

**Visual Deficits in Dyslexia: Examination of stress patterns
and the impact of emotions on students' reading
performance**

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A thesis submitted for the degree of
Doctor of Philosophy in Applied Linguistics

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January 2023

Abstract

The present study investigates the presence of visual deficits in students with developmental dyslexia as well as their emotions in relation to their reading performance. Dyslexia occurs in approximately 4% of the population (Simmons & Singleton, 2000) and concerns difficulties in reading and spelling for both L1 and L2 learning. One of the most common difficulties of dyslexic individuals has been noticed in stress errors (Paizi, Zoccolotti & Burani, 2011). However, the Greek and English language present differences regarding the visual information that entails stress pattern (such as the diacritic mark in Greek language). Additionally, emotions significantly affect students' performance whether they are positive or negative (Pekrun et al., 2017).

In this mixed-method research, 110 Greek students with dyslexia participated in a training program with pre- and post-phase. The training was assessed through visual and auditory stimuli to observe differences between these two sensory abilities. Moreover, questionnaire, interview and observational data were collected to examine the emotional impact.

Results indicated an improvement in the stress pattern assignment of the Greek language after visual training while no improvement was observed in the English language since the stress pattern is not marked. The evidence supports the findings that visual impairments do play a role in the reading performance for both L1 and L2 learning. In addition, both positive and negative emotions were found to play a particular role in students' performance but the extent of which positive emotions would lead to a positive outcome and negative emotions to a bad outcome was questioned. Nevertheless, anxiety was found to play a crucial role in students' overall performance.

Acknowledgments

First, I would like to express my deepest and sincere gratitude to my supervisor Dr. Christina Gkonou. Her professional knowledge, support, advice, patience, and motivation were vital for the completion of this thesis. Without her, my development as a researchers would be impossible.

I would also like to thank the internal examiner, Dr Hannah Gibson, and the external examiner, Dr Angelos Lengeris, whose advice was greatly appreciated.

Further appreciation goes to all the participants who volunteered to take part in this study and who made this research possible as well as enjoyable and worthwhile. Special thanks go to the teachers at the schools who made my empirical research to go smoothly.

I am also thankful to those people that supported my efforts by formal or informal conversations and were essential for me to delve into the subject.

Finally, deepest gratitude goes to my family who have always supported my endeavours, believed in me, and helped me achieve my goals. My friends, close or far away, who were supportive and encouraged me throughout these years.

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Chapter 1: INTRODUCTION

1.1. Introduction

This chapter aims to introduce the background framework of the present thesis. The purpose and rationale of the researcher to conduct this project will also be explained alongside the significance of and personal motivation for this research. Lastly, the thesis outline will be presented.

1.2. Background of the Study

Reading is the cognitive process of understanding written-down speech (Ziegler & Goswami, 2005) and implies the production of words based on a visual stimulus (Wittrock, 1981). It is a psycholinguistic skill which interacts not only with phonological, but also visual, orthographic and semantic systems (Calet, Gutiérrez-Palma, Defior & Jiménez-Fernández, 2019). In particular, in order to learn reading, children have to learn the code used by each culture so as to represent oral speech as a line of visual symbols (Ziegler & Goswami, 2005).

Learning to read in orthographically consistent languages relies fundamentally on grapheme-phoneme recoding strategies. In particular, according to Caravolas et al. (2012), phonological awareness is one of the main predictors of the development of reading in orthographic systems. However, deficits in phonological awareness are an indicative characteristic of dyslexia and other reading difficulties (Lyon, Shaywitz & Shaywitz, 2003).

Dyslexia is a reading ability difficulty which is characterised by defects in the development of the reading skills and specifically by difficulties in recognition of words and poor abilities in decoding (Vellutino, Fletcher, Snowling & Scanlon, 2004). A

considerable body of research has attempted to explore the causes and characteristics of these reading problems (Shaywitz et al., 2002; Vellutino, 1997; Stein & Walsh, 1997). Although there are various theories which have tried to explain and describe the nature and origin of dyslexia (for more details, read Section 2.2.5), still there is no universal agreement.

The deficit in segmental phonology among dyslexic individuals has been studied thoroughly in research, but the role of suprasegmental phonology and specifically stress pattern in reading needs further investigation. Furthermore, in alphabetic languages, apart from the grapheme-phoneme correspondence it has been argued that the awareness of sub-lexical units is required as well (Ziegler & Goswami, 2005). Recent studies have established the crucial relationship between phonological (segmental and suprasegmental) skills and reading development (Rayner, Foorman, Perfetti, Pesetsky & Seidenberg, 2001; Snowling, (2000).

Moreover, apart from the cognitive and phonological difficulties which are the primary problems of dyslexia, reading difficulties play a significant role in other aspects of an individual's development and have various consequences on the social, academic and psychological domain. In particular, a significant amount of research on dyslexia demonstrates that students' academic difficulties are linked to a wide range of psychological issues (Greenham, 1999; Hellendorn & Ruijseenaars, 2000; Kavalo & Forness, 1996); specifically, emotions play a significant role in the development of the individual and in the learning process within educational settings.

The most widely studied emotion in the field of (language) education is anxiety (Dewaele, 2010). As Hill and Wigfield (1984) have stated, anxiety may impair students' performance and lead to drop in their academic achievement. Therefore, it is argued

that, in educational settings, negative emotions have a negative relation with student's performance (Pekrun, Linnenbrink-Garcia, 2014; Pekrun et al., 2008). However, apart from negative emotions, there are emotions that can be characterized as positive such as joy and confidence (Cohn & Fredrickson, 2009). In total, research in the field has concluded that in educational settings, negative emotions will lead to bad results and positive emotions to positive results (DeCuir-Gunby, Aultman & Schutz, 2009; Fredrickson, 2001).

1.3. Purpose and Rationale of the Study

One of the key characteristics of written and oral speech is its multisensory nature as both auditory and visual information is importantly involved (Benoit, Guiard-Marigny, Goff, 1996 in Schaadt Mannel van der Meer, 2016). Theories explaining the nature of dyslexia have found evidence that sensory (visual and auditory) deficits may be one of the reasons why individuals with dyslexia face reading difficulties. In particular, there is growing evidence centering on the existence of visual deficits such as the Magnocellular Deficit Theory (Stein & Walsh, 1997) and the Visual Deficit Theory (Lovegrove, Bowling, Badcock & Blackwood, 1980). Considering the above information on dyslexia context, this research aims to provide further evidence on the existing debate between a visual or auditory deficit in children with developmental dyslexia and its effect on their reading performance (For more details, read Section 2.2.8.). In particular, by the use of the measurement instruments, the rationale is to shed light on the multidimensional nature of these deficits.

To address this, the phonological errors that students with dyslexia make (Porpodas, 1997) will be examined. Models of reading argue that oral reading includes the relation of two different routes which generate lexical/ semantic and sub-lexical information

(Caravolas et al., 2012). Thus, one of the most common difficulties of dyslexic individuals has been noticed in stress pattern (Paizi, Zoccolotti & Burani, 2011). Stress assignment of dyslexic children has been examined in various languages, both transparent and non-transparent, such as English (Leong, Hämäläinen, Soltész & Goswami, 2011), Filipino (Dulay & Hanley, 2015), Spanish (Jiménez-Fernández et al., 2015), Italian (Paizi, Zoccolotti & Burani, 2011) and Greek (Protopapas, Fakou, Drakopoulou, Skaloumbakas & Mouzaki, 2012).

However, ‘the isomorphic relationship between graphemes and phonemes, the high degree of consistency in the phonetic realization of vowel and consonant graphemes, the articulatory simplicity, and the syllabic structure make Greek highly regular for reading’ (Douklias, 2009, p. 706). Greek students with dyslexia have been found to face difficulties in reading (Propodas, 1997) especially in stress pattern. However, in the Greek language, a diacritic mark is included in most of the words. Its role is to indicate the stressed syllable in the majority of words (Protopapas, Gerakaki & Alexandri, 2007), a valuable source of information, while most of the other languages do not present this diacritic. Thus, the use of stress-related information could ameliorate the performance on stress assignment. According to Paizi et al. (2011), for languages including lexical stress such as Italian, Spanish and Greek, in which the stress position may vary, stress assignment is critical for correct pronunciation. Based on this rationale, the aim of this project is to examine whether Greek individuals with dyslexia faced difficulties to apply stress patterns due to visual impairments that prevent them from identifying small visual stimuli.

On the other hand, English is a worldwide spoken language which is non-transparent and does not include stress indicator (Aidinis & Nunes, 2001; Lefkens, 2015;

Protopapas et al., 2007). Learning a new language is challenging for every individual especially if they have dyslexia or other learning difficulties. At the same time, first language skills are an important first base for second language learning. In Greece, the English language is taught at school as a compulsory school subject. However, dyslexia can affect a student's performance in second language learning as well. Taking into consideration the differences between the two languages, another aim of this thesis is first, to test whether there are visual deficits affecting the stress assignment of individuals with dyslexia (research question 1) and secondly, how students perform in English as a second language (L2) (research questions 2,3).

Finally, 'emotions are intimately involved in virtually every aspect of the teaching and learning process and therefore an understanding of the nature of emotions within the class context is essential' (Schutzt & Lanehart, 2002, p.67). In particular, emotions are divided into positive and negative. This categorization is examined in connection with the performance of students with dyslexia since the relationship between emotions and performance could also be considered ambiguous (Section 2.4.5). Specifically, some emotions may be regarded as positive from one perspective (e.g., how students feel) but as negative from another (its consequences e.g., Solomon & Stone, 2002). Research on the emotions of students with dyslexia is limited despite theoretical advances and the call for further studies (Efklides & Violet, 2005). The present thesis aims to provide further evidence and understanding of various emotions such as anxiety, that especially students with dyslexia experience and their effect on their reading performance (research questions 4, 5).

1.4. Significance and Personal Motivation

Language plays a crucial role in human life. Via this, individuals express their love or hate, achieve their goals and careers, they pray or blaspheme. Through language, lives are planned, and individuals remember the past; exchange ideas and experiences; form social and individual identities. Language is one of the most valuable things and as Cicero said in 55 BC, ‘the one thing in which we are especially superior to beasts is that we speak to each other’. However, learning difficulties pose a significant risk to the successful development of individuals and can lead to academic, occupational and psycho-social consequences (Huestegge et al., 2014). Dyslexia is one of these conditions and specifically deals with difficulties in reading and spelling. Children with learning difficulties have been and continue to be a real mystery to teachers and parents because while they could be considered as capable as their peers, their performance is inexplicably low and the problems at school seem insurmountable until nowadays. Moreover, dyslexia occurs in 4% of the population, approximately (Simmons & Singleton, 2000). Considering the necessity to further understand these learning difficulties that concern a large proportion of the population, and especially dyslexia, I decided to focus my doctoral thesis on this and contribute to the field.

Furthermore, still nowadays, a universal theory to explain these difficulties does not exist. The phonological theory has been the predominant hypothesis for over 20 years, but recent studies have emerged which argue the existence of auditory, visual and motor impairments in dyslexics. Findings that these visual difficulties may be present even before schooling and could predict later reading difficulties suggest causality (Ramus, 2003). The present study aims to give further insights into the relation between dyslexia and a visual deficit. Nevertheless, the primary cause of these visual deficits and their significant impact on reading skills could be seen as the primary biological cause of

visual disorders and their impact on reading performance still requires to be clarified (Ramus, 2003). Based on this call for research, I centered my focus of interest on the existence or not of visual difficulties.

This aspect differentiates this study from similar, previously conducted studies on dyslexia since it provides further information about the pattern that children follow in order to stress syllables. Furthermore, there are theories on the causes and origins of developmental dyslexia which state that a deficit in visual processing is likely to exist and this may explain some of the difficulties that individuals with dyslexia are facing (Stein, 2018). Further proof of this argument is demonstrated by Ziegler and Goswami (2005), who state that especially in regular orthographies, children may be more susceptible to stress dominance because stress is supposed to rely to a large extent on sub-lexical reading. The results of the current study aim to provide further support to these arguments and theories.

In addition, there was an aggregation of reasons that determined my decision to investigate dyslexia among students in the Greek language. The first is my professional and academic curiosity and interest in the issue of dyslexic children and their right to social inclusion. My enthusiasm about understanding the issues concerning children with disabilities increased during my studies for my BA degree in Greek Philology. Getting familiar with learning difficulties motivated me to learn more and more and, in my way, to help these individuals deal with their difficulties. Another reason is that the Greek language and its stress diacritic can be considered as another way to explore these difficulties from a perspective different from the one that was adopted until recently.

Furthermore, foreign language learning gives the opportunity to communicate with non-English speakers in order to share ideas and visions and create a common understanding. This experience should be common for all young people. However, for dyslexic individuals who are struggling to acquire their own language, learning a foreign language may seem like another unbearable burden clouding in demotivation and failure. However, still evidence on dyslexia in a second language context is scarce and further research needs to be conducted. Being a teacher, all these issues highly concerned me in the years before starting this project. The fact that there are students that need guidance and support is a great motive to conduct research focusing on these issues. For these reasons, as well as realising the difficulties that especially students with dyslexia face and the little focus that has been placed on the Greek educational system, I was motivated to learn more about that.

Finally, 'learning to read is one of the key outcomes for early education and children who have reading difficulties often enter a downward spiral of low educational attainment and poor employment prospects with negative consequences for adult well-being' (Hulme & Snowling 2016, p. 731). However, little attention has been paid to emotions of students with dyslexia, as research has focused particularly on the cognitive aspect of dyslexia. However, emotions highly affect the performance and development of individuals. Since there is lack of evidence on this topic, I was motivated to investigate how emotions affect these students and to understand further their emotional conditions. The emotional reactions that individuals feel during simulation such as the training, that was conducted through this research, can have a major impact on what they attend to, what they recall from these experiences, their judgments and problem-solving techniques, as well as their motivation to engage in learning behaviours.

1.5. Thesis Outline

The thesis consists of six chapters. The present chapter provides an introduction to the topic, offering information about the background and rationale of this study. Moreover, the researcher's motivation and aims to study students with dyslexia as well as the significance of the present study for dyslexia research are explained.

Chapter 2 presents an overview of the three major areas that are examined. First, the theory and research of developmental dyslexia is discussed. This is followed by how dyslexia manifests in second language learning and its relation to different language systems. Next, the relationship between dyslexia and emotions is presented, focusing on how the latter affects students' cognitive performance.

Chapter 3 describes the methodology of this project. The decision of conducting a mixed-method study is presented first, followed by the methodological decisions that were made. Followingly, the Sensory Training with the Stress Assessment task is described as well as the administered instruments to examine and analyse the emotional states of these students. Information on data analysis and quality of research is also provided.

Chapter 4 presents the results that derived from the analysis of both quantitative and qualitative data. Regarding quantitative data, descriptive and inferential statistics are presented. For qualitative results, the predominant themes and codes that were elicited from the transcripts and field notes are summarised through the support of quotes from the participants.

In chapter 5, the findings are discussed in comparison to the literature reviewed and previous research. The quantitative and qualitative results are integrated and discussed, offering a holistic, overall picture of the topic under investigation.

Chapter 6 summarizes the main results and concludes the thesis with the strengths and limitations of the project. It also shows how the aims and research questions that were set at the beginning have been achieved and answered. Implications for future research are also suggested.

Chapter 2: LITERATURE REVIEW

2.1. Introduction

The present chapter is going to introduce the theoretical background of developmental dyslexia. In particular, the theories and hypothesis regarding the nature of this learning difficulty as well as its relation to stress patterns. Moreover, the characteristics of second language learning and educational emotions are going to be discussed in order to interpret the outline and outcome of the thesis. Practical issues as well as current approaches will be discussed.

2.2. Developmental Dyslexia

2.2.1. Definition of Learning Disorders

Learning disorders is one of the most frequently diagnosed developmental disorders throughout childhood (Moll et al., 2014). Studies have presented comparable rates of 4-9% for deficits in reading and 3-7% for deficits in mathematics (DSM-5, 2013). As such, extended research has been conducted within different scientific fields such as pedagogy and education, neurology and psychology to further understand the mechanisms related to the learning processes among individuals with learning disorders.

Even nowadays, a universal terminology hasn't been established to describe such disorders. 'Learning difficulties', 'Learning Disabilities' and 'Specific Learning Disorders' are some of the terms that have been used. The first term is used mostly in the field of education and in school performance difficulty, while the latter two terms are adopted by scientists who research this topic from a medical point of view, who examine its nature and causes. Specifically, the label 'Specific Learning Disorder' was applied to describe this condition after the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association ('DSM-5', 2013), indicating that is a neurodevelopmental disorder with characteristics such as difficulties in acquiring and practising academic skills.

Apart from terminology, the definition of learning difficulties is still under debate as well. First, in 1963, the label 'Learning Disability' was used by Kirk (1963) and referred to a general group of developmental disorders in a variety of skills that theoretically each student is required to acquire during the learning process (Panteliadou and Botsas, 2007). Specifically, Kirk (1973, p. 63) argued that:

Children with Learning Disabilities have a disorder in one or more of the basic psychological processes involved in understanding or using spoken or written language. These disorders can manifest as a disorder in comprehension, thinking, speech, writing, spelling, or arithmetic. They include conditions such as perceptual impairments, brain damage, minimal brain dysfunction, dyslexia, developmental aphasia, etc. Learning Disabilities do not include those learning problems due to visual, auditory or motor impairments or mental retardation.

Lloyd (2002, p.427) further suggests that it is heterogeneous combination of various characteristics rather than a unified condition. He further explains that students facing learning disabilities struggle with reading, but not all do, while other students with learning difficulties have difficulty in paying attention, but not all do. Some students face difficulties with planning algorithms for solving mathematical problems, however

not all do. Thus, no student can present so typical learning disability characteristics to safely refer to ‘the learning-disabled child’.

Based on the above, standardizing the definition of language disorders and producing criteria for identification purposes is still a difficult process for the researchers of the field. According to Markovitis & Tzouriadou (1991) and Peters & Ansari (2019), the existence of various definitions and terminology is attributed to the complexity of the etiology and symptomatology of learning disorders. Specifically, individuals with learning disorders present variability in the difficulties they face, and the reasons for these disorders may vary. At the same time, students with learning disorders are differentiated from another much larger population who present other learning difficulties due to a possible lack of ability, motivation or other environmental factors (Silver & Hagin, 2002).

