllable Substitution	χ Α ψ Σ				
4c. Word Substitution	χ Α ψ Λ				
5. REVERSALS	χ ΑΣ		TOTAL		TOTAL
5a. Letters Reversal	(1) Γ Α				
5b. Syllables Reversal	(1) Σ Α				
5c. Words Reversal	(1) Λ Α				
6. OMISSIONS	χ -		TOTAL		TOTAL
6a. Letter Omission	χ - Γ				
6b. Syllable Omission	χ - Σ				
6c. Word Omission	χ - Λ				
7. ADDITIONS	χ +		TOTAL		TOTAL
7a. Letter Addition	χ + Γ				
7b. Syllable Addition	χ + Σ				
7c. Word Addition	χ + Λ				
8. MISINTONATION	(1) Π				
9. ENDINGS	χ ΚΑ				
10. PUNCTUATION	χ Στ		TOTAL		TOTAL
10a. Punctuation Substitution	(1) Α Στ				
10b. Punctuation Omission	(1) - Στ				
10c. Punctuation Addition	(1) + Στ				
11. POINT MARKS	(1) ΟΣ				
12. LINE MISSING	(1) ΧΣ				
13. REPETITIONS OF ERRORS	χ Λ Ε		TOTAL		TOTAL
13a. Letter Substitution Repetition	χ Ε Α Γ				
13b. Syllable Substitution Repetition	χ Ε Α Σ				
13c. Word Substitution Reprtition	χ Ε Α Λ				
13d. Letter Reversal Repetition	χ Ε Γ Α				
13e. Sylable Reversal Repetition	χ Ε Σ Α				
13f. Word Reversal Repetition	χ Ε Λ Α				
13g. Letter Omission Repetition	χ Ε - Γ				
13h. Syllable Omission Repetition	χ Ε - Σ				
13i. Word Omission Repetition	χ Ε - Λ				
13j. Letter Addition Repetition	χ Ε + Γ				
13k. Syllable Addition Repetition	χ Ε + Σ				
13l. Word Addition Repetition	χ Ε + Λ				
13m. Misintonation Repetition	χ Ε Π				
13n. Ending Repetition	χ Ε ΚΑ		TOTAL		TOTAL
13o. Punctuation Substitution Repetition	χ Ε Α Στ				
13p. Punctuation Omission Repetition	χ Ε - Στ				
13q. Punctuation Addition Repetition	χ Ε + Στ				
13r. Point Marks Repetition	χ Ε ΟΣ				

SPECIAL CATEGORIES			
a) Non - Words	χ ΨΛ		
b) Corrected Errors*	χ Δ		
Corrected Errors %			
c) Non-Corrected Errors	χ ΜΔ		
Non-Corrected Errors %			
Repetitions *(Categories 2 & 13)*			
Total Errors *(except for Repetitions)*			

READING PARAMETERS		
VOICE COLOURING (1- 5)		
READING SPEED (1-5)		
READING QUALITY(1-5)		
SYLLABISM (1-5)		

TOTAL OF WRONG WORDS		
TOTAL OF WRONG WORDS %		
TOTAL OF CORRECT WORDS		
TOTAL OF CORR. WORDS %		
TOTAL WORDS READ		
TOTAL ERRORS		
% OF TOTAL ERRORS		

* ALL ERRORS CORRECTED EXCEPT FOR
REGULAR REPETITIONS AND REPETITIONS OF ERRORS

SCORING SHEET FOR READING ERRORS (ADULT DYSLEXIC STUDENTS & NORMAL CONTROLS)

PARTICIPANT CODE:	
AGE:	
SEX:	
GROUP:	

READING ERRORS CATEGORIES	CODES	TEXT 1 (1st half)	*or* TEXT 1 (2nd half)	& TEXT 2 (1st half)	*or* TEXT 2 (2nd half)	& LIST OF WORDS
1. HEM	χ K					
2. REGULAR REPETITIONS	χ K E	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
2a. Letter Repetition	χ E y Γ					
2b. Repetition of Adjacent Syllables	χ E y Σ					
2c. Word Repetition	χ E y Λ					
3. SYLLABICATION	χ Σ					
4. SUBSTITUTIONS	χ AK	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
4a. Letter Substitution	χ A y Γ					
4b. Syllable Substitution	χ A y Σ					
4c. Word Substitution	χ A y Λ					
5. REVERSALS	χ AΣ	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
5a. Letters Reversal	(1) Γ A					
5b. Syllables Reversal	(1) Σ A					
5c. Words Reversal	(1) Λ A					
6. OMISSIONS	χ -	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
6a. Letter Omission	χ - Γ					
6b. Syllable Omission	χ - Σ					
6c. Word Omission	χ - Λ					
7. ADDITIONS	χ +	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
7a. Letter Addition	χ + Γ					
7b. Syllable Addition	χ + Σ					
7c. Word Addition	χ + Λ					
8. MISINTONATION	(1) Π					
9. ENDINGS	χ KA					
10. PUNCTUATION	χ Στ	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
10a. Punctuation Substitution	(1) A Στ					
10b. Punctuation Omission	(1) - Στ					
10c. Punctuation Addition	(1) + Στ					
11. POINT MARKS	(1) ΟΣ					
12. LINE MISSING	(1) X Σ					
13. REPETITIONS OF ERRORS	χ Λ E	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
13a. Letter Substitution Repetition	χ E A Γ					
13b. Syllable Substitution Repetition	χ E A Σ					
13c. Word Substitution Reprtition	χ E A Λ					
13d. Letters Reversal Repetition	χ E Γ A					
13e. Sylables Reversal Repetition	χ E Σ A					
13f. Words Reversal Repetition	χ E Λ A					
13g. Letter Omission Repetition	χ E - Γ					
13h. Syllable Omission Repetition	χ E - Σ					
13i. Word Omission Repetition	χ E - Λ					
13j. Letter Addition Repetition	χ E + Γ					
13k. Syllable Addition Repetition	χ E + Σ					
13l. Word Addition Repetition	χ E + Λ					
13m. Misintonation Repetition	χ E Π					
13n. Ending Repetition	χ E KA	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
13o. Punctuation Substitution Repetition	χ E A Στ					
13p. Punctuation Omission Repetition	χ E - Στ					
13q. Punctuation Addition Repetition	χ E + Στ					
13r. Point Marks Repetition	χ E ΟΣ					

SPECIAL CATEGORIES

a) Non - Words	χ ΨΛ					
b) Corrected Errors*	χ Δ					
Corrected Errors %						
c) Non-Corrected Errors	χ ΜΔ					
Non-Corrected Errors %						
Repetitions *(Categories 2 & 13)*						
Total Errors *(except for Repetitions)*						

READING PARAMETERS

VOICE COLOURING (1- 5)					
READING SPEED (1-5)					
READING QUALITY (1-5)					
SYLLABISM (1-5)					

TOTAL OF INCORRECT WORDS					
% OF INCORRECT WORDS					
TOTAL OF CORRECT WORDS					
% OF CORRECT WORDS					
TOTAL WORDS READ					
TOTAL ERRORS					
% OF TOTAL ERRORS					

* ALL MISTAKES CORRECTED EXCEPT FOR REGULAR REPETITIONS AND REPETITIONS OF ERRORS

APPENDIX 12a – Individual reading performance of teachers & pupils given in descending order for both Ancient & Modern Greek

Teachers – Reading Speed & Comprehension

ANCIENT GREEK				ANCIENT GREEK			MODERN GREEK				MODERN GREEK		
ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED
1	AL	150	71	1	SIL	269	28	AL	189	29	22	SIL	388
7	AL	145	57	22	SIL	261	1	AL	185	100	26	SIL	343
32	AL	140	57	8	SIL	247	7	AL	176	71	25	SIL	335
30	AL	139	33	32	SIL	247	30	AL	176	50	20	SIL	333
28	AL	132	50	7	SIL	233	32	AL	176	71	24	SIL	331
10	AL	131	57	24	SIL	233	8	AL	171	86	8	SIL	330
22	AL	131	57	10	SIL	219	18	AL	169	86	32	SIL	328
8	AL	130	71	26	SIL	219	22	AL	169	100	1	SIL	326
2	AL	127	67	20	SIL	217	35	AL	169	71	17	SIL	322
9	AL	127	60	18	SIL	209	4	AL	167	71	18	SIL	311
20	AL	127	71	15	SIL	204	10	AL	167	71	10	SIL	285
18	AL	124	67	30	SIL	194	25	AL	167	71	3	SIL	273
3	AL	123	50	3	SIL	188	24	AL	165	43	6	SIL	273
31	AL	122	60	33	SIL	184	17	AL	162	71	35	SIL	265
34	AL	122	40	2	SIL	179	20	AL	162	86	4	SIL	262
12	AL	118	40	19	SIL	177	3	AL	159	71	13	SIL	262
11	AL	116	80	28	SIL	173	12	AL	159	71	28	SIL	262
14	AL	116	100	9	SIL	169	14	AL	156	100	19	SIL	255
15	AL	116	50	11	SIL	166	13	AL	150	57	30	SIL	255
16	AL	116	60	17	SIL	166	26	AL	150	100	33	SIL	249
24	AL	116	43	35	SIL	166	34	AL	150	100	5	SIL	245
19	AL	114	67	13	SIL	160	19	AL	148	86	31	SIL	244
25	AL	114	60	14	SIL	158	31	AL	148	50	14	SIL	242
5	AL	113	40	6	SIL	157	2	AL	146	86	27	SIL	236
13	AL	113	60	12	SIL	153	15	AL	146	57	2	SIL	228
6	AL	111	60	21	SIL	150	5	AL	144	57	15	SIL	228
26	AL	111	33	25	SIL	150	27	AL	144	83	12	SIL	222
35	AL	111	60	31	SIL	145	6	AL	138	71	11	SIL	214
4	AL	110	60	4	SIL	143	16	AL	138	100	7	SIL	201
17	AL	108	40	5	SIL	143	21	AL	138	60	21	SIL	191
33	AL	106	50	27	SIL	143	23	AL	135	20	34	SIL	189
23	AL	103	0	16	SIL	140	11	AL	130	83	16	SIL	176
27	AL	103	0	34	SIL	129	33	AL	130	50	9	SIL	164
21	AL	98	40	23	SIL	106	29	AL	128	50	23	SIL	158
29	AL	92	50	29	SIL	106	9	AL	113	80	29	SIL	128