Moreover, a considerable number of studies have been conducted presenting significant differences between children with learning disorders and normally developed students in language processing areas. Scarborough (1990) proved that in tasks related to language skills, children with learning disorders performed worse than children in control groups. More recent studies like Roth et al. (2002) again investigated the relationship between oral language and early reading development through measures of background variables such as IQ, word recognition and comprehension. They found deficit in oral language and early reading development in a group of students with language disorders.

Other areas that students with learning disorders may present weaknesses are their working memory, phonological processing, processing speed or executive functioning (Kormos, 2017). All these weaknesses are likely to be accompanied and be the reason

of low school performance or failure. Morrison & Cosden (1997) prove in their study that reading disability is a risk factor of school dropping and in combination to other secondary factors such as hyperactivity and discipline problems could affect an individual's emotional, familial and societal adjustment. Select Committee on Youth Affairs (1992), also, supports these findings as in their research, 76% of juvenile delinquents had reported learning disorders and low literacy-numeracy difficulties at the upper primary school level (Siegel & Himel, 1998). All these characteristics could be considered cumulative, and contemporaneously could lead to socio/emotional difficulties (Siegel & Himel, 1998). For that reason, the main focus of educational systems and teachers should be children's individual needs (Thomas & Loxley, 2007) and further attention should be paid to how the environment of students itself builds barriers against their learning.

2.2.2. Classification of Learning Disorders

Learning Disorders belong to the broader context of Specific Developmental Disorders, along with Communication Disorders and Motor Skills Disorders. They are inherent in the individual, attributed to central nervous system dysfunction and may occur throughout an individual's life (Visscher, Houwen, Scherder, Moolenaar, & Hartman, 2007). Recently, studies have started examining the relationship between deficits in different learning domains (i.e., deficits in reading and deficits in mathematics) to better understand their overlap, instead of focusing on a single deficit only. Despite the various studies, associations and researchers may classify these disorders differently.

In this study, the proposed classification according to DSM V TM for Learning Disabilities, is adopted as it is the most recent and best empirically grounded (Kormos, 2017). Based on performance on learning variables, the classification is as follows: 1.

Learning Disorder with impairments in reading, 2. Learning Disorder with impairments in written expression, 3. Learning Disorder with impairments in mathematics. Moreover, in some cases, Attention Deficit and Hyperactivity Disorder (ADHD) is also considered to be in this group. However, in DSM-5, it is categorized separately from the overall learning disorders and is classified under neurodevelopmental disorders, though its definition is immediately followed by learning disorders to indicate their overlapping features.

In particular, the first category is commonly known as Dyslexia. Children with this type of disorder present exceptional difficulty in processing written words and as a consequence reading, which is disproportionate to their age and mental potential (Mavrommati, 1995). They face difficulties or are unable to interpret, recall and transform meanings into symbols resulting in falsifying words, doing inversions in syllables or letters and confusing words similar in spelling and pronunciation. The second category is referred as Dysorthographia as regards to a special learning problem manifested by unusually persistent difficulty in acquiring capacity for spelling, while the ability to read is cultivated seamlessly and effectively (Mavrommati, 1995) as it reaches the expected level based on age and the student's mental capacity. The third category is also called Dyscalculia. This situation affects the ability to acquire arithmetic skills. Students with Dyscalculia may present difficulty in understanding simple arithmetic concepts, be deprived of the intuitive perception of numbers and present problems in learning arithmetic operations (Butterworth, 2003). It also leads to reduced capacity in serialization, sequencing and classification.

Under the 'umbrella' term of learning disorders (Pumfey & Reason, 1991), researchers found that heterogenous cases such as difficulties in arithmetic or reading skills are

included and different causes may be attributed based on the various theories that have been created. It has been proved that individuals with dyslexia may present quite common impairments in all categories of literacy development like reading, writing and spelling (Peters & Ansari, 2019). However, there are studies that have found opposite findings. For example, in the study of Snowling (2008), there were children with dyslexia that did not present only phonological deficits but difficulties in other skills such as attention deficits. In this research, she used simple choice reaction time and two visual scanning tasks in which dyslexic children performed similarly to peers proving that only phonological deficits are insufficient to be considered the main cause of literacy difficulties. In another between-group study, such as in Bartelet et al. (2014), focus was placed on children with dyscalculia. They recruited 226 children with dyscalculia and administered number-specific and general cognitive measures to investigate the relation of mathematic achievements and number processing skills. Based on the analysis, the researchers found that non-symbolic number processing skills were not related to arithmetic achievement level while symbolic number processing efficiency was found to be a significant predictor.

However, apart from the heterogeneity of their causes, these disorders have no clear boundaries and often overlap with each other. These disorders present a comorbidity, not only with each other, but with other Specific Developmental Disorders (Cantwell & Baker, 1987) causing exceptional difficulty in isolating symptoms and accurately classifying them by the diagnosis. For example, students with a learning disorder in one domain such as in comprehension may present difficulties in another domain (e.g. dyslexia). This co-occurrence seems to be quite high as observed in the study of Landerl and Moll (2010). Specifically, tests for reading, spelling and arithmetic were used and in combination with a questionnaire for families, they found co-occurrence rates of

arithmetic and reading difficulties. These studies strengthen the idea that learning disorders could not be limited to core deficits reflecting isolated brain regions only (Peters & Ansari, 2019).

Taking the above into consideration, recently, the terms learning disorder and dyslexia are used interchangeably and synonymously (Pumfey & Reason, 1991; Miles, 1995), while in other resources it is stated that ‘specific learning difficulties are an umbrella term for a range of learning difficulties of which ‘dyslexia’ is one variant’ (Barbara Riddick, 1996) as both of these disorders are due to impairments in the linguistic system. This thesis will concentrate on the description and study of Special Reading Disorder, or Dyslexia.

2.2.3. Dyslexia

2.2.3.1. Definition and Classification of Developmental Dyslexia

Dyslexia, or learning disorder with impairment in reading, was recognized by specialists as a specific learning disorder in the last decades of the 19th century and until now important developments have been made in the dyslexia field. The word ‘dyslexia’ has its origin in Greek etymology consisting of the prefix *dys-* which means difficult and the root *lexis* which means word -in other words *difficulty with words*. It was first used, as a word, by Rudolf Berlin, in 1887 (Shaywitz, 2003), but it was first reported in the international literature by Orton (1937). Despite the fact that dyslexia is a widely studied disorder, a lot of hypotheses and theories have been created to describe its origins and nature although as yet there is no concrete definition.

According to Lyon, Shaywitz and Shaywitz (2003), dyslexic children face difficulties with accurate and/or fluent word recognition, poor spelling and abilities in decoding.

They argue that the base of these difficulties typically comes from a deficit in the phonological part of the language, and it is usually not correlated to other cognitive abilities. Moreover, this specific learning difficulty is manifested despite conventional instruction, adequate intelligence and sociocultural opportunity (Zappaterra, 2013).

Another definition which has been widely applied is by the American Psychiatric Association (1994); 'Dyslexia or specific reading disability (SRD) is often defined as a deficit in reading and spelling despite adequate intelligence and access to conventional instruction.'

The above definitions attempted not only to describe but to also explain this reading disorder and they are considered the most representative ones in the chaos surrounding the attribution of a satisfactory and acceptable definition of dyslexia. On the other hand, from an educational and psychological perspective, definitions of dyslexia given from time to time are not based on any causal hypothesis. They state, however, that there must be a significant correlation deficit between children's manifested performance at school and the corresponding ability of the child (Snowling, 1987).

Generally, disorders can be characterized as 'acquired' or 'developmental'. While acquired dyslexia involves damage of reading systems that were functioning normally before a brain injury, people with developmental dyslexia fail to acquire regular language skills. Developmental dyslexia, which is the type of dyslexia on which this study focuses, is characterized by specific impairment of reading and spelling ability and can be detected in people with an average or above average IQ, normal sensory acuity and experience of educational instruction (World Health Organization, 1993).

It is interesting to note that some fields argue that dyslexia has many 'faces', which means that each individual faces different difficulties to different degrees. The symptoms of a dyslexic child are varied such as difficulties in reading, writing, correct language, in short and long term memory, coordination, difficulties in organization, in the process of receiving information and phonological difficulties (Peer & Reid, 2003). Nevertheless, it is not necessary for all the symptoms to coexist to characterize a person as dyslexic, but it is not enough either for a single symptom to justify the characterization (Porpodas, 1997).

Moreover, another characteristic of dyslexia is that there is differentiation between low performance and intelligence/ educational level (Vellutino, Fletcher, Snowling & Scanlon, 2004). This kind of disorder with average or above average intelligence is independent of general cognitive level as it is mainly focused on language acquisition impairments. Moreover, apart from difficulty in reading and writing, individuals with low intelligence facedifficulty in coordination and information retrieval process (Stasinios, 1999). For example, indicative symptoms such as movement or motor control (e.g., tying shoelaces) and deficit in organizing information of learning have been found to be significantly related (Reid, Szczerbinski, Iskierka-Kasperek & Hansen, 2007). Moreover, attention and hearing are functions which may present a deficit. According to Petkov, O'connor, Benmoshe, Baynes and Sutter (2005), attentional control mechanisms seem to be impaired, and dyslexics facedifficulties in focusing and corresponding what they hear with what is written in a text. Furthermore, poor alphabetic knowledge is another distinctive element that is characteristic of dyslexics as they find it difficult to substitute the grapheme- phoneme correspondence (Rack, Snowling, & Olson, 1992). Last but not least, regarding working memory, while dyslexics are processing the phoneme-grapheme, the procedure is superficial, resulting

in no correlations and links between spelling representations of the words (Caravolas, Hulme & Snowling, 2001). This results in them not being able to use this information when they need it.

One of the most important factors of reading difficulties is language processing. In the case of dyslexia, although individuals facedifficulties in a variety of reading skills, there are also mainly deficits in the areas of auditory- phonological and visual- orthographic processing which are discussed in the following sections. The lack of phonological awareness, knowledge and use of language phonemes is considered to be the most powerful predictor of reading difficulties.

2.2.4. Phonological awareness

In the dyslexia domain, a lot of researchers have argued that the underlying cause is difficulty with phonological processing (Anthony & Francis, 2005; Liberman, 1973; Stanovich, 1988; Snowling, 2000). In particular, there are three phonological processing abilities: phonological memory, phonological access and phonological awareness.

Regarding the last term, there are numerous definitions, each with quite well-developed theoretical background and empirical support. According to Anthony and Francis (2005), phonological awareness is related to the level of sensitivity to the sound structure of oral language. It refers to auditory discrimination, that is the ability to manipulate and discriminate between phonemes.

This single unified ability was tested by Schatschneider, Francis, Foorman and Fletcher (1999) with the aim to examine the nature of phonological awareness. Their research included various tasks such as tests about blending onset and rime, blending phonemes into words, blending phonemes into nonwords, phoneme elision, phoneme

segmentation, sound categorization and sound comparison. Their findings and measures were strongly related to other studies and highlighted the role of phonological awareness to reading performance. Interestingly, they also argued that phonological awareness is a factor which varies according to age and level of literacy experience.

Indeed, in some longitudinal studies (Bowey, 2005; Ehri et al., 2001), phonological awareness is an important factor of learning to read in typically developing children. In the study of Ehri et al. (2001), they evaluated 52 studies and they found that phonological awareness instructions had a significant impact on the development of an individual's reading skills and spelling. In the first grades of school, it has been noticed that there is a stable relationship between phonological awareness and word reading efficiency (Blachman, 2000; Hogan, Catts, & Little, 2005). According to these findings, children should have a basic level of phonological awareness to be able to learn reading (Bruck, 1992).

Moreover, phonological awareness is a factor which contributes to reading achievement universally in young readers, across orthographies (Goswami et al., 2010). In particular, transparent and non-transparent languages can affect the relation of phonological awareness and reading efficiency (Georgiou, Parrila, & Papadopoulos, 2008). Examining both Greek and English participants, Georgiou et al. (2008) found that each phonological and orthographic processing affected reading ability differently. Difficulties with phonological awareness can manifest at the level of syllabic knowledge (the ability to identify and manipulate syllables) and phonemic knowledge (the ability to divide words into sounds, and to differentiate and manipulate sounds).

Findings from research of Howard and Best (1996) and Stuart and Masterson (1992) confirm the existence of a close relationship between deficits in phonological awareness

and dyslexia. Other findings are provided by the study of Ehri et al.'s (2001) and their results regarding at-risk disabled readers. In their quantitative meta-analysis, they found that although the phonological awareness instructions helped children to improve their reading, children did not present significant improvement in spelling. This is again indicative of the deficit element of individuals with learning difficulty in phonological awareness. Poor phonological awareness skills can work as a predictor of poor reading and spelling development. In other words, in the case of dyslexic children, the degree of phonological awareness can differentiate good from poor readers. For example, in studies such as Bruck and Treiman (1990) and Olson, Wise, Connors and Rack (1990), it was found that since children with dyslexia had deficit in the phonological awareness, their performance was not only poorer than a normal reader's at the same age but also poorer than younger normal readers' who have the same reading level. Nowadays, there are studies (Ramus, 2003; Lyon et al., 2003; Fawcett & Nicolson, 1995) that enhance the idea of a relation between deficits in phonological awareness of dyslexics and their disability in reading (Swan & Goswami, 1997a).

2.2.5. Causes and origins: theories and hypotheses

The nature and features that generate dyslexia are maybe the part that fascinates researchers the most. There are several different schools of thought as dyslexia has mostly been attributed to deficiencies in different fields such as visual, linguistic, auditory and low-level sensory functions (Vellutino, Fletcher, Snowling, Scanlon, 2004).

2.2.5.1 The Phonological Deficit Theory

One of the most predominant theoretical explanations of dyslexia is the ‘Phonological Deficit Theory’, which was strongly defended and outlined by a lot of researchers such as Fowler (1991), Snowling (2000), Stanovich (1988), and Vellutino (1977).

For many years, it was believed that the main cause of developmental dyslexia is based on a phonological deficit. One of the earliest research projects related to phonological processing came from a case study by Temple & Marshall (1983). A 17-year-old girl, who was a very poor reader, presented efficiency with reading and spelling of irregular words but severe difficulty with phonological processing. The symptoms of the child are now considered characteristics of developmental dyslexia (e.g., impaired ability of reading non-words).

This theory is focused on difficulties that are mostly found in tasks requiring phonological awareness. In other words, it deals with deficits in representation, storage and/or retrieval of speech sounds (phonemes), which has consequences on the grapheme/phoneme correspondences (syllables) (Ramus, 2004). Having this deficit, dyslexic people face difficulties in maintaining and recalling phonological information into working memory, syllable counting or lexical retrieval. Moreover, further evidence has been found in the field of neuroscience as the phonological deficit is associated to alternations in the left-hemisphere language system (Demonet, Taylor, & Chaix, 2004). Specifically, studies have shown that there are abnormal responses in the left inferior frontal region with high activation, the left parietal-temporal regions and the left inferior temporal-occipital regions with lower activation during reading and phonological tasks (Demonet et al., 2004; Hoeft et al., 2006; Shaywitz & Shaywitz, 2005).

In particular, Fawcett and Nicolson (1995) tested three groups of children 8, 13, 17 years old in tasks about sound categorization and phoneme deletion. The results indicated that dyslexics performed less significantly, showing impaired working memory and overall deficit in phonological awareness skills even across adolescence. The evidence of this hypothesis is so strong that Stanovich (1986) proposed that dyslexia should be defined as a core phonological deficit.

Although the phonological deficit theory is considered the most widely referenced explanation for dyslexia and has been predominant for around 20 years, controversy still exists since there are dyslexic individuals who do not present difficulties in phonological processing. Moreover, according to this model, phonological deficit is considered as the only cause of dyslexia, and it lacks explanation regarding the other linguistic difficulties such as fast naming tasks and tasks in vocabulary, grammar and comprehension. For this reason, Kitzen (2001) highlighted the necessity to extend this theory including the prosodic aspects of phonology. Last, according to Ramus (2003) evidence have emerged for auditory or visual impairments providing support to sensimotor theories.

2.2.5.2. The Magnocellular Deficit Theory

However, it is still questionable whether the phonological deficit can explain all of the issues around dyslexia. Some characteristics of dyslexia are clumsiness, temporal sequencing difficulties and poor spatial awareness, which cannot be correlated with phonological processing (Stein & Walsh, 1997). Specifically, Stein and Walsh (1997) proposed the magnocellular theory, which deals with visual processing and the visual magnocellular system. The visual system consists of the magnocellular pathway which is responsible for the quick input transmission from the retina to the occipital and

parietal brain regions, and the parvocellular which processes the information of this input (Greatrex & Drasdo, 1995).

In their research, Stein & Walsh (1997) found evidence that a general deficit of magnocellular pathway may lead to phonological, visual and motor deficits. Originally, the first explanation of dyslexia was a vision-based theory regarding typically developing students that were facing difficulty in acquiring advanced literacy skills (Kussmaul, 1878). These visual deficits have since been included in the hypothesis of the magnocellular theory. In this way, by testing sensitivity of visual contrast especially with monitoring the eye movements, Stein and Walsh (1997) suggested that dyslexic individuals have a deficit in the magnocellular pathway.

The proponents of this theory therefore argue that reading problems are a result of impaired development of a system including large neurones in the brain (magnocells), which deals with timing sensory and motor events (Stein, Talcott, & Witton, 2001). To add further validity to the theory, Schulte-Korne, Deimel, and Remschmidt (2003) examined dyslexic children against a control group using a motion-onset visual. They found significant amplitude in the dyslexic group compared with the control group and confirmed that the processing of moving stimuli is impaired in dyslexics.

Thus, the magnocellular deficit can be attributed more efficiently to visual rather than phonological deficit. According to this theory, individuals with dyslexia are differentiated from individuals without dyslexia as they have reduced sensitivity of spatial contrasts under specific conditions, present shorter duration of visual persistence at frequencies of high spatial and show reduction in sensitivity of coherent motion (Talcott, Hansen, Assoku & Stein, 2000). In comparing the above theories, Morton and Firth (1995) argued that they are compatible to each other and not exclusive as

theoretical explanations should not be promoted to a specific level of framework (Kuerten et al., 2020).