AV	119	53	180	155	72	259
SD	13	19	42	18	20	61
SD/AV	0.1	0.4	0.2	0.1	0.3	0.2
MIN	92	0	106	113	20	128
MAX	150	100	269	189	100	388
RANGE	58	100	163	76	80	260

Pupils – Reading Speed & Comprehension

ANCIENT GREEK				ANCIENT GREEK			MODERN GREEK				MODERN GREEK		
ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED
9	AL	163	71	21	SIL	301	9	AL	214	71	21	SIL	408
18	AL	162	71	13	SIL	292	8	AL	204	100	9	SIL	396
20	AL	162	71	19	SIL	286	7	AL	201	100	7	SIL	386
21	AL	160	71	7	SIL	274	18	AL	201	100	19	SIL	375
16	AL	158	57	16	SIL	271	10	AL	200	71	16	SIL	352
22	AL	158	57	20	SIL	269	21	AL	200	100	10	SIL	346
23	AL	158	43	18	SIL	252	24	AL	197	100	13	SIL	344
24	AL	155	33	22	SIL	236	16	AL	194	43	8	SIL	342
19	AL	152	43	9	SIL	233	13	AL	189	86	25	SIL	322
7	AL	150	43	10	SIL	227	19	AL	189	71	6	SIL	319
10	AL	150	57	6	SIL	223	22	AL	189	86	15	SIL	301
12	AL	150	43	17	SIL	219	25	AL	189	57	18	SIL	299
13	AL	150	57	23	SIL	219	6	AL	188	71	12	SIL	295
11	AL	147	67	12	SIL	214	12	AL	186	71	20	SIL	289
3	AL	144	57	14	SIL	204	3	AL	185	100	14	SIL	285
15	AL	140	86	34	SIL	202	14	AL	185	100	22	SIL	285
6	AL	139	57	3	SIL	196	20	AL	185	86	5	SIL	281
8	AL	139	71	8	SIL	195	15	AL	182	100	23	SIL	278
25	AL	136	20	15	SIL	194	23	AL	180	86	2	SIL	273
27	AL	135	60	11	SIL	186	29	AL	180	67	11	SIL	273
4	AL	133	50	24	SIL	186	5	AL	179	71	31	SIL	273
34	AL	133	33	1	SIL	185	27	AL	179	83	3	SIL	262
5	AL	130	60	2	SIL	185	4	AL	176	86	4	SIL	261
17	AL	130	43	4	SIL	178	11	AL	176	71	24	SIL	261
14	AL	127	71	5	SIL	170	26	AL	176	83	34	SIL	261
30	AL	123	80	25	SIL	159	30	AL	173	83	27	SIL	258
35	AL	123	40	35	SIL	153	35	AL	169	80	1	SIL	252
2	AL	119	100	31	SIL	145	2	AL	168	100	17	SIL	247
31	AL	119	40	27	SIL	134	34	AL	167	67	29	SIL	241
33	AL	112	75	29	SIL	131	1	AL	160	83	26	SIL	203
26	AL	106	75	30	SIL	122	28	AL	158	40	30	SIL	203
28	AL	103	75	26	SIL	119	17	AL	156	43	35	SIL	185
1	AL	101	50	33	SIL	114	31	AL	146	71	28	SIL	176
29	AL	99	0	28	SIL	106	33	AL	138	60	33	SIL	169
32	AL	73	50	32	SIL	106	32	AL	128	60	32	SIL	138

AV	135	56	197	180	78	281
SD	22	20	55	19	17	65
SD/AV	0.2	0.3	0.3	0.1	0.2	0.2
MIN	73	0	106	128	40	138
MAX	163	100	301	214	100	408
RANGE	90	100	195	86	60	270

Teachers & Pupils – Reading Errors

TEACHERS

	ANCIENT GREEK				MODERN GREEK		
ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors
28	43.69	25.24	18.49	17	15.38	13.47	1.92
17	30.00	20.77	9.93	28	13.92	10.76	3.15
1	29.70	20.79	8.93	13	9.52	6.88	2.65
4	19.55	14.29	6.27	5	8.94	6.15	2.80
3	19.44	9.03	11.63	16	8.25	6.71	1.56
15	19.29	12.86	6.99	22	7.41	4.76	2.65
6	18.71	7.91	10.80	3	7.03	5.40	1.62
29	17.17	11.11	6.06	20	7.03	5.40	1.62
14	16.54	8.66	8.08	18	6.97	5.47	1.49
27	16.30	13.33	2.96	4	6.25	5.11	1.14
10	14.67	8.67	6.67	31	6.16	5.48	0.68
13	14.67	8.00	7.34	7	5.97	4.48	1.50
8	14.39	10.07	4.60	6	5.85	2.66	3.19
18	12.96	6.17	7.18	2	5.36	2.99	2.40
24	12.90	9.68	3.23	23	5.00	3.89	0.56
26	12.61	8.40	4.20	15	4.95	3.30	1.65
5	12.31	9.23	3.08	25	4.76	3.17	1.59
2	11.76	6.72	5.20	21	4.50	2.50	2.00
7	11.33	7.33	4.00	1	4.38	1.88	2.52
25	10.29	5.15	5.17	30	4.05	1.74	2.32
34	9.77	3.76	6.26	27	3.91	3.36	0.56
9	8.59	6.13	2.45	29	3.89	3.34	0.56
16	8.23	4.43	3.80	10	3.50	2.50	1.00
32	8.22	2.74	5.48	33	2.90	0.00	2.89
35	8.13	7.32	0.81	11	2.84	2.27	0.57
33	8.04	0.89	7.24	9	2.80	1.87	0.93
20	7.41	6.79	0.62	26	2.72	1.14	1.14
23	5.70	2.53	3.15	24	2.54	1.53	1.02
30	5.69	4.88	0.81	14	2.16	2.16	0.00
31	5.04	0.00	5.04	34	1.80	1.20	0.60
22	4.43	3.16	1.63	32	1.56	1.56	0.00
21	4.38	1.88	2.88	35	1.18	0.00	1.18
11	2.72	0.68	2.04	19	1.06	0.53	0.53
12	2.67	0.67	2.01	12	0.54	0.54	0.00
19	1.97	1.97	0.00	8	0.49	0.00	0.00

AV	12.84	7.75	5.29	5.02	3.55	1.43
SD	8.63	5.87	3.72	3.38	2.91	0.95
SD/AV	0.67	0.76	0.70	0.67	0.82	0.67
MIN	1.97	0.00	0.00	0.49	0.00	0.00
MAX	43.69	25.24	18.49	15.38	13.47	3.19
RANGE	41.72	25.24	18.49	14.89	13.47	3.19

PUPILS

	ANCIENT GREEK				MODERN GREEK		
ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors
19	12.28	7.02	5.27	9	12.39	10.61	1.77
7	11.03	5.52	5.52	29	9.38	0.84	2.34
8	10.00	6.15	3.85	33	6.92	6.16	0.77
27	9.71	5.83	3.88	23	5.93	2.22	3.70
13	7.08	1.77	5.30	22	5.92	4.14	1.78
25	7.02	3.51	3.52	16	5.80	4.34	1.44
22	6.87	6.11	0.76	12	5.03	3.78	1.26
23	6.80	2.91	3.88	15	4.79	3.42	1.36
1	6.67	2.67	4.00	34	4.67	2.67	2.00
33	6.60	5.66	0.94	11	4.62	3.85	0.77
2	6.30	3.94	2.36	8	3.51	2.34	2.34
9	6.30	3.94	2.37	27	3.47	1.39	2.08
30	5.76	2.88	2.88	14	3.21	1.92	1.28
18	5.65	4.84	0.81	4	2.99	1.80	1.20
14	5.17	1.72	3.45	25	2.99	1.20	1.80
35	4.50	1.80	2.70	13	2.67	0.67	2.00
31	4.10	1.64	2.46	20	2.47	1.85	0.62
21	4.08	3.06	1.02	10	2.40	1.80	0.60
20	3.94	0.79	3.15	35	2.37	2.37	0.00
17	3.70	0.00	3.70	21	2.17	0.00	2.17
4	3.64	3.64	0.00	31	2.03	2.03	0.00
24	3.45	0.00	3.44	3	1.89	1.89	0.00
34	3.28	0.82	2.46	7	1.70	1.14	0.57
29	3.26	1.09	2.17	6	1.45	0.00	1.44
28	3.03	0.76	2.28	2	1.40	0.68	0.68
15	2.59	1.72	0.86	18	1.18	0.59	0.59
12	2.54	0.85	1.70	30	1.14	0.00	1.14
3	2.44	0.81	1.62	1	1.08	0.54	0.54
5	0.88	0.88	0.00	5	0.69	0.00	0.69
11	0.86	0.00	0.86	19	0.68	0.00	0.68
16	0.86	0.00	0.86	17	0.62	0.00	0.62
10	0.76	0.00	0.76	24	0.61	0.00	0.61
32	0.71	0.00	0.71	26	0.00	0.00	0.00
6	0.00	0.00	0.00	28	0.00	0.00	0.00
26	0.00	0.00	0.00	32	0.00	0.00	0.00