In developing the magnocellular theory, it was argued that the theory can be extended including the auditory processing system (Stein & Talcott, 1999). Auditory processing does not have a separate magnocellular system which means that it is possible for auditory sequencing skills to be slightly impaired since individuals with dyslexia show deficit in the magnocellular pathway. Moreover, apart from the visual and auditory deficit, the magnocellular theory supports evidence to the cerebellar deficit of dyslexic individuals (Stein, 2001). Since the cerebellum receives information from the magnocellular system, the cerebellum could be affected by a magnocellular dysfunction.

2.2.5.3. The Cerebellar Deficit Theory (Automatization Deficit Hypothesis)

The Cerebellar Deficit Theory was proposed by Nicolson, Fawcett and Dean (1995) and offers a theoretical explanation not only about phonological and visual deficits but also about a number of impairments manifested by dyslexic individuals. According to the proponents of this theory, dyslexics have difficulty in skill automatization such as balance, dexterity and other motor abilities, reading and implicit learning. These manifestations are the consequence of a deficit in the cerebellum; an area in the brain which is responsible for automatization in motor skills, fluency and, in general, attention and language (Nicolson & Fawcett, 2008; Stein & Glickstein, 1992). In particular, individuals with dyslexia, due to a dysfunction of the cerebellum, fail to fully develop automaticity in their reading skills. This dysfunction has been also reported in studies with brain image and found reduced activation confirming the magnocellular deficit also affects the cerebellum (Nicolson et al., 1999; Rae et al., 1998).

During the last decades, the belief that the cerebellum could participate in cognitive skills, especially in language processing, has been highly supported (Fabbro, & Moretti, Bava, 2000; Justus & Ivry, 2001; Marien, Engelbotghs, Fabbro, & De Deyn, 2001). Rae, Lee, Dixon, Blamire et al. (1998) found biochemical differences in the cerebellum of dyslexic men than the controls, and suggested that it is strongly connected with dyslexia. Moreover, recent brain imaging research has provided further information about this belief as researchers detected activation in the cerebellum area during administration of reading tasks (e.g., Mechelli, Gorno-Tempini, & Price, 2003).

On the other hand, the opponents of this hypothesis posed questions regarding the fact that patients with cerebellar damage do not present difficulties in reading (Moretti et al., 2002). In general, magnocellular and cerebellar theory cover different areas than just the phonological deficit. It is interesting that both theories consider dyslexia not just a reading deficit but a blend of varied difficulties requiring theoretical explanation.

2.2.5.4. The Visual Deficit Theory

Another theory on dyslexia was presented by Lovegrove, Bowling, Badcock and Blackwood (1980). In particular, according to their study, dyslexia deals with the visual aspect of reading tasks but it also includes the element of phonological impairment. In their research, they tested normal and disabled readers using short stimulus duration and showed that participants with reading difficulties differ in the level that spatial frequencies were sensitive. This theory fuelled the magnocellular theory and further argued that the eye movements of dyslexic individuals are different from normally developed individuals as they are less harmonic and regular. However, other researchers state that this may happen as a result of difficulties with text comprehension (Nijakowska, 2010).

This was proven inaccurate by a study by Vellutino et al., (2004) at the University of Albany. He asked dyslexic and non-dyslexic American students to reproduce a series of Hebrew letters that none of them had ever seen before. The dyslexic students were able to perform the task just as accurately as the non-dyslexic students, showing that their dyslexia did not affect their eyesight.

2.2.5.5. The Double Deficit Hypothesis

Researchers have argued that the difficulties faced by dyslexics are not exclusive in nature and are mostly associated with a phonological deficit (Lovett, Steinbach, & Frijters, 2000; Wimmer, Mayringer, & Landerl, 2000; Wolf & Bowers, 2000). For that reason, the double deficit hypothesis, which was first proposed by Wolf, Bowers and Biddle (2000), recognized a deficit in rapid serial/ automatized naming (RAN) apart from the role of phonological processing skills. In particular, this framework acknowledges that dyslexics may have a particular deficit in one of those skills or double deficit in both of these skills. The phonological deficit and the naming speed deficit are two separate sources of reading deficit; the phonological deficit is related to decoding accuracy and the naming-speed deficit is associated with reading fluency.

Researchers have found some evidence for the support of this theory. More precisely, naming speed tasks have been found to represent unique variance (Manis, Doi, & Bhadha, 2000). Moreover, children who have been categorized into single or double deficit subgroups, tend to have worse results than children presenting non deficit of separate measures of reading achievement. In the research of Manis, Doi, & Bhadha (2000) the group with the double deficit performed worse than the single deficit groups. Finally, in the cluster analysis by Morris et al. (1998) on reading disabled populations, subgroups of the types that are specified according to the double deficit theory were found. The researchers also evidenced that double deficit groups were more impaired

than single deficit groups. However, a significant implication is that single naming-speed deficit requires training that is not solely based on phonological skills especially for transparent languages such as Greek and Italian (Nijakowska, 2010).

2.2.5.6. Neurobiological factors

There is general consensus according to which developmental dyslexia is a disorder by neurobiological origin with difficulties specifically in reading and writing skills (Cook & Ryan, 2016). One of the earliest investigations was conducted by Norman Geschwind, an American neurologist, who performed neuroanatomical analysis of the brain of individuals with dyslexia and confirmed the existence of a left-right hemisphere asymmetry. He found 'insufficient amount of brain tissues' in the left hemisphere, which is known to be related to language processing. Geschwind's proposal was further investigated by Galaburda et al. (1985).

Having in mind that dyslexia is considered a disorder of neurobiological origin, researchers have focused on the differences in the neurobiological level among dyslexics and typically developed individuals. Regarding genetics, there is evidence that a number of inherited genes (such as *DYX1C1* and *DCDC2*) may have a significant role to play in the development of dyslexia (Fisher & DeFries, 2002; Fisher & Francks, 2006). Moreover, dyslexia is considered a congenital neurobiological disorder which may be due to abnormal brain structure, for example abnormal magnocellular pathways or abnormal cerebellum (Shastri, 2007).

Unfortunately, in spite of extensive research, these different schools of thought have failed to account for the full range of difficulties established for dyslexic children. Phonological Deficit Hypothesis is the most prominent account, and its concept is based

on the fact that problems in reading can be based on deficit in phonological awareness. The main alternatives of this hypothesis are the Magnocellular Theory, the Cerebellar Theory and the Double Deficit Hypothesis. One common characteristic among these is the decisiveness of phonological deficit. These theories do not contest the role of phonology in the development of dyslexics, but they argue for the existence of a wider range of related parameters. In particular, the Magnocellular Theory and the Cerebellar Theory focus on investigating the visual deficit characterizing dyslexic individuals combining it with the phonological deficit. Their focus is on explaining dyslexia not just as a reading deficit but as a sum of difficulties which need theoretical explanation.

2.2.6. Sensory (visual and auditory) components of dyslexia

Sensory integration and function are two components that are much needed for the functions of cognitive and executive development. Gradually, more and more evidence has been found which suggest visual, auditory, and motor impairments in individuals with dyslexia. These are summarised in what follows.

2.2.6.1. Visual deficit in dyslexia

The relation between dyslexia and a visual deficit has been argued as early as dyslexia was discovered since researchers thought that dyslexia was a hereditary deficit particularly affecting the visual processing of letters and words. More precisely, in 1878, Adolf Kussmaul introduced this learning disorder as ‘word blindness’. A few years later, Pringle Morgan presented his case of ‘congenital word blindness’ in which a boy called ‘Percy’ was unable to learn to read despite his high level of intelligence. However, after the revolutionary theory of Chomsky about the concept of recursive phonology (Chomsky, 1957), dyslexia started to be considered as a linguistic phonological problem.

Based on these views, more and more studies found a relationship between dyslexia and impairment in visual processing. Current research shows that in a small percentage of children (5-10%), the visual processing of written speech is slowed down (Kotsopoulos, 2005). Moreover, Rutter (1978) argues that there is a relationship between a particular type of movement of eyesight and reading ability, which is not different from the standard relation that eyesight difficulties will lead to reading disabilities. In other writings, dyslexia is attributed to a weakness of visual perception of the concepts of succession, direction and orientation (Benton, 1975). Based on these views, visual processing has been found to be linked to dyslexia by multiple ways.

Specifically, one of the first instances where the visual element is apparent in dyslexia is in theories that are trying to categorize the different types of dyslexia. Johnson and Mykelbust (1962) had proposed a type of dyslexia called visual dyslexia, which refers to a difficulty in learning mainly through visual function (Porpodas, 1997) and which has little to do with the sight of the individual alone. It is characterized by deficits in visual perception, visual discrimination and visual memory (Stasinou, 1999). In particular, people with visual dyslexia have difficulty in distinguishing words or letters that are visually similar or mirror correspondence and confuse the understanding of written symbols. For example, a characteristic of visual dyslexia is that these individuals present difficulty reading the words "totally".

Apart from the categorization of different types of dyslexia, the presence of visual processing in dyslexia is detected in theories that have been developed to explain developmental dyslexia. Nowadays, the attention of research has been focused to whether a visual deficit may be the cause of dyslexia or to what extent visual affect the phonological deficit (Ramus, 2003). Specifically, Stein (2018) pioneered the magnocellular visual impaired function and according to his research, reading process

comes with accurate and fast visual identification of words. Apart from the magnocellular deficit theory, other theories such as the cerebellar theory and the visual deficit theory are giving responsibilities to the visual aspect. Both these studies, add eye movements and other visual aspects to the explanation of the nature of dyslexia. Considering Stein (2001), the visual system is imperative in reading, and dyslexia is the outcome of deficits in the neural pathways of this system.

Moreover, another area that seems to be influenced in individuals with dyslexia is the visuo-spatial attention. Studies have reported some visual attention impairments in dyslexic students (Ackerman, Dykman & Gardner, 1990; August & Garfinkel, 1990), which means that some attentional deficits may account for dyslexia. In particular, a 'spatial cueing' deficit may be the cause of dyslexia (Facoetti et al., 2003). In their research, Casco, Tressoldi and Dellantonio (1998) found that students who performed the lowest in searching a target letter in a set, showed significantly slower reading rates and higher number of visual errors compared to students who performed well.

Furthermore, an area that is also related to visual impairments in individuals with dyslexia is visual stress. When the ability to detect visual stimuli is reduced, this results to visual stress, a visual discomfort during reading. This condition could be considered a possible cause of reading difficulty as well. In particular, dyslexics present various symptoms of visual stress like headaches, eye strain, difficulty to remember what has been read, poor concentration, omission of words and lines during reading. This condition which consists of a cluster of symptoms, has been attributed to multiple cortical neurological mechanisms (Wilkins et al., 1984). In the study of Robinson and Conway (2000), they conducted a small-scale investigation and discovered the effects of Irlen filters in people who had undergone visual stress. Last, Singleton and Trotter (2005) found that based on their evidence, students who have high levels of visual stress

are more likely to improve their reading speed with optimal color than students who do not have dyslexia. Concluding, the above studies confirm the arguments, indicating deficits in the visual system of individuals, have been the most common and influential theories of dyslexia, even before the turn of the century (Vellutino et al., 2004).

2.2.6.2. Auditory deficit in dyslexia

Since speech is considered an acoustic signal, auditory deficit could be a ‘parsimonious’ cause of the deficit in phonological processing in dyslexics. Specifically, in the womb, sensitivity to rhythm in speech is present and newborns can distinguish languages of different rhythm categories as well as awareness of phonetic information is already present after birth (Goswami, 2015). Therefore, deficits to utilize ‘the acoustic structure of the speech stream should have consequences for phonological processing’ (Goswami, 2015, p.8). The inability to hear and the inability to hear phonograms found in dyslexic students causes problems in analysis as well as in word composition leading to a negative effect on reading performance (Markou, 1996). Various studies and theories have confirmed the existence of auditory deficits in dyslexic individuals (Ramus, 2003).

Specifically, one of the first researchers who examined auditory processing was Tallal (1980). In this study, she used an auditory temporal order judgement (TOJ) task and showed that children with dyslexia required more time to detect the correct order of three tones than the control group. Other studies have used the repetition test (De Martino, Espesser, Rey, & Habib, 2001; Rey, De Martino, Espesser, & Habib, 2002) and found poorer performance among dyslexic individuals compared to the control group.

Stein (2018) states that some children do not appear to have a visual problem, but their difficulties seem to be mostly auditory. Similar to visual dyslexia, Johnson and Myklebust (1962) had proposed a type of dyslexia called acoustic dyslexia. Acoustic dyslexia is characterized by a deficit of the individual to represent in the mind the distinct sounds of the spoken language, to use phonetic rules, to decode unknown words, to proceed in a mixture of sounds, to name people and things and to keep the acoustics sequence (Stasinos, 1999). The child in this category has difficulty analyzing words on a syllabic basis and in the synthesis of syllabic acoustic units in dictionary sets with conceptual content (Porpodas, 1997). Because the child with auditory dyslexia cannot recognize small differences between sounds, which correspond to vowels or consonants, it is not able to associate sounds with their corresponding written symbols (Stasinos, 1999).

Apart from the categorization of different types of dyslexia, the presence of auditory processing in dyslexia is detected in theories that have been developed to explain developmental dyslexia. The probability that auditory perceptual processing is impaired in childhood gives evidence for the phonological deficit theory according to longitudinal studies (e.g. Boets et al., 2011; Goswami, et al., 2011; White et al., 2006). Moreover, the double deficit theory proposed by Wimmer, Mayringer, and Landerl (2000) provides support to the relationship between auditory deficits and developmental dyslexia.

Lastly, studies such as Goswami et al. (2002) and Richardson, Thomson, Scott, and Goswami (2004) demonstrated that auditory perceptual difficulties in children impair their development of high-quality phonological representations and, consequently, literacy. Goswami et al. (2002) reported a deficit in the perceptual experience of rhythmic timing which is linked to dyslexia. In their research, one hundred and one

participants were tested on a battery of tasks about auditory and phonological processing. They found a significant difference between normally reading children and students with dyslexia in amplitude envelope onsets which affect suprasegmental attributes of the speech vowels.

Concluding, as reading requires visual sequencing of letters in a word which is written, it also requires auditory sequencing of the phonemes of a spoken word. However, speech is quite complex and our knowledge and understanding of the neural processing of speech is not yet complete.

2.2.7. Lexical Stress

2.2.7.1. The role of lexical stress

Segmental phonology in dyslexia is widely investigated (for example, through the phonological awareness hypothesis like Snowling (2000) and Vellutino (1979)). On the other hand, on suprasegmental phonology, very little research has been conducted. The term suprasegmental refers to prosody and its features such as stress, intonation and rhythm. In particular, reading with sufficient prosody facilitates the reading process by applying the appropriate intonation and stress ability (Whalley & Hansen, 2006). Regarding stress, in stress-languages, the syllables of multisyllabic words are not equal. Some of the syllables may be more accentual prominent and others may not. This results in one syllable being different in the phonological representation as well as in the acoustic instantiation (Whalley & Hansen, 2006).

Fluctuations in certain acoustic properties of the speech signal are apparent and are correlated with stress. These properties are amplitude, duration, intensity and fundamental frequency (F0). In other words, variations along these acoustic dimensions

are perceived as differences in loudness, length and pitch, and in this way stressed syllables appear to be louder, longer, and higher in pitch than unstressed syllables (Fry, 1955; 1958). Although these variations are not significant in every language, most studies opt for a combination of these acoustic cues (Ball & Müller, 2005).

Recent theories suggest the role of stress in general prosodic sensitivity in the phonological development (Pierrehumbert, 2003). Vihman and Croft (2007), in reviewing previous studies of both children and adults, argued that in the earlier stages of phonological learning, word shapes characterized by prosodic features are being developed. The individual acquires a wider variety of structures by the adult input and their own babbling, resulting in an adult template model of phonological representation. It is apparent that stress pattern is used in a really early stage of life. Using infants soon after birth, Kuhl (2004) found that they use rhythmic stress patterning to separate the speech stream into words and syllables.

2.2.7.2. Stress pattern and phonological awareness

To successfully acquire reading, children need to learn letters (graphemes) and sounds (phonemes) correspondence. In the latter, the prosody and, as a consequence, the stress pattern is included. For this reason, phonological awareness is necessary as readers should learn to map symbols and decode them into words in order to read and spell efficiently. But what is the exact relation between stress and phonological awareness? Regarding this question, few studies have been conducted and the opinions are controversial as the studies are not conclusive.

In particular, Goswami, Gerson and Astruc (2010) focused on rise time of speech rhythm and argued that this skill is crucial for the creation of phonological representations. In their research, they created a purely auditory task in which as the

rise time of the sound was becoming sharper, it was more possible for participants to detect a beat. They also found that beat could explain differences in phonological awareness of individuals after controlling variables such as age, vocabulary and IQ. In this way, finding a correlation between beat detection and deficit in phonological representations of dyslexics indicates poor prosodic sensitivity.

However, it is possible that linguistic rhythm (metrical stress and lexical stress) and nonlinguistic rhythm have a different function impacting differently on reading and phonological awareness. Specifically, Goodman, Libenson and Wade-Woolley (2010) tested preschoolers and how stress sensitivity can affect reading development and phonological awareness. In particular, they created different tasks for both metrical and stress sensitivity and found that only lexical stress is significantly related to these two factors that they examined. They agreed with Goswami et al. (2010) that lexical stress sensitivity explains differences in phonological awareness. Though, as far as early reading ability is concerned, once they controlled for phonological awareness, lexical stress could not predict it.

Regarding metrical stress, Wood and Terrell (1998) found that poor readers were less sensitive to metrical stress than the control group who were of the same age. Schoolchildren in elementary school heard a sentence with removed phonemic components but with maintained prosodic element. In the second phase, children listened to two clear, normal sentences and were asked to decide which of the two clear sentences was most similar with the first sentence. Additionally, in this research, metrical stress was correlated with phonological awareness. The results indicated that participants presented a delay in the development of rhythmic awareness. Furthermore, Holliman, Wood and Sheehy (2012) included in their study the relation between

prosodic sensitivity and phonological awareness and found that there was a significant correlation between the two.