AV	4.62	2.35	2.27	3.09	1.84	1.11
SD	3.12	2.17	1.60	2.72	2.17	0.86
SD/AV	0.68	0.92	0.70	0.88	1.18	0.77
MIN	0.00	0.00	0.00	0.00	0.00	0.00
MAX	12.28	7.02	5.52	12.39	10.61	3.70
RANGE	12.28	7.02	5.52	12.39	10.61	3.70

APPENDIX 12b – Individual reading performance of dyslexics & controls given in descending order for each reading material

Dyslexics – Reading Speed & Comprehension

EASY TEXT				EASY TEXT				DIFFICULT TEXT				DIFFICULT TEXT				LIST OF WORDS		
ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	%COMP	ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	%COMP	ID	ALOUD	SPEED TOTAL
7	AL	150	50	13	SIL	154	0	13	AL	153	0	23	SIL	164	20	14	AL	66
19	AL	150	0	9	SIL	146	20	1	AL	140	20	7	SIL	160	100	24	AL	60
23	AL	146	10	23	SIL	139	20	7	AL	140	30	19	SIL	160	20	13	AL	60
15	AL	143	30	11	SIL	135	10	11	AL	138	0	24	SIL	137	20	7	AL	60
11	AL	140	30	15	SIL	131	0	15	AL	133	20	25	SIL	135	0	17	AL	58
24	AL	136	20	17	SIL	130	20	19	AL	131	10	10	SIL	134	0	1	AL	56
13	AL	135	0	7	SIL	127	20	23	AL	131	40	17	SIL	133	0	23	AL	56
1	AL	131	50	6	SIL	125	0	14	AL	129	60	13	SIL	131	0	15	AL	53
3	AL	130	0	25	SIL	125	0	22	AL	129	0	15	SIL	127	0	19	AL	53
10	AL	122	100	14	SIL	122	70	3	AL	127	70	6	SIL	127	0	16	AL	50
16	AL	122	10	10	SIL	117	0	24	AL	127	10	18	SIL	125	0	3	AL	47
20	AL	118	0	16	SIL	114	40	20	AL	125	0	11	SIL	124	0	22	AL	45
9	AL	114	20	3	SIL	111	40	17	AL	124	20	14	SIL	123	20	2	AL	45
14	AL	114	50	19	SIL	111	20	2	AL	118	20	3	SIL	122	0	10	AL	43
17	AL	111	0	24	SIL	111	60	25	AL	118	20	20	SIL	122	0	25	AL	43
25	AL	106	0	20	SIL	108	20	9	AL	112	10	2	SIL	114	30	20	AL	41
21	AL	102	0	18	SIL	102	0	26	AL	110	70	9	SIL	112	0	11	AL	41
2	AL	99	40	26	SIL	95	0	6	AL	108	20	22	SIL	109	0	9	AL	40
18	AL	99	80	8	SIL	87	0	10	AL	108	0	16	SIL	107	80	26	AL	39
6	AL	94	0	2	SIL	82	30	18	AL	107	20	1	SIL	106	40	18	AL	37
22	AL	94	0	22	SIL	77	0	16	AL	101	30	26	SIL	100	20	6	AL	37
8	AL	90	0	1	SIL	76	0	21	AL	90	0	21	SIL	86	10	8	AL	35
4	AL	86	20	21	SIL	73	10	4	AL	84	20	8	SIL	85	20	4	AL	35
26	AL	85	80	12	SIL	66	0	8	AL	84	0	12	SIL	72	0	21	AL	33
12	AL	76	0	4	SIL	65	60	12	AL	74	20	4	SIL	70	10	12	AL	26
5	AL	49	0	5	SIL	56	0	5	AL	54	0	5	SIL	41	0	5	AL	25

AV	113	23	107	17	115	20	116	15	46
SD	25	29	27	21	23	21	29	25	11
SD/AV	0.2	1.3	0.3	1.3	0.2	1.1	0.2	1.7	0.2
MIN	49	0	56	0	54	0	41	0	25
MAX	150	100	154	70	153	70	164	100	66
RANGE	101	100	98	70	99	70	123	100	41

Controls – Reading Speed & Comprehension

EASY TEXT				EASY TEXT				DIFFICULT TEXT				DIFFICULT TEXT				LIST OF WORDS		
ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	%COMP	ID	ALOUD	SPEED	%COMP	ID	SILENT	SPEED	%COMP	ID	ALOUD	SPEED TOTAL
16	AL	200	0	3	SIL	278	60	25	AL	224	20	20	SIL	320	30	16	AL	96
28	AL	200	20	20	SIL	278	40	17	AL	210	40	3	SIL	305	30	25	AL	94
11	AL	194	20	25	SIL	273	20	28	AL	205	0	25	SIL	285	30	1	AL	86
24	AL	194	20	16	SIL	261	20	22	AL	204	30	7	SIL	269	0	18	AL	86
17	AL	193	0	19	SIL	261	20	3	AL	195	60	1	SIL	266	50	24	AL	84
25	AL	185	0	1	SIL	250	0	16	AL	195	0	16	SIL	258	20	17	AL	82
3	AL	182	50	18	SIL	222	60	6	AL	192	20	18	SIL	235	80	20	AL	80
7	AL	182	30	22	SIL	222	20	7	AL	186	0	22	SIL	228	0	11	AL	79
20	AL	182	20	7	SIL	211	60	18	AL	182	90	6	SIL	222	40	28	AL	79
22	AL	178	80	8	SIL	202	80	4	AL	177	10	2	SIL	216	0	22	AL	78
15	AL	171	10	24	SIL	202	90	11	AL	177	0	19	SIL	210	20	3	AL	75
19	AL	171	60	13	SIL	200	10	2	AL	177	20	5	SIL	200	40	19	AL	74
4	AL	167	20	21	SIL	194	0	15	AL	173	30	24	SIL	198	70	21	AL	74
23	AL	167	0	28	SIL	193	100	14	AL	172	0	8	SIL	192	50	12	AL	73
12	AL	162	30	5	SIL	188	60	20	AL	170	10	28	SIL	192	50	4	AL	72
6	AL	159	40	12	SIL	178	100	1	AL	168	80	17	SIL	190	30	13	AL	71
18	AL	159	50	23	SIL	171	20	10	AL	168	70	21	SIL	190	0	15	AL	71
8	AL	158	30	9	SIL	164	20	21	AL	168	20	9	SIL	182	20	23	AL	67
9	AL	150	0	17	SIL	162	30	13	AL	164	40	12	SIL	182	50	14	AL	66
1	AL	148	40	10	SIL	154	20	12	AL	163	30	13	SIL	181	0	27	AL	64
21	AL	148	40	14	SIL	154	30	23	AL	160	20	26	SIL	170	50	5	AL	63
26	AL	148	50	11	SIL	153	30	24	AL	160	30	4	SIL	160	60	6	AL	60
10	AL	143	70	15	SIL	153	60	26	AL	153	30	15	SIL	160	70	7	AL	60
14	AL	143	40	2	SIL	146	20	8	AL	148	0	23	SIL	156	40	8	AL	60
27	AL	143	10	27	SIL	143	40	5	AL	146	0	14	SIL	153	0	9	AL	57
2	AL	139	60	4	SIL	143	20	9	AL	140	20	27	SIL	143	70	26	AL	56
13	AL	135	80	26	SIL	140	60	27	AL	138	40	10	SIL	140	30	2	AL	54
5	AL	123	20	6	SIL	120	30	19	AL	138	40	11	SIL	140	20	10	AL	54

	Easy Aloud Speed	Easy Aloud %Comp	Easy Silent Speed	Easy Silent %Comp	Difficult Aloud Speed	Difficult Aloud %Comp	Difficult Silent Speed	Difficult Silent %Comp	List of Words Speed Total
AV	165	32	193	40	173	27	205	34	72
SD	21	24	47	28	22	25	50	24	12
SD/AV	0.1	0.8	0.2	0.7	0.1	0.9	0.2	0.7	0.2
MIN	123	0	120	0	138	0	140	0	54
MAX	200	80	278	100	224	90	320	80	96
RANGE	77	80	158	100	86	90	180	80	42