Moreover, in a study regarding Spanish developmental dyslexia, Jimenez-Fernández, Gutiérrez-Palma and Defior (2015) found a correlation between stress impairment and phonemic awareness deficit. They used stress tasks including both words and pseudowords. They found that while using phonemic awareness as a covariate, the difference between the groups vanished in words. However, this did not happen in the pseudowords where lexical knowledge was not required.

Finding that stress sensitivity differentiates individuals' phonological awareness indicates the crucial relation between these two factors. On the other hand, there is research that revealed different results. For example, in the research of Wood (2006), children were tested on identifying a word that although the stress naturally is placed on the first syllable, it was suited on the second syllable of the word. In his findings, lexical stress was significant for spelling, reading and letter-sound correspondence. However, once vocabulary and age were controlled, lexical stress sensitivity was accounted only for spelling. Perhaps the outcome was such because of the small sample size and the large range in the factor of age ($SD= 10.51$). Holliman, Wood and Sheehy (2005) used a different and smaller age range. They found that lexical stress sensitivity accounted for phonological awareness after they tested 5-6 year old and controlling for vocabulary and age. They argued that in the case of high levels of stress sensitivity, children had better results in reading ability.

In conclusion, there is a variance in the explanations. Having in mind that the phonological information, that words provide, has to be represented neurally, the role of stress should be crucial for the development of well-structured representations. The

study of Goodman, Libenson et al. (2010) provides further support for the question about the early development of stress sensitivity. It is possible to be a factor that contributes to the complexity of phonological awareness. Tilanus, Segers and Verhoeven (2013) argued that phonological awareness skills and especially skills of phonemic awareness are the factors that favour the words' representation the most. However, as far as the dyslexic population is concerned, the deficit of phonemic awareness is the one which can be linked to the development of poor representations (Swan & Goswami, 1997) which typically developing children are possible to have fully employed for accomplishing the words tasks successfully. Nevertheless, stress is a tool for phonological awareness but the role of stress pattern in the development of reading is still unknown (Paizi, Zoccolotti & Burani, 2011).

2.2.7.3. Stress pattern and developmental dyslexia - Relevant Studies

Having discussed the relation between phonological awareness and stress pattern, another question arises. What is the effect of developmental dyslexia in this relationship? Despite the crucial role of prosodic patterning in language acquisition, little attention has been given to the role of suprasegmental phonology in developmental dyslexia. In particular, a dyslexic individual who faces phonological difficulties can present impaired sensitivity to stress and rhythmic patterning such as in phonological segments like syllables, rimes and phonemes. Moreover, having in mind that lexical stress is necessary for the accomplishment of correct pronunciation, a difference may arise between transparent and non-transparent orthographies. For this reason, it is interesting to notice this difference regarding stress patterns and what effect it might have on various language skills.

Regarding nontransparent languages, most of the research has been conducted in the English language. In particular, Leong, Hämäläinen, Soltész and Goswami (2011),

examining the area of stress perception, added rise time to the game. They tested 40 adults designing a stress perception task with 4 syllable words with stress in the first syllable or in the second syllable. In these, they had to judge if they are the same or different. They also measured phonological awareness, auditory perception of rise time and others. The results indicated that dyslexics performed worse in the task than the control group, highlighting the deficit in stress sensitivity. They showed difficulty in same languages with different stress which, according to the researchers, indicates the existence of an auditory difficulty with stress perception. This difficulty was related with sensitivity to amplitude envelope rise time, which was unique for each participant and evolved throughout development.

After some years, in expanding the previous study, Goswami, Mead, Fosker, Huss, Barnes & Leong (2013) used a different task to examine the same topic, the Deedee task, and they tested different groups of dyslexics. Kitzen (2001) adapted first this task which was used before in aphasia studies for the dyslexia field. In reiterant speech, every syllable of the word is converted into the same syllable by removing phonetic information and retaining the rhythm and stress. For his task, Kitzen used film and story titles and he found that dyslexic participants performed significantly poorer in the task than the control group. In the research of Goswami et al., (2013), they used children aged 9 and 13 years as participants and they conducted a longitudinal study by applying the Deedee task and a stress perception task. They found that dyslexics performed more poorly than individuals without dyslexia at the age of 7. The results also showed that in the age of 9 the dyslexic group performed more poorly in stress perception than reading-level and age-matched group. In the age of 13, they presented impaired sensitivity only regarding the age- matched group. However, this task is about the perception and not how students would perform in a stress task.

On the other hand, research on stress assignment has not focused on phonologically predictable languages. Most studies have focused on English-speaking populations and the question that arises is what happens with the other languages? As noted earlier, it is possible to identify developmental dyslexia in transparent orthographies in applying stress when reading words aloud. In general, stress regularization errors in acquired as well as in developmental dyslexia have been observed in different languages. Transparent languages are those languages which have one-to-one relation between form and meaning, such as Greek, Spanish, Italian and Filipino, contrary to English which is non-transparent.

In particular, Jiménez-Fernández et al. (2015) created a stimulus to test the level of stress awareness in Spanish dyslexics and to what level phonological awareness plays a specific role. Their experiment included two tasks with words and non-words to test 31 dyslexic and 31 non-dyslexic children on reading with varying words. The results indicated that children show impaired sensitivity to stress awareness, possibly because of the phonemic awareness. In particular, examples from Spanish suggest that the stress is particularly free and usually falls on the last three syllables.

Greek is a transparent language, and the pattern is different from English. Evidence of impaired stress awareness has been found in some other transparent languages such as Italian and Filipino, where the exceptions of the stress assignment are not marked in the orthography. Italian differentiates from Greek language as Italian can be characterized as a language with a very good level of grapheme-phoneme correspondence. The stress is located on the penultimate syllable and rarely in antepenultimate syllables. In their study, Paizi, Zoccolotti and Burani (2011) took into account the frequency of words as a factor. Children at the age of 11.6 were tested and researchers found that children made more regularization errors on no high frequency

words. Moreover, they found that words which present similarities with other words regarding the stress pattern were read more correctly than those with not so many words with similar stress pattern. They concluded that both typical and non-typical readers are sensitive to the properties of language.

Regarding Filipino language, Dulay and Hanley (2015) conducted a case study examining stress pattern in developmental dyslexia. Regarding Filipino stress pattern, stress falls on the penultimate syllable of multisyllabic words. In this research, they tested a student of grade 5 aged 11 years on reading task with typical and atypical words including both high and low frequency words and on a task with nonword reading. They found that the participant stressed typical words just as the control group but made stress errors reading atypical words. On nonword reading, he presented no impairment and in general his reading speed was significantly slow. Therefore, he did not present phonological impairment, but they confirmed that this was a clear example of developmental surface dyslexia.

As Holliman, Wood, and Sheehy (2008) have asserted, it is important to examine prosodic processing in different orthographic systems, since the specific features of each system may show different patterns of results. Nevertheless, most of the studies regard stress sensitivity and its correlation with developmental dyslexia (Goswami et al., 2013) and not stress assignment during reading. For this reason, this study focuses on the Greek language to examine this matter as it is language with uncommon grammatical particularities.

2.2.8. Developmental dyslexia in Greek

2.2.8.1. Greek Language and lexical stress

In contrast with other languages, Greek is simpler in phonotactic structure and is quite consistent on orthography and phonology mapping (Douklias et al., 2009). In particular, the most common syllable structure is the open consonant-vowel (CV) (Zachos, 1991) and the majority of Greek words are multisyllabic as they include a lot of derivational and inflectional affixes.

Moreover, contrary to English, the Greek language is categorized as a transparent language and is one of the few languages that include a diacritic mark indicating the right position of the lexical stress in every word. As far as the stress pattern is concerned, every word of two or more syllables carries stress on a single syllable which protrudes phonologically and phonetically. Since Greek has only a few single-syllable content words (2.5% of tokens; Protopapas & Vlahou, 2009), stress pattern concerns most of the written and spoken words. There are no specific rules except the fact that stress must fall on one of the last three syllables in a word and not before. Moreover, the position of the stress in every word is morphologically determined and cannot be predicted phonologically (Arvaniti, 2007). Stress plays a critical role in Greek: it carries a significant functional load, to a greater extent than stress in English, since there are many pairs and even triplets of words that are only distinguished by stress location (Arvaniti, 2007). In many cases, these pairs and triplets are semantically unrelated, e.g. ['poli] 'city', [po'li] 'much'. As a matter of fact, stressing a word on the wrong syllable is one of the least tolerated mistakes a non-native speaker can make in Greek (Arvaniti, 2007).

To avoid potential problems during reading, the writing system includes a diacritic mark in the form of a sharp accent in order to highlight the stressed syllable

(Protopapas, Gerakaki, Alexandri, 2007). The position of this diacritic mark is a lexical property which sometimes gets influenced by morphological type. For example, the verb [a'llazo] 'change' in the 1st person of present tense gets ['allaça] 'changed' in the 1st person of simple past tense. It is worth noting that in the case of a word with two and more syllables, if the stress is not included, it can be considered a misspelling. However, this is an issue which is taught at great length during primary school.

Greek language has a long history regarding stress marking. Breathing marks and phonologically inconsequential accenting were used until four decades ago. Still, there is the diacritic mark which each multisyllabic word must have on the vowel of the syllable which is stressed (Petrounias, 2002).

2.2.8.2. Phenomena of Greek developmental dyslexia

As previously mentioned, dyslexia is the difficulty in the acquisition of oral and written speech. The percentages of dyslexia in participants vary in different countries. Regarding Greek percentages, there is a lack of clear data for the official calculation of the frequency of dyslexia based on accurate observations on a pan-Hellenic scale. However, Stasinou (1999) states that it is expected that one to two out of 25 children in a Greek classroom have dyslexia. In Greece, according to a survey conducted in 1998, in 6,644 children of preschool age from five prefectures (Karapetsa & Mitsiou, 1999), the percentage of children with learning disabilities is about 15%. It is widely known that children with dyslexia do not present all the same characteristics and at the same degree of appearance. The symptoms of dyslexia in children are various and can be found in reading, spelling, writing, short and long term memory, organization and coordination (Peer & Reid, 2003).

In particular, Protopapas, Fakou, Drakopoulou, Skaloumbakas and Mouzaki (2012) tried to analyze and classify the most common spelling errors that Greek schoolchildren with and without dyslexia make. In their research, 542 typically developed children and 44 children with dyslexia of grades 3, 4 and 7 participated. For the testing, they used pseudoword repetition, pseudoword reading, word reading, passage reading and comprehension, phoneme deletion, speech sound discrimination and arithmetic. Errors were classified into seven major and thirty-seven minor categories. The major categories were graphophonetic mappings, grammatical types, orthographic word knowledge, and diacritic and punctuation conventions. Regarding the stress diacritic mark, they found that it was omitted at a high rate which supports considering it as a deficit in dyslexic children. As for the other categories, the results were conflicting suggesting further research. The symptoms of dyslexia are varied and refer to the perception, mobility, cognitive development and neurological condition of each individual.

As far as the reading characteristics of dyslexic children are concerned (Propodas, 1997), these are:

- ❖ Slow reading.
- ❖ Difficulties in recognizing letters during ‘first reading’.
- ❖ Spelling, ‘compiler’ reading in the first grade of school.
- ❖ Mechanical and monotonous reading, word-for-word, no rhythm and coloring in the voice.
- ❖ Difficulty in distinguishing different words, which include the same letters e.g. της [tis] – στη [sti], μάτια ([ˈmatia] = eyes) - ματιά([maˈtia] = look).
- ❖ Stress errors

- ❖ Ignoring punctuation. Reading ‘breathless’, without taking in mind the pause in dots or commas.
- ❖ Difficulty in reading and pronouncing polysyllabic or unusual words.
- ❖ Skipping monosyllabic words, especially articles, intentions.
- ❖ Replacement of words with others that have the same or similar meaning e.g. river - water, tree - wood.
- ❖ Word reading by moving and replacing letters eg. άριστος ([ˈaristos] = excellent) – άόριστος ([aˈoristos] = indefinite), μοιάζουν ([ˈmiazu:n] = they look alike)- μοιράζουν ([miˈrazu:n] =they share).
- ❖ Replacement of a word with its semantic opposite eg. white - black, happy - unhappy.
- ❖ Opposite reading of small words, such as αχ [ax] – χα [xa], αν [an] – να [na], πονώ ([poˈno] = ache) – νωπό ([noˈpo] = raw).
- ❖ Wrong pronunciation of letters that are phonologically similar as θ /θ/ - δ /ð/ , β /b/ - φ /f/, γ /j/ - σ /s/, γ /j/ - χ /x/.
- ❖ The dyslexic child faces severe difficulties in their treatment of symbols of the written language.
- ❖ Difficulties in reading comprehension when the child itself is reading. Typically this is because attention is depleted in the decoding of words. Correct and accurate reading with simultaneous ‘sacrifice’ of understanding.

2.2.9. The present study

As previously summarized, several researchers have argued that individuals with developmental dyslexia perform significantly more slowly and less accurately than controls on reading tasks (Tressoldi et al., 2008). Surface and phonological

developmental dyslexics in English have also been observed to differ in their performance on phonological awareness tests that acquire overt sensitivity to the sounds in words. Phonological awareness of a phonological dyslexic is often extremely poor (Campbell & Butterworth, 1985) (For further details, see section 2.2.4.). For this reason, as Douklias, Masterson and Hanely (2009) have suggested, it could therefore be predicted that Greek phonological dyslexics should show impairment on phonological awareness tasks. As there is paucity of research into the further understanding of word reading, the main issue that will be investigated is stress errors. In other languages, although there is stress assignment impairment in reading aloud, there is no mark indicating the correct syllable.

On the other hand, the Greek language includes a diacritic mark highlighting where the stress should be. Nevertheless, Greek dyslexic children face difficulties with the stress pattern. In Greece, the effect of phonological awareness in the development of reading and orthography started in the 1980s. Several studies have concluded that students with dyslexia compared to non-dyslexic peers make more phonological errors, as has been shown in Bourassa and Treiman (2003). Phonological awareness is a necessary skill to recognize the phonological parts of a word and the ability to manipulate and reconstruct these parts is important for an individual so as to isolate phonemes which are the sounds of a word (Panteliadou, 2000). However, while reading, dyslexic students have a lower performance than typical peers.

As was previously discussed, there are various hypotheses regarding the correlation of dyslexia with phonological awareness, visual processing or general auditory processing deficits. In practice, these deficits lead the dyslexic individual to replace or ignore letters and other information of a text. Such information could be the stress indicator in the Greek language. Moreover, Van Wassenhove, Grant and Poeppel (2005) found that

visual speech information speeds up the processing of auditory speech information in the English language. For this reason, the main issue that will be investigated is the stress assignment of dyslexic children and whether it could be affected by a visual deficit (research question 1, 2). This thesis focuses on testing whether after training there will be an improvement in stress errors, which means that indeed there is a visual deficit. The fact that their spelling errors are quantitative and not qualitative leads to the hypothesis that perhaps students with dyslexia may benefit from active teaching methods and that their improvement will be important (Cassar, Treiman, Moats, Pollo, & Kessler, 2005). In the intervention, training with non-linguistic tasks is used including both visual and auditory tasks to examine two different kinds of training.

2.3. Second Language Learning

Knowing only one language is quite rare, nowadays. People around the world call themselves speakers of at least two languages, although the level of acquisition may vary. Indeed, the use of the term 'second language' covers any language other than the primary language acquired by a learner or group from birth (Smith & Candlin, 2014). Specifically, it could involve both 'foreign' languages such as English for Greek learners, and languages which are not considered mother tongues but are spoken widely in the same community such as German in Belgium. Learning a second language can also be conducted in natural settings or through classroom instructions, during childhood or later in adulthood (Krashen, 1982).

The field of language learning has been developed for 40-45 years and since being a complex phenomenon, its research covers a range of topics. Specifically, a large number of studies found that general language skills have a significant effect on the learning of a foreign language (Sparks & Ganschow, 1991). Nevertheless, until

recently, the relation between second language learning and additional needs had been neglected. As such, this diversity is going to be studied in this section as equal and appropriate opportunities should be provided to students with dyslexia (Kormos et al., 2009).

2.3.1. First Language Acquisition and Second Language Learning

First language skills are a first important base for second language learning (Kormos, 2017). In fact, first language proficiency is a crucial indicator for success in second language learning. Language skills of two languages are found to be correlated (Sparks and Ganschow, 1991) and the high level of acquisition of a first language enables the competence of a second language at the same level. A hypothesis which supports this argument is the Linguistic Interdependence Hypothesis by Cummins (1979). According to this, in order for bilingualism to be cognitively beneficial, first language skills should be adequate. In this way, there are characteristics which could determine whether first language skills are an important foundation for second language learning.

First, evidence supports that foreign language aptitude can be related to the level of native language proficiency regarding sound discrimination and grammatical sensitivity (Skehan, 1986). According to Sparks and Ganschow (1991) and their Linguistic Coding Differences Hypothesis, success in second language learning is based on orthographic, syntactic and phonological skills in the mother tongue. More precisely, this theory argues that low achievement in second language can be attributed to the same cognitive reasons with those that explain difficulties in the first language.

Moreover, it is believed that reading skills are more proficient in the language with which individuals are more familiar as these skills are more efficient and automatized in a text of the native language rather than a text in the second language. Studies present

evidence that readers without learning difficulties have faster access to the mental lexicon of the mother tongue rather than the second language (Favreau, Komoda & Segalowitz, 1980; Shimron & Sivan, 1994).

Moreover, studies such as Fillmore (1976), Milon (1974) argue that second language learning has a lot of similarities with first language acquisition, and they argue that structured second language teaching programs including audio lingual materials could be misconceived. Dulay and Burt (1974) have supported this view with studies of error behaviour in L2 learners and found similar developmental sequences in first and second language acquisition, regardless of age, learning method and nature of the first language.

Nevertheless, according to the common underlying process framework (Geva & Ryan, 1993), the reading process of monolingual and bilingual students could be influenced by a group of individual difference variables. Such variable is the phonological decoding process having a crucial role in the reading processing of every language (Perfetti et al., 1992) and being a universal predictor of the level of development in reading. For example, a learner with good phonological decoding skills in English will influence positively the reading of other languages such as Greek, a language with another alphabet. Followingly, failure in foreign language learning can be due to native language deficits. Studies argue that the difficulties of poor second language learners are due to difficulties in native language skills (Ganschow, Sparks & Schneider, 1995).

2.3.2. Differences between Greek and English

2.3.2.1. The Greek language

The Greek language is characterized as phonologically transparent because of the high degree of coherence and regularity. Regarding reading, in the grapheme -phoneme correspondence, each grapheme represents a unique phoneme. There are vowels with 14 possible combinations, which keep the same sound irrespective of whether they are stressed or not and 17 consonants with 28 possible combinations. As for the syllabic structure, it is open, and the syntactic structure of words is flexible.

In spelling, the Greek language is facing some anomalies, partly due to the use of historic orthography. According to the historic orthography, words are written not according to how they are pronounced today but according to the way they were pronounced in the past. The biggest difficulty can be faced in the representation of vowels. Contrary to consonants which have only one graphic representation, in whatever combination they appear, the same does not happen in vowels (Arvaniti, 2000). For example, the sound / e / is written as <ε> or <αι>, while / o / is presented as <ο> or <ω> and the most complex sound is / i / which has six different graphic forms (ι, η, υ, ει, οι, υι). These different representations confuse the choice of the correct spelling and reading. Moreover, letters such as <υ> in different environments can be related to different vowels. For example, such as in <υ> can be pronounced as /f/ or /v/ as in εϋθύνη /efθini/ and εϋγένεια /evjenia/) respectively. However, in most cases, the spelling of words is not random as it is determined by morphological and grammatical rules. Nevertheless, there are words in Greek that are considered exceptions falling under no rules and, for this reason, they must be memorized as such (Pavlidis & Giannouli, 2003). For example, a word is difficult to be written without the necessary grammatical information. For the writing of the word [lipi] someone should only

understand from the context if it is a noun and they should write the word «λύπη», and if it is a verb, they should write the word «λείπει».

2.3.2.2. The English language

On the other hand, the English language, in which the majority of research especially on dyslexia has been conducted presents a different pattern. This could be attributed to the fact that the correspondence between phonemes and graphemes is not stable and, therefore, it is characterized as a phonologically non-transparent language (MacMahon, 2002). The English language is a non-transparent language having 26 letters with almost double number of matching sounds (about 44). Especially, the lack of coherence is more apparent in phonemes since 5 phonemes correspond to 19 different sounds. For example, the phoneme /a/ is pronounced differently in words like ball, cat and hand. This correspondence may add to the difficulty faced by learners with learning difficulties such as dyslexia.

2.3.2.3. Their Differences

Taking the above into consideration, the Greek language is characterized by strong coherence in contrast to English regarding their reading system. On the contrary, its orthographic system is rather similar to the opaque English system, which is confirmed by Cossu et al.'s (1995) conclusions that reading and spelling skills may not develop to the same degree.

However, there are some crucial differences which should be considered when a Greek student is learning English as an L2. The Greek language presents a largely phonetic writing with the peculiarity that some vowels and diphthongs are represented by different letters (Arvaniti, 2000). In this case, when a student is learning a foreign

language such as English, phonological differences can cause problems, especially for those students who face reading difficulties (Helland & Kaasa, 2005). First, only 9 capital letters out of the 24 of the Greek alphabet coincide with the corresponding capital letters of European languages (A, E, I, K, M, N, O, T, Y) while 5 lower-case letters from above are again written differently (e, i, m, n, t). Thus, second language learning is characterized by difficulties in the perception and production of nonnative phones (Helland & Kaasa, 2005). This observation has been also found and supported by the study of Lengeris (2009). For instance, native Greek speakers fail to identify English /i+/ from /w/ because their L1 lacks such a contrast and instead has only one vowel category /i/ in the acoustic/perceptual region covered by the two English vowels.

Regarding verbs, Greek has a strong verb use that stands in the text without the personal pronoun, while in other European languages, the verb is not as strong in the sentence as it is always based on the personal pronoun. Moreover, the dictionary and the grammatical function are indicated by a separate morpheme and therefore there is a fixed order of the words, as well as mandatory declaration of the subject. There are also three different types of definite articles and different endings to nouns, something that does not happen in English. Thus, languages have different orthographic consistency and size of the correspondences between orthography and phonology, which to an extent can determine the level of learning of reading.

2.3.3. Dyslexia in different Language Systems

While there are researchers who state that the phonological awareness deficit could be a cause of difficulties that dyslexics face (Fowler, 1991), there are other researchers

arguing that it could be the cause only for difficulties in alphabetical language systems and especially in non-transparent languages, in which the relation between grapheme and phoneme is not quite clear (Wagner & Barker, 1994). They add that the visual recognition process plays a significant role in language skills, and the development of the spelling lexicon is based on both visual recognition and phonological awareness. All these theories gave the opportunity for dyslexia to be studied in various countries and across different language systems.

First of all, the phenomenon of dyslexia exists both in transparent (Greek, Italian, Finnish) and non-transparent languages (English, German) depending on the coherence or not of the relation between phoneme and grapheme (Seymour, 1990). However, phonological non-transparency increases the difficulties of dyslexics, as the study of Satz et al. (1978) had presented. The percentages of dyslexia in various countries seem to support these views. Specifically, in the United States and United Kingdom, the percentage of individuals with dyslexia are over 10%, in Germany 5-7% and in Italy only 3% while in Japan there is evidence that they are only 1% (Makita, 1968).

In the Greek language, besides the correspondence of grapheme- phoneme, 10% of the population has dyslexia which could be attributed to historical writing. This specific orthographic system may produce various difficulties and weaknesses, particularly in dyslexic children. On the other hand, the majority of dyslexia research is done on the English language, where the correspondence between phoneme and grapheme is not clear. In English, there are 44 phonemes for 26 graphemes and their correspondence is a great difficulty for dyslexics. Phonological ability is one of the problems in the English language. Differences between English and Greek dyslexics in spelling were studied in 2003 by Pavlidis and Giannouli. According to this research, the quantitative differences between the two groups were not statistically significant since the number

of errors noted were about the same. Remarkable differences, however, were presented in the quality of errors, apparently due to the different structure of the two languages. On the contrary, in the English language the opaque phonological system and simple morphological and grammatical rules led to diametrically opposite errors (Pavlidis & Giannouli, 2003).

In German, which is also a transparent language, Landerl et al. (1997) hypothesized that the higher level of non-transparency of English will lead to a higher number of difficulties. In this research, 18 German and 18 English students of 12 years of age participated in a non-word reading task, and German students presented better results than English. Moreover, English students faced higher difficulties in uncommon three syllable words than German students and a comparison of reading errors in the two groups showed that, in contrast to the English language, few of the errors in the German language were due to grapheme-phonemics correspondence. The researchers noticed that the errors in German were about omissions, while in English they were about substitutions, omissions and additions, a fact which is indicative of the confusion in distinguishing phonemes. Landerl (2001) concluded that indeed deficits in phonological decoding have an impact on the manifestation of dyslexia and confirmed the phonological theory. This evidence is also confirmed by more recent research (Wimmer & Mayringer, 2002), which showed that German dyslexics were indeed extremely slow readers.

It is interesting to note that the lowest rates of dyslexia have been reported in countries such as Japan and China (Makita, 1968), where logographic or ideographic language systems are used. Wydell and Butterworth (1999) studied the case of a bilingual person (Japanese - English), who had dyslexia only in the English language. This was attributed to an inability to use the rules of graphemic-phonemic correspondence while

they argued that both the Kana and Kanji (language systems in Japan) do not rely on this correspondence and, as a consequence, do not cause major difficulties to dyslexics. Reading in logographic languages appears to be an activity controlled more by the right hemisphere of the brain, which processes visual stimuli, a fact confirmed by Wydell through functional magnetic resonance imaging (fMRI). Instead, during processing in alphabetic languages, the left hemisphere is more active (Hoosain, 1991 as cited in Jackson, Lu & Lu, 1994). The comparative study by Jackson et al. (1994), however, concludes that the differences in the two language systems do not have a major impact on reading ability, since the main differences were observed only in the reading of less frequent words.

Regarding second language learning, it is interesting to examine what happens in learners of non-alphabetic first language, for example Chinese. Another difficulty that dyslexics may face is the learning of a non-alphabetic second language which is comparatively different from English. According to Chung and Ho (2010), dyslexic students underperformed compared to the chronological age control group in both English and Chinese. They also found that they had difficulty in the phonological awareness of English, but this did not happen in Chinese. They suggested the existence of cross-linguistic transfer from first language to second language, having in mind that cognitive skills in Chinese affected the ability of reading English words. In this way, it is understandable again that L1 can contribute to the learning of L2, although Chinese has a different writing system.

As for the Italian language, it is characterized as a completely transparent language phonologically. After observations in dyslexic children (Cossu & Marshall, 1985), it was reported that the ability to read and write are not two parallel functions and can be independently and selectively affected in phonologically transparent languages.

Research conducted on 70 normal children (Cossu et al., 1995) confirmed that the same phonological system has a disproportionate impact on reading and spelling mechanisms. The findings were confirmed by Cavalli (1996), who proved that this asymmetry in performance is characteristic of phonologically transparent languages.

Concluding, dyslexia is not observable only in English but is found in every written language. Grigorenko (2001) summarizes that errors of dyslexics are significantly lower in transparent languages although again they present significant differences from non-dyslexic learners. If a student's first language is more transparent than English, it might often happen that dyslexic students do not experience speaking difficulties with reading and spelling in their mother tongue or can successfully overcome them with efficient strategies.

2.3.4. Second Language Learning and Dyslexia

The biggest part of the research on developmental dyslexia has been on first language learning related to reading and spelling process. However, there is a growing interest in examining bilingual and multilingual readers, as learning a new language is challenging for every individual. Dyslexic students face various challenges when writing and reading in their first language, and the effort should be double when they try to read and write in a foreign language. Students with dyslexia usually find themselves unable to succeed in school and meet foreign language requirements (Ganschow & Sparks, 1993; Ganschow, Sparks & Schneider, 1995).

First of all, one question that comes up is the following: are all dyslexic students capable of learning another language? In answering that question, Crombie (1995, 1997) proved that students with dyslexia have equal possibilities to learn. How successful they will

be in this process depends on each student, the approach they follow and, to some extent, the language they choose to learn (Broom & Doctor, 1995). Learning a foreign language usually becomes a demanding task even for dyslexics mastered in the acquisition of first language (Sparks & Ganschow, 1991).

Researchers have questioned whether individuals with learning difficulties in their mother tongue will face similar difficulties in learning a second language. Van der Leij and Morfidi (2006) found that there is a possibility of transferring difficulties from first language to second language and showing low orthographic competence and rapid naming among poor learners. Like dyslexia can cause difficulties in mother language, it can cause difficulties in a foreign language such as mixing up words, reading slowly, misreading words (Sparks and Ganschow (1991). In another study, Downey, Snyder and Hill (2000) researched the relation between phonological processing and second language learning in college students with dyslexia and compared them to a control group. Both cognitive and language measures tasks were administered, and the findings presented worse performance in dyslexics on phonological tasks and first language aptitude test. However, it is interesting to note that the results presented an aptitude in second language and not a competence, while dyslexics presented similar levels of academic proficiency to controls.

Thus, dyslexic students may vary to the difficulties they face in learning a new language and evidence regarding L2 skills is still complex. Since developmental dyslexia may have a negative influence on academic development, foreign language learning has also an impact causing impairment on orthographic/ phonological, syntactic-grammatical and semantic processing (Schneider & Crombie, 2003). Often, dyslexics encounter more difficulties than non-dyslexic students in reading and writing activities. Regarding reading performance, there are various individual differences and linguistic

features which work together. Usually, students with dyslexia who study languages have difficulty listening to sounds, associating these sounds with letters and memorizing new vocabulary. In their research, Ramus and Szenkovits (2008) found that dyslexics performed worse in the discrimination and production of lexical stress.

Based on the above, not only in mother tongue but in learning a foreign language, the difficulty of dyslexic learners may have a phonological base. For example, a person who has spelling problems in Spanish will present similar problems in English (Rooney & Schwarz, 1999; Schwarz, 2000). However, research has focused particularly on students learning English as second language whose first language is another Roman alphabetic system like Spanish or French. In particular, Comeau, Cormier, Grandmaison and Lacroix (1999) included in their research dyslexic, bilingual participants and a control group. Both verbal and non-verbal tasks were administered in both English and Italian. They found that dyslexic individuals had worse results than the other groups in all exercises except tasks of reading comprehension in Italian. They concluded that English as a second language may present some challenges for dyslexic learners but may strengthen learning in bilingual children. Regarding the phonological deficit, a number of research findings indicate that dyslexic-type difficulties (such as phonological processing) tend to be associated with L2 reading comprehension problems. Both Norwegian (Helland & Kaasa, 2005) and Hungarian children with an official diagnosis of dyslexia (Kormos, 2014) were found to have lower L2 reading achievement than non-dyslexic children.

In conclusion, dyslexia and learning difficulties, in general, may have a significant effect on the learning of other languages. However, there are many advantages for students with dyslexia who decide to enter the language learning process and could be benefited by the learning of foreign languages. Appropriate teaching certainly makes a

difference, however, there is the dilemma whether it is better to have a unified language curriculum or deprive some students who may need additional support.

2.3.4.1. Dyslexia and English as a Second Language in Greece

Across the world, there are differences between the language learning systems of every country. Such differences should be considered with respect to the level of acquisition of both the first and second language of students. In the example of Greece, all students begin to learn English as a foreign language in the second grade of primary school. In other words, students with dyslexia or not, are obligated to study English in really early stages. Furthermore, in the fifth grade of primary school another foreign language is introduced. Students have the option to choose between French and German. In some cases, students start learning English even in the first or second grade of primary school, taking private lessons or studying in private institutions. This implies that children often learn English at the same stage as they learn to read and write in their mother tongue.

Having discussed above the differences between Greek and English, it is interesting to discuss how this relation affects the learning process of dyslexic students. In Greece, students with dyslexia are part of mainstream education. Moreover, they are considered to be individuals with learning difficulties. In learning English as a foreign language, dyslexia is likely to cause the following difficulties (Markou, 1996): a) Problems in the auditory perception and discrimination of sounds, b) Problems in visual capture and retention in long-term memory, c) Problems in orientation in space and time, and d) Reading and writing problems. Some of these difficulties will be discussed below.

First of all, low reading performance is for many researchers the most characteristic difficulty in acquiring written language. In English, with its particularly opaque spelling system, low performance of people with reading difficulty usually extends to both low

accuracy and low speed. On the contrary, Greek language reading accuracy is found to be high even in weak younger readers (Nikolopoulos et al., 1997; Porpodas, 1999), which is justified by the correspondence between graphemes and phonemes (For further details, read Section 2.3.2.). The same is observed in other orthographically transparent languages, such as German (Landerl, 2001; Wimmer & Mayringer, 2002), Spanish (Jimenez-Gonzalez & Hernandez-Valle, 2000), and Italian (Tressoldi et al., 2001).

Following reading, another field in which dyslexics may face difficulties is spelling. Greek students with learning difficulties are based on the phonological - orthographic coding for the writing of words and they ignore or fail to retain historical and morphological rules writing (Porpodas, 1999). The differences between English and Greek dyslexics in spelling were also studied in 2003 by Pavlidis and Giannouli. There were notable differences, in the quality of the errors which could be attributed to the different structures of the two languages. The types of errors in which English dyslexics are more prone are mainly phonological-auditory with 85% of the total errors and secondarily visual errors were observed. On the contrary, the errors of Greek dyslexics were mainly visual errors, followed by grammatical errors, and only few were phonological-auditory. The results of this study concluded that the phonological coherence of the Greek language contributes to the elimination of phonological errors in spelling. However, due to its complex grammatical system and the varied graphic representation of vowels, students make visual and grammatical errors. In contrast, in the English language the opaque phonological system and the simple morphological and grammatical rules lead to diametrically opposed errors (Pavlidis & Giannouli, 2003). Thus, the strategy of phonological coding for writing words in a system with strong graphemic-phonemic coherence, such as Greek, contributes to causing visual rather than phonological errors (Porpodas, 1999).

Moreover, regarding the supra-segmental level, teaching perception and pronunciation of prosodic features of speech has been long neglected by language teachers. In the study of Kainada and Lengeris (2015), they examined the effects of Greek as L1 on the production of English prosody as L2. The data revealed that learners applied the tonal events of the Greek language into English and that their speed rate was slower with deviating pitch range point in English. Based on this evidence they concluded that there is an effect of L1 on the production of intonation in English as L2. Similar findings regarding the influence of L1 on L2 in the Greek context were found in the study of Lengeris and Hazan (2010) regarding nonnative phones. They focused on segmental phonology and tested whether success in processing vowels of English as second language is related to L1 vowel processing ability. The methodology of the research included a training to test whether an effect can be found to learners' frequency discrimination acuity and to their L1 vowel processing. Results indicated that indeed L1 influence L2 vowel perception and production by presenting slower identification slopes and lower discrimination accuracy for English vowels.

Regarding vocabulary, Zacharaki (2017) investigated how explicit strategy instruction affects the vocabulary knowledge and strategy awareness of a dyslexic student. The research participant was a Greek primary school student with dyslexia, who has been learning English as a foreign language for two and a half years. The researcher used explicit teaching to teach cognitive and metacognitive strategies such as testing, visualising and monitoring. The research method adopted was the extended individual behaviour analysis, consisting of two phases, the baseline phase and the manipulation phase, in which the subject acts at his own control. The data showed that the performance of the student improved in terms of both receptive and expressive vocabulary knowledge, while awareness of the strategies also increased.

Finally, a study by Kaperoni (2016) investigated the hypothesis that students diagnosed with dyslexia face more difficulty when trying to learn a foreign language, especially English. The research used a questionnaire: two groups of students completed the same questionnaire on their difficulty in learning basic skills such as reading, writing, listening and speaking. The questions focused primarily on the difficulty they experience in spelling, reading and listening, which are the main aspects of dyslexic students' scores in their language and which are significantly lower than those of non-dyslexic students. The research findings showed a large difference in the scores produced by the two groups, which shows the greater degree of difficulty faced by dyslexic students in confirming the original hypothesis.