Dyslexics – Reading Errors

EASY TEXT				DIFFICULT TEXT				WORD LIST			
ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors
5	105.40	94.59	10.80	5	80.36	71.42	8.94	12	212.67	185.34	27.34
26	56.76	45.94	10.80	12	66.92	53.38	13.53	5	202.67	165.99	36.66
12	52.00	47.00	5.00	20	60.90	47.36	13.54	18	166.00	141.33	24.67
18	47.30	32.43	14.86	18	57.14	43.75	13.39	20	90.67	72.67	17.99
20	41.00	33.00	8.00	21	52.63	34.22	16.54	16	70.00	52.67	17.34
16	39.00	32.00	7.00	25	45.54	27.68	17.86	8	67.33	30.91	12.67
4	38.00	30.00	8.00	8	45.11	29.32	15.79	4	62.00	49.33	12.67
25	33.78	24.32	9.46	4	36.09	27.82	8.26	9	60.67	42.00	18.66
8	27.00	17.00	10.00	26	35.71	25.00	10.71	11	60.00	42.00	18.00
10	27.00	20.00	7.00	11	33.08	23.31	9.77	21	58.00	52.67	5.34
21	25.00	17.00	8.00	10	28.57	19.54	9.01	25	58.00	39.99	18.01
6	22.97	8.10	14.86	14	25.00	16.97	8.04	6	57.33	43.33	14.00
14	22.97	20.27	2.70	7	24.06	12.02	12.02	26	50.67	39.33	11.33
9	20.27	9.45	11.45	23	23.31	16.53	6.76	19	50.00	42.67	7.34
13	20.27	8.10	12.15	9	23.21	16.07	7.14	15	46.67	31.34	15.34
3	18.00	15.00	3.00	6	22.32	11.61	10.71	24	46.00	40.67	5.34
17	17.58	13.52	4.05	3	21.80	17.29	4.50	23	42.67	32.67	10.01
2	16.22	12.16	4.05	2	21.43	16.96	4.46	2	40.00	33.34	6.68
24	16.00	11.00	5.00	17	20.54	16.07	4.46	10	35.33	29.34	6.00
11	13.00	9.00	4.00	24	20.30	17.29	3.00	3	34.00	24.66	9.35
1	10.81	6.76	4.05	16	19.55	13.54	6.01	13	25.33	19.33	6.00
19	8.00	7.00	1.00	19	19.55	15.78	3.75	22	23.33	18.67	4.67
23	8.00	4.00	4.00	13	12.50	3.57	8.93	17	21.33	15.33	6.00
15	7.00	3.00	4.00	1	8.93	6.25	2.68	14	20.67	14.67	6.01
22	6.76	5.40	1.35	15	7.52	3.76	3.75	1	12.00	8.00	4.01
7	5.00	3.00	2.00	22	4.46	2.68	1.78	7	3.33	2.67	0.67

AV	27.12	20.35	6.79	31.41	22.66	8.67	62.18	48.88	12.39
SD	21.53	19.68	4.02	19.25	16.28	4.55	52.74	45.55	8.34
SD/AV	0.79	0.97	0.59	0.61	0.72	0.53	0.85	0.93	0.67
MIN	5.00	3.00	1.00	4.46	2.68	1.78	3.33	2.67	0.67
MAX	105.40	94.59	14.86	80.36	71.42	17.86	212.67	185.34	36.66
RANGE	100.40	91.59	13.86	75.90	68.74	16.08	209.34	182.67	35.99

Controls – Reading Errors

	EASY TEXT				DIFFICULT TEXT				WORD LIST		
ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors	ID	Total Errors	Timing Errors	Accuracy Errors
10	18.92	14.87	4.05	27	24.81	18.80	6.01	27	38.00	28.66	9.34
27	17.00	12.00	5.00	24	14.29	9.02	5.26	26	31.33	18.01	13.34
15	15.00	9.00	6.00	26	13.39	6.25	7.15	14	22.67	15.99	6.68
5	12.16	10.81	1.35	13	12.50	8.92	3.56	9	21.33	14.67	6.67
6	12.16	9.46	2.70	12	12.03	5.26	6.76	13	19.33	13.34	6.01
12	12.00	8.00	4.00	15	12.03	6.02	6.00	4	18.00	12.00	6.00
26	10.81	4.05	6.75	4	11.28	5.26	6.00	10	18.00	17.33	0.67
22	8.11	5.41	2.70	9	8.27	6.26	3.00	17	13.33	9.34	4.00
16	7.00	3.00	4.00	23	8.27	3.01	5.25	23	13.33	9.33	4.00
23	7.00	6.00	1.00	5	7.14	3.57	3.56	15	12.67	10.00	2.67
14	5.41	2.70	2.70	10	7.14	4.47	2.68	5	8.67	6.01	2.67
18	5.41	2.70	2.70	18	7.14	4.46	2.67	24	8.67	2.99	2.67
25	5.41	2.70	2.35	8	6.77	3.76	3.00	12	8.00	5.33	2.66
8	5.00	2.00	3.00	17	6.25	1.78	4.46	8	7.33	6.66	0.67
11	5.00	3.00	2.00	20	6.02	0.75	5.25	11	6.67	5.34	1.33
13	4.05	1.35	2.70	14	5.36	1.79	3.57	16	6.00	2.67	3.34
9	4.00	2.00	2.00	16	5.26	0.75	4.51	18	5.33	3.33	2.00
24	4.00	2.00	2.00	28	5.26	4.51	0.75	28	5.33	3.33	1.33
4	3.00	2.00	1.00	6	4.46	0.89	3.58	19	4.67	4.00	0.67
20	3.00	0.00	3.00	2	3.57	1.79	1.79	22	4.67	0.67	4.00
2	2.70	0.00	2.70	22	3.57	0.00	3.57	1	3.33	2.00	1.34
28	2.00	2.00	0.00	11	3.01	1.50	1.50	2	2.67	2.01	0.67
17	1.35	0.00	1.35	7	2.26	0.00	2.25	3	2.67	2.00	0.67
7	1.00	1.00	0.00	19	2.26	0.00	2.25	20	2.67	0.00	2.67
19	1.00	0.00	1.00	1	1.79	0.00	1.78	6	2.00	0.00	2.00
1	0.00	0.00	0.00	3	1.50	0.00	1.50	25	2.00	1.33	0.67
3	0.00	0.00	0.00	21	0.00	0.00	0.00	7	1.33	0.00	1.34
21	0.00	0.00	0.00	25	0.00	0.00	0.00	21	0.00	0.00	0.00