2.3.5. Emotions of language learners

The field of second language learning has long acknowledged emotions as an important component of individual differences in learning achievements (Ellis, 1994). The previous three decades an important development in research on emotion and second language learning has been witnessed (Dewaele & Li, 2020; Horwitz, Horwitz, & Cope, 1986; Saito, Garza, & Horwitz, 1999). However, before that, little attention had been received possibly due to the fluid nature of emotions (Miyahara, 2019). In particular, a variety of emotions has attracted the attention of researchers.

In the field of second language learning, there has been a particular interest in negative emotions as was illustrated in the study of Horwitz (2001) on anxiety in language learning. Language anxiety and motivation had been the main focus of research on emotions in second language learning (Dornyei & Ryan, 2015). For that reason, 'language anxiety' is distinguished from other types of anxiety (Horwitz,

Horwitz,&Cope, 1986), and it is a particular form of anxiety since it has been shown to affect not only academic but cognitive and social aspects of language learning (MacIntyre, 2017). Researchers indicate that language anxiety has a detrimental impact on learning performance. In particular, Steinberg and Horwitz (1986) conducted early research on the subtle effects of anxiety on language use. They discovered that participants who were treated in an anxious manner tended to avoid using the Second language to propose innovative, personal interpretations of confusing pictures. They claimed that, over time, minor impacts of anxiety arousal might have a considerable impact on students' speech in the classroom and beyond. Following up on the study of anxiety's subtle effects, MacIntyre and Gardner (1994) incorporated 29 measures of second and native language performance organized across three phases of cognitive processing. They investigated (1) the language input stage, (2) the language processing and interpretation stage, and (3) the output stage where language knowledge may be demonstrated. At each of these three levels, the authors suggested assessing both anxiety and performance. Language anxiety was linked with the requirement for extra time and effort to compensate for difficulties obtaining knowledge from a prior stage on specific activities. This was similar to the findings of Horwitz et al. (1986), who highlighted over-studying as a possible reaction to language anxiety. Especially, this emotion has been mostly investigated via questionnaires such as the Foreign Language Classroom Anxiety Scale (Horwitz et al., 1986).

However, Sparks and Ganschow (2007) have questioned whether anxiety truly causes reduced success, claiming that poor achievers/communicators are equally likely to be anxious, a cyclical discussion that is difficult to address through correlational, questionnaire-based studies. In particular, Sparks and Ganschow (2007) discovered that early L1 literacy achievement is a very strong predictor of both L2 proficiency and L2

anxiety in later schooling in a longitudinal study that tracked L1 literacy development among American schoolchildren as well as their L2 aptitude, proficiency, and anxiety. As a result, they suggest that anxiety is caused mostly by poor achievements, rather than the opposite way. Nevertheless, MacIntyre (2017) is doubtful of this finding, but admits that additional longitudinal and experimental research is required to settle such arguments. Another approach of the nature of language anxiety is viewed by Gkonou (2017) as well. Gkonou conducted a new exploration on language anxiety of seven very anxious adult Greek EFL learners using Bronfenbrenner's (1979) nested ecosystems model. She administered weekly diaries and interview data as research tools and the results demonstrated that language anxiety is possible to be caused not only by language performance but by complex ecosystems as well that interact dynamically.

Apart from anxiety, scholars have researched other emotions as well in recent years. For example, Teimouri (2018) focused on shame and guilt and their relation to second language motivation and achievement. The sample were Iranian English learners and both qualitative and quantitative data were collected by developing a sound psychometric instrument. The data revealed a significant relationship between these emotions and second language motivation and achievement. In particular, shame negatively affected language learners while guilt had a positive influence on them. In the research of Imai (2010), emotions were found to mediate both learning and development. The English-as-a foreign-language learners participants stated in a joint task that boredom and frustration could be considered detrimental to learning and could contribute to development and success depending on how they perceive these emotions in a learning activity and whether they are influential for students. In another study, MacIntyre and Vincze (2017) classified a list of nineteen basic emotions related to second language motivation including ten positive emotions (joy, gratitude, serenity,

interest, hope, pride, amusement, inspiration, awe, love) and nine negative emotions (anger, contempt, disgust, embarrassment, guilt, hate, sadness, feeling scared and stressed). The research was conducted in an Italian secondary school using German as a foreign language. The results indicated that positive emotions are positively related to variables of motivation while negative emotions showed a weaker relation to motivation. Based on their correlation analysis, they concluded that a variety of emotions is experienced in second language learning and not only one -two key emotions.

Apart from these studies, enjoyment in comparison to anxiety has been the focus of attention in research as well, especially after the introduction of the concept of Foreign Language Enjoyment by Dewaele and MacIntyre (2014). Dewaele and MacIntyre (2014) recruited more than one thousand participants around the world, by using a questionnaire collecting both qualitative and quantitative data. Based on their findings, they concluded that enjoyment and anxiety are negatively correlated. These emotions were also studied by Piniel and Albert (2018) by using Pekrun's (2006) framework. The sample was Hungarian English majors and the results indicated that enjoyment and anxiety were the most often experienced emotions in participants' reports. This evidence is also supported by Shirvan and Taherian (2018).

Thus, researchers are starting to look beyond anxiety to investigate a range of different second language emotions. Indeed, there is an outburst in the studies about SLA the last decades as emotions are not just present in the classroom but have an impact on students' learning, performance and achievements. One of the most important things is feeling involved and accepted in a learning experience regardless of the level of achievement. Based on that, current studies have raised the importance of teachers'

emotions as well (Dewaele, Mercer, & Gkonou, 2018; Miller & Gkonou, 2018; Agudo, 2018)

2.3.6. Emotions of language learners with dyslexia

Students may feel various emotions in educational settings. Such a setting is considered the second language classroom and the influence of emotions is crucial. However, according to Kormos et al. (2009), the research field of second language learning has neglected language learners who face learning difficulties. Thus, there is lack of studies regarding emotions of language learners with dyslexia as well.

For instance, anxiety is an emotion that has been long studied in second language learners, nevertheless attention on language learners with dyslexia has not been particularly made yet. Considering the significant influence of anxiety in students with learning disorders, this emotional upheaval may present an impact on these students in cases where they are trying to find their way in a new context. This is supported by the study of Ganschow et al., (1994). Thirty-six university students were recruited and were asked to participate in battery of tests in language skills. In addition to the negative cognitive effects of phonological difficulties, they found that poor performance in the foreign language classroom can result in motivational and anxiety fluctuations. Especially, poor language learners were found to have higher anxiety levels than well performed language learners. Similar evidence was found in the study of Sparks, Ganschow & Javorsky (1993) regarding self-perception. As they tested foreign language academic history, learning attitudes, and academic skills, they concluded that poor language learners present poorer self-perceptions compared to other language learners. Both studied commented that these outcomes are possible to be a result of principal native language difficulties. As Ganschow, Sparks & Schmeider (1995)

suggest, difficulties faced by poor language learners is possible to be a result of poor first language skills (see Ganschow, Sparks & Schmeider 1995). Moreover, cognitive difficulties and negative experiences in the language lessons may decrease the language learning motivation of students with dyslexia (Kormos et al., 2009). Kormos, Sarkadi et al. (2009) suggest students with dyslexia can be taught in foreign language in special groups and specific methods which strengthens the development of second language competence of these students.

The interaction of emotions, cognition and action is more complex and nonlinear relation than second language learning research had assumed in the past (Imai, 2010). Therefore, all these factors need to be examined to test the level that negative or positive emotions lead to educational and emotional consequences weighting the dyslexic student.

2.4. Emotions

Researchers and philosophers have tried to answer questions such as ‘What are emotions? How do they affect an individual’s life?’ for thousands of years, from Greek philosophers to more recent researchers such as Ekman (1993). However, till nowadays this question has not been fully answered as new theories are challenging the existing definitions and their theoretical/methodological perspectives.

Emotion is not just a simple phenomenon and individuals tend to use this term in different ways. It is commonly accepted that emotions play a crucial background role in an individual’s life, and they are usually differentiated according to which objects and events cause them. According to Pekrun, Muis, & Frenzel (2017), emotions are complex phenomena that involve several interrelated psychological processes. ‘These

processes include subjective feelings, cognitions, motivational tendencies, physiological processes, and expressive behaviors' (Pekrun et al., 2017).

Moreover, researchers have been led to debates about their definition and the level of contribution of nature (for example, biology) and culture (social interactions and cultural rules) to the experience and communication of emotions. For that reason, it is important to discuss the three most widely known approaches to the study of emotions: biological, cognitive, and poststructural/discursive as cited in Benesch (2007). Each of these approaches has their own assumptions of the nature of emotions, their construction and how research on emotions should be developed.

2.4.1. Biological Approach

The central organizing idea of the biological approach is that emotion is an individual's physiological phenomenon which is universal and innate (Ekman, 1993), originating in the brain. Its theoretical framework is based on the Darwinian theory of universality of specific basic emotions based on the theory of evolution. In other words, emotions are considered common and mutual to all humans regardless of cultural and social identities, geography and history.

Basic Emotions

Over the last 30 years, an attempt has been made to establish the universality of specific human facial expressions of emotions. This corresponds to a set of 'basic' or 'primary' emotions and an impressive body of evidence has been amassed such as Ekman's (in Ekman, Friesen, O'Sullivan et. al., 1987), Alan Fridlund (1994), and James Russell (1994). Each of these researchers argue for different numbers of these basic emotions. Ekman (1993) stated that there are seven basic emotions: happiness, sadness, anger, fear, surprise, disgust, interest. These are similar to Darwin's basic emotions apart from the addition of surprise while Plutchik (1980) states that there are eight (anger,

anticipation, joy, trust, fear, surprise, sadness and disgust). However, these emotions are considered fundamental because the remaining emotions are considered to derive in a way from them. These emotions display survival-related themes of responses to events which have been acquired through the course of the evolutionary theory. Moreover, Plutchik (1980, p.129) states that each basic emotion has ‘an adaptive role in helping organisms deal with key survival issues posed by the environment’.

Researchers working with the biological approach assess emotions as affective states, which can be distinguished into pleasant and unpleasant. A characteristic example is the research of psychologist Ekman (1993) on basic emotions in which he tested Darwin’s view regarding universality of some basic human emotions. Moreover, the two assumptions guiding his research were that emotions are distinguishable from one another and are biological mechanisms which enable us to react to important life tasks (Ekman & Cordaro, 2011). For his research, he asked educated participants to identify emotions that are expressed in pictures of human faces. Ekman (1993) expected that participants would select the same emotions with the pre-assigned pictures proving that these emotions are innate and not learned. Indeed, they identified the same faces with the equivalent emotion words. However, Ekman & Friesen (1971) expressed their concerns that it is possible for respondents to have been exposed to the same photographs before. For that reason, they conducted another study in New Guinea with two groups that were isolated from literate cultures. They asked them to identify emotions that they saw in photographs, and stories were read representing each of the basic emotions. Again, they concluded that the expressions administered correspond to a set of basic emotions and concluded that ‘particular facial behaviors are associated with particular emotions’ (Ekman & Friesen, 1971, p.128). Later studies used other

methods such as Facial Action Coding System (FACS) which enables observers to record information like facial movement, duration of these movements and facial muscles (Cohn, Ambadar & Ekman, 2007). In particular, using this system, researchers are able to code almost all facial expressions and recomposed in action units. Thus, since they can analyse the smallest visually discriminable facial movements, FACS is considered as the standard measure for facial behavior.

Moreover, researchers adopting the biological approach emphasize the impact of emotions on the learning and teaching experience (Kaufhold & Johnson, 2005; McPherson & Young, 2004; Pekrun et al., 2004; Vuorela & Nummenmaa, 2004). In the study of McPherson & Young (2004), for example, the researchers recruited students and asked them about attributions of teachers' anger. They found that students could understand that something they did had triggered the anger of their teacher, but this was in relation to internal causes too. These studies are based on the assumption that emotions are, first of all, reactions of individual subjects and an interpretation of a personal reaction to an external stimulus (Parkinson, 1995).

Ekman's research has received critique mostly by those who have attempted to bridge the biological and cognitive approach. In particular, Barrett (2012) expressed her concerns about Ekman's interpretation of Darwin's emotions and his research foundations. Barrett (2012) claimed that humans may unconsciously move their facial muscles and those may have no correlation to particular emotions nor signal their function. Moreover, her perspective of Darwin's theory was that emotions are not monolithic in nature but are quite variable behaviourally, and cognitively. Another concern of Barrett (2012) was about the use of photographs to represent emotions in Ekman's research, as she questioned whether they were representative of movements usually used in everyday life. For this reason, in her research she did not just use facial

movements and cardiovascular responses, but also voice analysis (Lewis, Haviland-Jones & Barrett, 2010).

Moreover, Parkinson (1995) argues that there are some important limitations of this approach in general. As emotions are considered instantaneous, these theories do not consider emotions as embedded in sociocultural contexts. Moreover, these emotions are not studied during the interactions that arise with other people, for instance. In this approach, the meaning of emotions has not yet included the sociocultural factor and aspects such as power relations and historical conditions. In addition, the methods that are mostly used are self-reports and surveys aiming to better understand the experience of emotions and the ways they are expressed.

2.4.2. Cognitive Approach

The central assumption of the cognitive approach is that thought, and emotion are inseparable and are related to outer events as a judgment of value. One of the researchers that started the modern cognitive approach was Magda Arnold. According to Arnold (1960), all emotions are dependent on 'appraisals', that is the process of judgement by which events are judged as good or bad. An emotion is not just a physical state, but conscious and unconscious 'appraisals' (Oatley & Johnson-Laird, 2014) of events (Benesch, 2017). Researchers who were focused on the cognitive approach argue that emotions begin with a comparison between an individual's goal and their perception of the expected outcome as the judgements of appraisals are related to the emotions that occur. Moreover, Moors, Ellsworth, Scherer & Frijda (2013) argued that emotions are processes and not states, which is in contrast to the biological claim.

Researchers working within the cognitive approach argue that in order to capture emotions, methodology on measurements of various experiential, physiological and

behavioural aspects should be used as these are considered to be the components of emotion episodes. One of the most well-known experiments in the field of psychology is the study of Schachter and Singer (1962), which despite being somewhat outdated, it illustrates the role of appraisals in the determination of emotions. In their experiment, participants were injected with epinephrine (a hormone which induces arousal) and were divided into two groups. They were told to sit in a waiting room and an actor (confederate) was also there as part of the study process. In one group, the actor performed happily and was acting silly, while in the second group the actor played angrily bothering the participants. At the end of the process, when they asked the participants how they felt, the first group reported that they were happy and the second group reported that they felt angry and mad. In conclusion, both groups were aroused, and the context (actor) determined how they would appraise the event. The first group attributed their arousal to the actor having a happy attitude while in the second condition they stated that feelings of anger were produced.

Within educational settings, the view of appraisals theorists is based on the fact that emotions should be divided into positive and negative categories resulting in equivalent results. Positive or 'pleasant' emotions are considered to have a positive relationship with 'learning-related motivation, self-regulatory efforts, activation of cognitive resources, and performance' (Frenzel, Goetz, Luktke, Pekrun & Sutton, 2009, p. 705). Specifically, Schumann (1999, 2001) approached emotions in second language learning and applied biological and cognitive approaches. By brain imaging techniques and applying Scherer's taxonomy of appraisals, he studied the dimensions on which stimulus appraisals are made. Moreover, to further describe the language learning process, Schumann (2001) developed a model called 'The Neural Mechanism for Stimulus Appraisal' according to which parts of the brain connected to systems such as

the nervous system receive information from the environment such as learning stimuli. The perception of these stimuli generates the feeling and emerges as a result of the perception of the current event and past experiences. This feeling is an appraisal.

However, Harding and Pribram (2009) critiqued some of the theory's dimensions such as mind/body relationship, knowledge production, authentic vs. fake self. Regarding the discussion of body and mind, they stated that the mind dominates, and the body has a less central role in the emotion episode. However, according to the poststructural approach, bodies are mediated, and emotion episodes are socially constructed rather than being seen as natural or rational (Bensch, 2017). On the other hand, Harding and Pribram (2009) state that there are no 'terms' as real self and fake self, nor is there a tension between the two. Although researchers that adopt the cognitive approach are interested in measuring emotions, Scherer (2005) claimed that in taking into account the different components of emotion episodes, it is quite difficult to achieve a comprehensive measurement of emotions as theorists have tended to examine components individually.

2.4.3. Poststructuralist Approach

Taking into consideration that there is no adequate definition of emotions, some researchers adopt another approach according to which emotions are 'contextual, cultural, overlapping and related to power' (Benesch, 2017, p. 16). Studies in the 1980s started to point out the view that emotions are cultural artefacts which include sociocultural messages (Harre, 1986; Lutz, 1988). This approach does not subdivide emotions into components or tries to describe their interaction but considers emotions as a communicative experience. It focuses not on what emotions are but rather on what

emotions do (Ahmed, 2004) and how they affect the individual socially thus creating a reciprocal relationship. Even Ekman (1972) has identified the significant role of culture in the regulation of emotional displays.

Unlike biological and cognitive approaches, this approach considers emotions not as inner states of humans but as encounters with objects, ideas, memories, people etc. (Benesch, 2017). These encounters generate emotions, and these emotional experiences are connected to bodily sensations, according to Ahmed (2014). On the other hand, based on her study on multilingualism and emotional experiences, Pavlenko (2012) states that students may bring distinct emotional worlds to the process of learning that are sometimes difficult to be understood.

In understanding emotions, researchers should perceive them as part of a dynamic and fluctuating system which consists of meaningful experiences (Schutz & DeCuir, 2002). Holstein and Gubrium (2000) advises that narrative approach and interpretive methodologies should be used because emotions are important aspects of storytelling, linking our desires and actions and exploring the meanings of our emotional experiences. In practice, Zembylas (2011) argues that emotions are contextual, created in specific socio-spatial contexts. He investigated exclusion in Greek schools where both Greek and Turkish minority students would study together. In this racialized climate, he was interested to examine how emotional geographies of exclusion are manifested. To collect data, he conducted interviews with teachers, students and classroom/playground observations as well as school documents. In the analysis, Zembylas adopted Ahmed's (2004) cultural-political perspective and focused on emotional practices of inclusion and exclusion. He found that emotions are contextual as Greek Cypriot children socialized with each other and no attempt was made for the other group to join them. This research could be seen as proof of the discursive character

of emotions in educational settings, which is in contrast to the biological and cognitive approaches.

Nevertheless, one of its limitations is that emotions as an entity are not quite comprehensive. In the research of those who argue for the social approach of emotions, the representation of emotions rather than how they are experienced is their main focus. It is considered limited, and there are researchers (Frenzel et al., 2009; Cohn et al., 2007) that disapprove the approach on focusing exclusively on how emotions affect individuals socially. On the contrary, there are those who are trying to bridge approaches such as Barrett (2012), who believes that biological and social aspects are important as bodily feelings and meaning making are located in the same brain region.

2.4.4. Emotions in educational settings

Emotions can be considered important experiences in a wide variety of cases, not only in everyday life but in education too (Pekrun et al., 2018). Students spend many hours in the classroom, social interactions are created, and the fulfilment of crucial life goals is accomplished within educational institutions. Thus, emotions play an indisputable part in education and their role has started to be recognized by theorists in the area (e.g. Lazarus, 1999; Pekrun, Goetz, Titz, & Perry, 2002; Punch, 1998; Schutz & De Cuir, 2002).

Yet, the study of educational emotions has been dominated by research on test anxiety (Zeidner, 1998) and Weiner's (1985) attributional theory, while other researchers have focused particularly on the cognitive outcomes of students and schooling (Pekrun, Muis, Frenzel, & Goetz, 2018). However, affect in education started to develop after a theoretical symposium that was presented at the American Educational Research

Association in April 2005 with the title 'Reflections on Emotion Research: The Theoretical Integration of Affect, Motivation, and Cognition'. Subsequently, in the last 15 years or so, research has been extended and proved that emotions are crucial to human achievement (Efklides & Volet, 2005; Linnenbrink, 2006).

Educational settings are characterized by intense emotional experiences affecting motivation, teaching, and self-regulated learning. Pekrun, Goetz, Titz, and Perry (2002) analysed five qualitative studies and concluded, indeed, that students may experience a variety and diversity of intense emotions such as anxiety, pride, boredom, hope, enjoyment, anger (based on the Achievement Emotions Questionnaire [AEQ] that they developed). Anxiety was the most frequently reported emotion while positive emotions also frequently appeared in students' motivation, self-regulation, learning strategies and achievement.

In particular, the influence of emotions can be observed in different settings such as in various aspects of the learning process. For example, Fredrickson and Branigan (2005) focused on the scope of attention and thought-actions based on the broaden-and-build theory (Fredrickson, 1998, 2001). In particular, Fredrickson conducted two experiments focusing on emotions of amusement, contentment, neutrality, anger, or anxiety with 104 college students. She found that positive emotions broadened attention and thought-actions while negative emotions had a negative impact on thought-actions. In another study, Pekrun et al. (2018) were interested to explore the diversity of emotions students usually experience in the learning process. They tested 54 student teachers and again, the majority of the answers reported anxiety as the most common emotion (15-27%). In addition to this, they also found that both positive and negative emotions had the same frequency in students. However, Maehr (2001) criticized this study and suggested that the role of emotions in education should be re-examined.

Apart from learning, another aspect that is strongly influenced by emotions is student engagement. Using a qualitative approach, Kahu, Stephens, Leach and Zepke (2015) interviewed 19 distance mature students throughout the first semester on their emotional experiences and their study engagement. They found that different emotions related differently to engagement and that the relation between emotions, engagement and learning is complex, thus favouring or not favouring the student. Moreover, another study on student engagement and whether emotions contribute to student success was conducted by Linnenbrink, Rogat and Koskey (2011). The researchers conducted two studies with the aim to learn more about affect during small group instruction taking also into consideration valence and activation. They found that positive affect leads to positive group interactions and negative affect leads to social loafing. Moreover, from a reciprocal view, positive interactions lead to the alternation of affect on group tasks. The above study highlights the reciprocal and cyclical relation between social-behavioural engagement and affect in educational settings.

Emotions are an important part of study motivation too, as shown by Meyer and Turner (2002). By revisiting previous assumptions and findings, they argued that classroom contexts are created by teachers' instructional responses, students' beliefs and actions, and an integral part of emotions. This conclusion is supported by Meyer and Turner (2006) in a subsequent publication, in which they argue that motivational theories have helped classroom researchers to have a better understanding of academic emotions. Creating positive emotional experiences about learning motivates students and fosters a better teacher-student relationship.

However, as noted above, emotions extend to teachers and administrators as well. Not only students but also teachers spend many hours inside the classroom. This makes teachers experience several emotions too, and if teachers inspire excitement and joy for

learning, the motivational benefits are much more substantial. In the study of Gkonou, Mercer and Daubney (2018), the researchers gathered data from teachers from different countries across Europe using surveys and interviews. Their goal was to learn more about teachers' perspectives on language learning psychology. They concluded that teachers highlighted the importance of psychological aspects of language learning, and they noticed a crucial link between teachers and students' psychology.

The above cited research is an example of the significant role that emotions play in various educational stages and settings. Therefore, 'an understanding of the nature of emotions within the class context is essential' (Schutz & Lanehart 2002, p.68). Researchers have employed various methodologies ranging from quantitative to qualitative research and different statistical techniques. However, emotions are quite fluid and usually 'they can be quick to occur and quick to change' (Schutz & Decuir, 2002, p.125).

2.4.4.1. Achievement Emotions

Students experience a hodgepodge of emotions in educational settings. As Pekrun et al. (2002, p. 92) have argued, 'learning and achievement are among the important topics across the life span in our society today, especially because careers, social relations are largely depended on individual achievement'.

Achievement emotions are defined as the emotions that are related to achievement activities (taking an exam or studying) and to the outcome of this achievement (success or failure) (Pekrun, Goetz, Frenzel, Barchfeld & Perry, 2011). These emotions are crucial for students' motivation, learning, identity and mental health (Schutz & Pekrun, 2007). Nowadays, there are studies that consider educational emotions and achievement emotions as synonyms and, as such, that they should be used interchangeably (Pekrun

et al., 2018; Schutz & Pekrun, 2007). According to Pekrun's et al., (2023) taxonomy, emotions can meaningfully be classified based on some more omnibus dimensions such as valence, activation, object-focus and reference of time. In educational research, valence is characterized as the degree of pleasantness or unpleasantness of emotions (Pekrun et al., 2018). In other words, they can be distinguished into positive emotions such as happiness and confidence and negative emotions such as anger and anxiety (Pekrun, Muis, Frenzel, & Goetz, 2018). Activation differentiates activating from deactivating emotions such as excitement about a task versus boredom for a lecture (i.e. activating versus deactivating). Object -focus is related to the activity that an emotion is linked, and reference of time signifies whether the emotion is present before, during or after an event.

However, in the past, research on achievement emotions was mostly focused on the relation between emotions and achievement outcomes, particularly on test anxiety (Zeidner, 1998) and on links between possible causes of success or failure and related emotions like shame and pride (Weiner, 1985; Zeidner, 1998). Although outcome emotions have a crucial role to play in achievements, emotions which having a direct effect on these activities performed are also considered achievement emotions and they have equal relevance (Pekrun et al., 2002a). For example, these emotions may be excitement of starting a new project, or boredom performing a routine task and they are examples of activity-related emotions that have been neglected and further research on these conditions should be conducted.

One of the first major studies on achievement emotions was conducted by Weiner (1985). The researcher stated that the cause of achievement outcomes (success or failure) shares three common properties: locus on control, stability, and controllability. These dimensions also affect emotional experiences based on a created motivational

episode. Thus, Attributional Research on achievement emotions provided innovative theorizing and produced a significant number of studies as well as consistent empirical evidence related to the cognitive characteristics of achievement emotions.

Following on from Weiner (1985), Pekrun and his colleagues developed another theoretical/research framework for the study of emotions in educational settings from a socio-cognitive point of view, this time. According to the Control Value Theory (Pekrun 2009; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Pekrun & Perry, 2013), student's emotions are characterized by their control and their value appraisals (Pekrun, 2006). Built on assumptions from transactional approaches (Lazarus & Folkman, 1984), attributional theories (Weiner, 1985) and models of effects of emotions on performance (Predrickson, 2001; Zeidner, 2007), this theory expands these ideas on achievement emotions. According to Pekrun, Perry (2014, p. 122), 'succinctly stated, it is proposed that individuals experience specific achievement emotions when they feel in control of, or out of control of, achievement activities and outcomes that are subjectively important to them'.

Contrary to these emotions, Linnenbrink and Pintrich (2002) tested emotions and affect related to their Achievement Goal Theory. Based on their study, emotions and goals have a reciprocal relation. However, they found some asymmetry as more structural aspects in the class such as grading, evaluation systems and nature of the tasks predict further performance goals. Moreover, they found that achievement goals are related to specific emotions, although their relation is complex. Nevertheless, they underlined that there is a clear need for further research on the relationship between emotions and achievement in classroom settings.

2.4.5. Positive and Negative Emotions

As explained in 2.3. section, emotions are classified by valence. Based on this dimension, emotions are divided into *positive* and *negative* categories. Although this terminology is commonly used by researchers in the field, it is also quite common to characterize emotions as *pleasant* or *unpleasant* (Oxford, 2017). There are cases where the division into pleasant vs. unpleasant is preferable as it avoids making value judgements about the nature of the emotion as being good/positive or bad/negative (Linnenbrink & Pintrich, 2002). In this thesis, in order to avoid confusion, emotions will be referred to as positive and negative as it is the most widely adopted terminology in the literature and a useful way for the participating children to understand, evaluate and talk about their emotions.

For example, in recent empirical studies it has been argued that the emotion of enjoyment (positive) is expressed in cases of positive events like solving a problem and engagement behaviours, while the emotion of anger or anxiety (negative) is experienced in negative events such as an upcoming deadline (Kahu, Stephens, Leach & Zepke, 2014; Skinner, Furrer, Marchand & Kindermann, 2008). Consequently, it is expected that their effect on individuals would be equivalent; positive emotions will lead to improvement, success and high self-esteem, and on the other hand, negative emotions will lead to 'bad', unwanted situations such as failure, sadness and anger. Nevertheless, both categories might be crucial for the wellbeing of individuals. On the one hand, positive emotions may benefit individuals to learn and build skills while negative emotions can enable individuals how to manage these and become less vulnerable (Kitayama, Markus & Kurokawa, 2000).

2.4.5.1. Positive Emotions

According to the Oxford Handbook of Positive Psychology, positive emotions are “pleasant or desirable situational responses... distinct from pleasurable sensation and undifferentiated positive affect” (Cohn & Fredrickson, 2009, p. 172). In general, positive emotionality is essential for human behaviour and prosperity (Pekrun et al. 2002a). These emotions are considered to contribute to envision goals and challenges, have open-mindedness, create attachments with others and guide the behaviours of groups and social systems.

Related to educational settings, experiences of positive emotions enable students to engage with the environment and participate in activities which may be evolutionarily adaptive for them (Carver & Scheier, 1990). Individuals who experience positive emotions are more likely to succeed and accomplish goals in different life domains (Lyubomirsky, King, & Diener, 2005). Moreover, Fredrickson (2001) argued that positive emotions increase academic competence since they encourage exploration and broadened methods of problem solving. Subsequently, positive/pleasant academic emotions have been shown to correlate positively with learning motivation, self-regulation, cognitive resources and performance (Pekrun et al., 2017).

2.4.5.2. Negative Emotions

Negative emotions are unpleasant to experience, or in other words, these are unhappy emotions which are experiences in individuals to express a negative effect for an event or another person (Pam, 2013). Historically, the majority of findings have focused on negative associations and particularly how anxiety is related to school outcomes (Duchesne, Vitaro, Larose & Tremblay, 2008; Valiente, Swanson & Eisenberg, 2012). For example, in educational settings, if students fail negative emotions such as anxiety

or boredom is possibly to demotivate them and undermine their will to remain in a class (Pekrun, Linnenbrink-Garcia, 2014).

One of the most possible reasons that has been argued is because psychology tends to focus and try to understand ameliorating psychological problems (Seligman & Csikszentmihalyi, 2000). However, anxiety has attracted most attention while other emotions remain conspicuously under-researched thus leaving a gap in understanding human and social development (Davidson, Scherer & Goldsmith, 2003; Lengua, West, & Sandler, 1998). For example, regarding anxiety, Woodward & Fergusson (2001) showed that adolescents with high levels of anxiety are at risk for educational underachievement by their first years of adulthood. Moreover, another emotion which can be characterized as negative is boredom (Berlyne, 1960). In the study of (Goetz & Frenzel, 2006 in Pekrun et al., 2011), authors aimed to explore different types of emotions and were analyzed based on the dimensions of valence and arousal. Results indicate that boredom seem to have discrepant motivational consequences.

2.4.5.3. Related Studies

A considerable number of studies have been conducted to compare and evaluate this binary element of emotions in educational settings. Indeed, both positive and negative emotions lead to student learning, self-regulation and scholarship achievement (Pekrun et al. 2002a). Although research on anxiety was the most widespread, measurement and scientific analysis of other emotions starts to gain prominence, particularly in relation to the role of both positive and negative emotions on learning.

First and foremost, one of the first theories related to emotions and their classification is the Attributional Theory of Weiner (1985). Attributions of success or failure are

considered important determinants of emotions. In Weiner's studies, one determinant of emotion is the outcome of the action. For example, in an athletic competition, an athlete may experience happiness after a victory whether the win can be attributed to various reasons such as extensive training or luck. Furthermore, such relation of causation could be also considered bidirectional as it has been argued that a student's experiences of positive and negative emotions (passion and enthusiasm or disappointment and anxiety) may have significant impact on learning outcomes (Goleman, 1995).

Specifically, in education settings, positive academic emotions reinforce the use of critical evaluation, organization and further creative learning strategies. By contrast, negative academic emotions facilitate the use of more rigid strategies (Pekrun al., 2002a). Regarding the achievement valence of emotions, Pekrun et al, (2002b) studied 5 qualitative studies with student participants and stated that positive emotions such as enjoyment may influence achievement positively via metacognitive strategies. Although empirical evidence is scarce, they supported that by reinforcing motivation and strengthening flexible learning, positive emotions could improve achievement. In particular, these results centred on enjoyment, pride and hope as for example, enjoyment enables directing attention towards a task. In total, as positive emotions had the same levels of frequency with negative emotions, they stated that positive emotions are not less apparent in academic environments than negative emotions. Negative emotions, on the other hand, negatively correlated with flexible learning strategies although this correlation was weak and not so consistent.

The relation between outcomes and positive or negative emotions is also supported by Villavencio & Bernardo (2013a), who further extended this research field by explaining that only positive emotions and self-regulation can promote academic

achievement. On the contrary, Pekrun, Elliot and Maier (2009) argued that negative emotions such as anger could contribute negatively towards reducing achievement. Negative emotionality affects higher order cognitive processes and attention on a set of behavioural choices (Fredrickson, 2001). Additionally, Blair (2002) researched self-regulation and thinking skills from a neurobiological approach and found that negative emotionality could be an important factor of low achievement. Also, Duschense, Vitaro, Larose and Tremblay (2008) found that there is a negative association between anxiety and school outcomes.

Another dependent field of academic achievement is academic performance, where researchers have also highlighted the significance of positive emotions. Specifically, in the study of Goetz, Frenzel, Hall and Pekrun (2008), the researchers found a relationship between positive emotions and students' academic performance affecting learning behaviour too. Focusing on academic enjoyment, they assessed academic enjoyment, self-concept and achievement in mathematics and verbal language classes. Mathematic performance positively predicted enjoyment in mathematics classes and negatively predicted the same emotion in language classes. In yet another study, Frenzel, Pekrun and Goetz (2007) focused on gender differences in achievement emotions in mathematics and found that students' pride in their school achievement can be a predictive factor of performance among students. At the same time, Yasutake and Bryan (1995) stated that negative emotions could lead to lower children's performance on mathematics and literacy tasks.

Pekrun et al. (2002a) have also suggested that happiness, pride and hope as general positive emotions are the basic components of learning motivation, while in another study Pekrun (2006) found that happiness and optimism could be considered as improving learning motivation. As positive emotions can contribute to motivation,

negative emotions could harm the motivation of students to learn. Under positive emotions, according to Olafson et al. (2001), students will focus on self-efficacy while with negative emotions the opposite may happen. Finally, Pekrun et al. (2002a) have stated that negative emotions such as boredom and hopelessness may negatively affect performance because they 'erode' motivation and attention, thus making any task-related information shallow and boring.

Furthermore, in educational settings, an aspect which plays a significant role is the cognitive function. In particular, Fredrickson & Branigan (2005) tested 104 children to examine whether positive emotions are possible to broaden the attention of students. Indeed, based on their analysis they found that positive emotions can encourage children to overcome mental limitations and strengthen their cognitive flexibility. These findings have also been supported by the study of Linnenbrink (2007) that cognitive engagement is affected by positive effect and opposite outcome by negative emotions.

In sum, we can conclude that positive emotions are not less part of students' affective life than negative emotions. All the above studies lead to the realization that most of the research has provided evidence that positive emotions lead to positive outcomes and situations as negative emotions to negative outcomes and situations too. Are these situations absolute and irreversible? Does for example, anxiety, a 'bad' emotion causes bad performance and confidence a 'good' emotions results in academic success? Specifically, there emotions are refereed as they were reported often by the participants as well as in other studies (Nalavany, Logan & Carawan,2018; Novita, 2016).

2.4.5.4. Abandoning these terms

As noted above, several studies tend to relate positive emotions to positive outcomes and negative emotions to negative outcomes (DeCuir-Gunby, Aultman & Schutz, 2009). Based on this conclusion, one could argue that positive emotions are good emotions and negative emotions are bad emotions that someone could avoid (Fredrickson, 2001). However, there is a small proportion of the literature that questions these relations and investigates the causation nature of these binary opposites.