	EASY Total	EASY Timing	EASY Accuracy	DIFFICULT Total	DIFFICULT Timing	DIFFICULT Accuracy	WORD LIST Total	WORD LIST Timing	WORD LIST Accuracy
AV	6.16	3.79	2.36	6.99	3.53	3.49	10.36	7.01	3.22
SD	5.27	4.12	1.77	5.34	4.06	1.97	9.47	7.05	3.04
SD/AV	0.86	1.09	0.75	0.76	1.15	0.57	0.91	1.01	0.94
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX	18.92	14.87	6.75	24.81	18.80	7.15	38.00	28.66	13.34
RANGE	18.92	14.87	6.75	24.81	18.80	7.15	38.00	28.66	13.34

APPENDIX 13

Analyses using the log transformation

a) Teachers & Pupils

Ancient Greek – Timing Errors

12th grade pupils made significantly more timing errors in Ancient Greek (M = 0.84, SE = 0.56) than teachers of Ancient Greek (M = 0.43, SE = 0.52), $t(68) = 5.36$, $p < .001$, $r = .55$.

Modern Greek – Timing Errors

12th grade pupils made significantly more timing errors while reading Modern Greek (M = 0.57, SE = 0.05) than the more experienced teachers of Ancient Greek (M = 0.35, SE = 0.05), $t(68) = 3.20$, $p = .001$, $r = .36$.

b) Dyslexics & Controls

Easy Text – Wrong Words

Adult dyslexic students read significantly more wrong words (M = 1.21, SE = 0.05) than normal controls (M = 0.60, SE = 0.06) in the easy reading material, $t(52) = 8.08$, $p < .001$, $r = .75$.

Easy Text – Timing Errors

Dyslexic students made significantly more timing errors (M = 1.19, SE = 0.07) while reading the easy text than their non-dyslexic peers (M = 0.52, SE = 0.07), $t(52) = 6.64$, $p < .001$, $r = .68$.

Difficult Text – Total Errors

Adult dyslexic university students made significantly more reading errors in total (M = 1.43, SE = 0.05) than normal controls (M = 0.80, SE = 0.06) in the difficult reading material, $t(52) = 7.60$, $p < .001$, $r = .72$.

List – Repetitions

Adult dyslexics made significantly more Repetitions errors (M = 1.20, SE = 0.07) than non-dyslexics (M = 0.56, SE = 0.07) in the list of words, $t(52) = 6.29$, $p < .001$, $r = .66$.

List – Substitutions

Dyslexics made significantly more Substitutions errors (M = 0.72, SE = 0.04) in the list than controls (M = 0.37, SE = 0.05), $t(52) = 5.40$, $p < .001$, $r = .52$.

List – Wrong Words

Dyslexics incorrectly read more words (M = 1.37, SE = 0.05) than normal controls (M = 0.71, SE = 0.06) in the word list, $t(52) = 8.35$, $p < .001$, $r = .76$.

List – Total Errors

Adult dyslexic students made significantly more reading errors in total (M = 1.68, SE = 0.07) while reading the list than non-dyslexics (M = 0.91, SE = 0.07), $t(52) = 7.67$, $p < .001$, $r = .73$.

List – Timing Errors

Dyslexic students made significantly more timing errors (M = 1.56, SE = 0.07) in the word list than controls (M = 0.72, SE = 0.08), $t(52) = 7.69$, $p < .001$, $r = .73$.

List – Accuracy Errors

The dyslexic group made significantly more accuracy errors (M = 1.04, SE = 0.06) than non-dyslexics (M = 0.53, SE = 0.05) in the list, $t(52) = 6.53$, $p < .001$, $r = .67$.

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