First, there is a continued debate about the dimensions of underlying emotions (Russell & Barrett, 1999; Watson et al., 1999). Researchers have tried to create models to help classify the emotions. Specifically, Gregersen and MacIntyre (2014), as were inspired by the Positive Psychology movement, state in their paper that negative emotions can be paralysing but are not always bad because they can aid learners in removing an impediment. Contrarily, positive emotions "may widen the field of focus and develop resources for the future" and assist students in "building relationships, personal strength, and tolerances for the moments when things become difficult. Nevertheless, most studies have been conducted from the perspective of particular traditions investigating only one or two of the emotions as it was discussed above. This implies that there is a lack of a broader perspective on emotions and there is a need for further study on this classification (For further details, read Section 2.4.4.).

Traditionally, it could be expected that positive emotions, notwithstanding their ability to foster creativity, can sometimes be maladaptive in performance. Because of inducing unrealistically positive appraisals and experiencing mood-congruent retrieval, individuals are likely to perform nonanalytical information processing and effortless expenditure thinking that everything will go well (Aspinwall, 1998; Pekrun et al., 2002b). This may lead to opposite results such as the failure of a student. Specifically,

students might have unrealistically positive appraisals because of the experience of positive emotions. This is due to the mood-congruent retrieval, nonanalytical information processing and without taking the necessary effort (Aspinwall, 1998; Pekrun et al., 2002b) and might consequently lead to opposite achievement outcomes. Related to this view, some studies have found null relations between activating positive emotions (or affect) and individual engagement and achievement (Linnenbrink, 2007; Pekrun, Elliot & Maier, 2009). In particular, Pekrun, Elliot and Maier (2009) published a paper regarding achievement goals and achievement emotions. In their research with student participants, they found a null relation between positive emotions and individual engagement and achievement.

In the same vein, a similar situation with negative emotions may be experienced by individuals. Broad measures and individual difference in negative emotions are related to bad students' grades and scores of achievements (Gumora, Arsenio, 2002). In the study of Caravaca and Romero-Ramos (2018), they recruited 44 students of primary school and were tested in a number of questionnaires and an intervention. They concluded that a negative emotion such as anger is possible to have a positive influence in participants. Moreover, anger, anxiety, and shame were found to positively correlate with the usage of rehearsal techniques by Pekrun et al. (2002b). These results support theoretical expectations that some learning strategies may be more easily applied when negative activating emotions are present, even though these effects are not consistently shown when learning strategies are measured using self-report methods.

Moreover, research has been conducted from the perspective of comparing this binary. For example, Dewaele and MacIntyre (2014) examined the link between enjoyment and Classroom Anxiety with 1746 learners of second language from around the world, highlighting the significance of both positive and negative emotions in second language

learning. Although some learners scored highly or poorly on both measures, they discovered that learners reporting higher levels of enjoyment experienced less anxiety. Furthermore, some other evidence that question this binary relation can be found on the research of Pekrun and his colleagues (2017) who have stated the classification of emotions turning the research attention on activation pattern (activation versus deactivation of emotions). According to the cognitive model of Pekrun (2006), activating positive emotions such as enjoyment and pride, have positive effects in the performance of a student. On the other hand, deactivating positive emotions such as relief or relaxation is possible to have the opposite result for positive emotions. At the same time, as recent empirical studies have brought to light (Pekrun, Muis et al., 2017), there are not only positive but negative activation emotions as well too. Emotions like anxiety and anger are considered activating emotions considered emotion which may lead to positive results related to learning and motivation; in other words, they can promote learning and increase motivation (Williams, Mercer, & Ryan, 2016).

Thus, there are studies which question the accountability of positive and negative emotions. Particularly, according to Valiente, Swanson and Eisenberg (2012) the evidence are inadequate as far as it concerns the relation between students' positive emotions and academic performance. The lack of research could be attributed to various reasons such as the fact that one positive emotion is for every three to four negative emotions and there are fewer positive than negative emotions (Ellsworth & Smith, 1988) or because it is believed that negative emotions are thought to have more effect on children's developing and function. Furthermore, some emotions, such as surprise, are neither positive nor negative.

Taking the above studies into consideration, emotions have negative or positive impact on individuals and specifically on children during the school ages. According to

Benesch (2017), the notion that a binary exists, and its ‘conflicting’ consequences has been long used in educational scholarship should be abandoned. Otherwise, based on this conservative relation, it is implied that specific emotions should be enhanced and others to be reduced in teaching practices. Characteristic example is that anxiety affects negatively in language learning and due to that reason is considered a bad emotions and is best to overcome and similarly, that teachers should feel emotions such as enthusiasm which affects positively the enthusiasm of students.

2.4.6. Anxiety

The most common and extensively studied primarily negative emotion is anxiety. Test anxiety in particular has been researched extensively since the 1950s (Mandler & Sarason, 1952) and prior to that too, whereas other student emotions were generally neglected. It can be reasonably assumed that all individuals have felt anxiety at some point through their lifespan. However, having in mind the saliency of this emotion, it is surprising that still there is not one widely accepted definition. Anxiety can be used in various cases such as ‘I am an anxious person’ or ‘I feel anxious’ representing different things each time (Simsek & Dornyei, 2017). For this reason, some researchers consider it as part of students’ personality (Gregersen & Horwitz, 2002), others see it as an emotion (Dewaele, 2010), while others have characterized it as an important motivational component (Dornyei & Ushioda, 2011).

The experience of anxiety can be accompanied by emotional, physical or cognitive reactions and can be identified in various settings and environments. Anxiety is possible to appear quite early in a child’s development (Pennington, 2002; Zahn-Waxler et al. 2000). Though anxiety can be perceived as an expected response to stressful events, it could also be experienced as a painful pressure affecting daily functioning not only at

home but in school too. For example, students may feel stress and anxiety regarding the homework of the next day, the social network of school or the learning of a foreign language. A considerable number of studies has been published suggesting that anxiety has a detrimental effect on academic achievements. In particular, Duchesne et al. (2005) stated that children exhibiting signs of anxiety during kindergarten are more likely to be faced with academic difficulties at the first year of high school. Likewise, Ialongo et al. (1995) also found that students in the first year of primary school who were in the top third of their class were found to be in the bottom third at the end of Grade 5, when academic achievement was measured again. These findings are also supported by Woodward and Fergusson (2001) who showed that adolescents with high levels of anxiety are at risk of educational underachievement by their first years of adulthood. Last but not least, Seip (1991) in her meta-analysis stated that highly anxious children did worse than children with low anxiety on tests measuring academic achievement.

There are studies which have shown that anxiety does not affect academic achievement during adolescence (Eady, 1999; Strahan, 2003; Vitaro et al., 2005) but it could have a beneficial role (DiLalla et al., 2004; Sharma, 1970). Conducting a longitudinal study, Vitaro et al. (2005) found that anxiety in kindergarten did not predict high school graduation by late adolescence above and beyond early risk factors (gender, socio-family adversity and disruptiveness). In another longitudinal study, Strahan (2003) found that anxiety was not related to college persistence and grade average. Thus, these findings are not in accordance with the results of DiLalla et al. (2004) in which students who showed signs of anxiety in preschool had the highest grades as adolescents. Moreover, Sharma (1970) also found a negative relationship between anxiety and academic achievement when achievement was tested four months later. In sum, the

above studies are proof that the role of anxiety on academic achievement is still not entirely fully understood and the same applies to test anxiety too.

2.4.6.1. Test Anxiety

As previously discussed, academic emotions were mostly neglected by researchers apart from test anxiety which was introduced in the late 1930s and much of the work concentrated on investigating its structure. Thus, throughout the years, a considerable number of attempts were made to define test anxiety (Liebert & Morris, 1967; Nicaise, 1995; Spielberger, Gonzalez, Taylor, Algaze, & Anton, 1978). Zeidner (1998) defined test anxiety as a specific form of anxiety related to taking an exam or test, as well as to the fear of failing and its consequences.

Furthermore, test anxiety can be accompanied by an alloy of physical, cognitive, and behavioral responses (Zeidner & Mathews, 2005) and can be experienced at any time after, during or before testing. Deconstructing its nature, cognitive responses refer to the negative thoughts which may affect performance and can be conceptualized by physiological responses such as faster heart rate and sweat glands, behavioural responses such as deficient study skills and procrastination of academic work (Whitaker et al., 2007).

Tests and examinations are considered an important and powerful tool for taking decisions in test-oriented educational settings (Zeidner & Most, 1992). Since people are evaluated based on their abilities and skills, evaluative situations and tests have become an anxiety-evoking stimulus. That leads to increased testing requirements in schools around the world (Whitaker et al., 2007). As a consequence, tests and exams have a significant effect on the emotions of students. It has been estimated that more than 33% of children and adolescents experience some form of test anxiety (Methia, 2004).

Specifically, it has been suggested that children perceive exams as a derivation of increased anxiety and feeling of uncertainty depriving them of the opportunity to demonstrate their true capabilities (Zollar & Ben-chain, 1990; Spielberger, 1985). Moreover, Hill and Wigfield (1984) argued that those kinds of emotions limit students' performance during a test resulting in reduced academic achievement. This often generates test anxious behaviour in which the student believes that the evaluative situation taxes or exceeds their intellectual, motivational and social capabilities.

For that reason, it is believed that test anxiety could prevent some students of fulfilling their academic potential. Some conceptualizations of test anxiety (Zeidner, 1998) are focusing on fear-of failure as its main characteristic. Moreover, Spielberger and Vagg (1995) stated that an individual with test anxiety is more likely to react with high levels of anxiety in an evaluating situation. For instance, O'Neil and Fukumura (1992), found cross-cultural differences regarding test anxiety across 14 different countries. For their measurements, they included tests about achievements in mathematics, social studies and Japanese language. They found a strong relationship between state of worry and performance as well as trait anxiety was lower in Japan than in the other countries of their sample. Researchers such as Hembree (1988) and Seipp (1991) focused on people at different age stages and the relationship of test anxiety and learning on various educational contexts. In their meta- analysis studies Seipp (1991), they found a negative correlation between test anxiety and school performance. Test-anxious students tend to be easily distracted on an exam, experience difficulty in comprehending relatively simple instructions and also have difficulty organizing or recalling relevant information during the test. All these are leading to negative consequences to students' performance in educational settings.

Moreover, it is widely known that anxiety has been long studied. For that reason, Pekrun, Goetz et al. (2004), were interested to examine other emotions than anxiety in school 'environment'. They included two studies with student participants and used the Test Emotions Questionnaire and interviews. In that way, the study proved that this questionnaire was reliable for other test emotions. Moreover, they found that test anxiety is not the only emotion that is apparent in academic settings and that there are other emotions with equal or even more importance.

The studies summarised above, have revealed that test anxiety can pose serious threats to students' learning. Nevertheless, there is still no full consensus on how test anxiety impacts on school performance. In the study of Pekrun, Molfenter, Titz & Perry (2002), researchers found evidence that test anxiety was related less closely to achievements rather than boredom and hopelessness. This once again indicates that test anxiety is not the most deleterious negative emotion as it commonly believed. It is apparent that test anxiety has persisted to attract several experts, while other achievement-related emotions have earned much less interest (Pekrun et al., 2002).

2.4.6.2. Language Anxiety

Different emotions may be experienced related to the objects or events that provoke them. As such, language anxiety 'encompasses the feelings of worry and negative, fear-related emotions associated with learning or using a language that is not an individual's mother tongue' (MacIntyre and Gregersen, 2012, p. 103). In psychology as well as in second language learning, language anxiety is considered a negative emotion. In particular, it is argued that it prevents learner interaction and impedes the learning and production of the language (Gregersen & MacIntyre, 2014). Nevertheless, anxiety is the most examined emotion in both psychology and education (Horwitz, 2001). Second

language acquisition researchers have indicated that language anxiety should be better conceived of as a situation specific emotion (Dewaele, 2010) because it is manifested in specific settings such as the language classroom.

Specifically, since the 1960s researchers have been suggesting that anxiety impedes in second language learning, performance and its achievement. One of the first studies was Horwitz, Horwitz and Cope (1986), in which the researchers first used the Foreign Language Classroom Anxiety Scale (FLCAS) to measure language anxiety and investigate the relationship between language anxiety and achievement. Indeed, they found a negative correlation between anxiety and students' grades. Another significant finding of this research was students with high level of anxiety have lower marks comparing students with lower level of anxiety, highlighting the negative consequences of anxiety. Moreover, these conclusions are also supported by MacIntyre and Gardner (1989) who measured students' performance and anxiety on a vocabulary task.

Moreover, regarding language proficiency, MacIntyre, Noels, and Clément (1997) found a negative correlation between anxiety and self-ratings of students. In their research, authors measured perceived competence in an L2 as a function of their actual achievements and language anxiety by using a variation of tests. Previously, Gardner and MacIntyre (1993) had presented a very extensive ensemble of findings about language anxiety as well. As they used in their methodology both classroom anxiety and language use anxiety such as a cloze test and a composition task, they presented negative correlation of anxiety with these language production measures. However, Horwitz (2001) questioned whether anxiety is a cause or result of poor language learning achievement and proposes that subtle first language learning deficits are the primary cause of poor achievement. Language difficulties, they argue, are likely to stem from native language learning and the ability to use one's language codes.

Studying the relation between anxiety and second language learning has emerged mix and confusing outcomes, suggesting that the emotion of anxiety is not a simple or understandable psychological construct. All these, confirm that school experience could be characterized by a rich variety/ diversity of emotions.

2.4.7. Emotions and dyslexia

Dyslexic students who face difficulties in reading tasks are likely to be vulnerable towards emotionally charged situations where they might experience high anxiety and low self-esteem. In the study of Casey et al. (1992), students with learning difficulties were more anxious, unhappier and less competent in the school settings than students with no learning difficulties. Their parents rated them with lower ratings in tasks related to self-esteem in comparison with children with other forms of learning disabilities. Similar results on anxiety-related difficulties were presented with university students with dyslexia (Carroll & Iles, 2006). In this study, the researchers also commented on the possibility that anxiety could potentially become permanent during adulthood.

Having in mind the difficulties that many individuals have in reading and writing, are individuals with dyslexia more anxious than students without dyslexia? A growing body of literature (Long, MacBlain, & MacBlain (2007); Livingston, Siegel, & Ribary, 2018) indicates that children with reading difficulties are at an elevated risk of both internalizing (emotional) and externalizing (behavioural) problems. Moreover, Cornwell and Bawden (1992) argued that children with learning difficulties had higher levels of anxiety. Regarding self-report measures, students with learning disabilities present small but significantly higher levels of anxiety than students in control groups (Paget & Reynolds, 1984; Rodriguez & Routh, 1989). Lawrence (1987) reported that

poor readers had low self-esteem compared to other children and that an approach which taught basic literacy skills and enhanced self-esteem through counselling was more effective than a skills-based approach on its own. Individuals with dyslexia face higher rates of academic anxiety (Jordan, McGladdery & Dyer, 2014), increased likelihood of dropping out of school (Bruck, 1987) and decreased enrollment in postsecondary institutions.

Thus, students with dyslexia may feel extended negative emotions comparing to individuals with no learning difficulties. One of the most studied emotions of this field is anxiety and in particular test anxiety (For further details, you can read Section 2.4.6.1.). Specifically, Lavis et al. (2019) found that students with learning difficulties are four times more possible to have a mental health difficulty in comparison to those with no learning difficulties. Moreover, Thakkar et al. (2016) found similar results as students with learning difficulties self-reported higher anxiety than their peers without. In a national survey focusing on college students, 60% of the sample reported being highly anxious and 35% being so depressed that it was difficult for them to function. In relation to learning, Alesi et al, (2014) children with learning difficulties in primary age presented higher levels of school anxiety and lower levels of self-esteem compared to those without learning difficulties. About mathematics, Sainio et al, (2019) focused on those students with difficulties in reading and mathematics and found that they had higher chance to experience anxiety in these fields. About achievements, as students with dyslexia have lower academic achievement, that in turns has an impact on their emotions and their self-competence. At the same time, self-competence and self-efficacy reduces engagement in learning as the researched of Hampton and Mason (2003) and Alesi et al. (2014) showed.

2.5. Research Aims

The present literature review chapter has led to the design of the following research questions. Thus, the thesis is going to address these five research questions:

1. Is there an improvement on stress assignment after the visual or auditory training in students with dyslexia?
2. Do students with dyslexia make stress errors in L2 (English) as in L1 (Greek)?
3. Do stress errors in L2 improve after the visual or auditory training?
4. How does anxiety affect students with dyslexia?
5. How do positive/negative emotions affect students with dyslexia?

The above research questions are going to be discussed along the present thesis to provide a thorough discussion on difficulties that students with dyslexia face and to attempt fill gaps in the existing knowledge of these issues.

2.6. Conclusion

In conclusion, the chapter highlighted the characteristics as well as the difficulties that individuals with developmental dyslexia face. Further information was provided regarding the Greek context. Moreover, the relation of first and second language acquisition was presented, and the influence of both positive and negative emotions was explained. Finally, the research questions that are going to be answered in the present thesis were presented. Followingly, the methodology of the research will be discussed.

Chapter 3: METHODOLOGY

3.1. Introduction

In this chapter, the research methodology that was applied in the present study will be discussed and explained. First, the mixed method approach and its applicability in the present study will be presented together with the rationale behind the study. Followingly, the participants and an analytic presentation and reasoning behind the data collection instruments and materials will be offered. Next, the data collection procedure, the coding process and its analysis will be addressed. The chapter ends with a discussion on the validity and reliability factors that were taken into account throughout the project.

3.2. Rationale of the Research tools

In the present study, deficits in sensory processing are investigated in children with developmental dyslexia. As discussed in the literature review, there is an extensive number of theories regarding the nature and features of this learning difficulty. The most dominant ones are attributing it to impairments in learners' phonological awareness (Snowling, 2000), visual processing (Stein & Walsh, 1997) or auditory processing (Douklias, 2009; Wolf & Bowers, 2000). These impairments are leading individuals to face difficulties in reading (Shaywitz & Shaywitz, 2008). Dyslexics are making systematic errors such as ignoring or mispronouncing words and letters (Vellutino, 1979). This is supported by studies that found that dyslexics perform significantly slower and less accurately than typical peers on reading tasks (Tressoldi et al., 2008). Therefore, this research focuses not only on behavioural manifestations of dyslexia (i.e., poor reading accuracy) but also on alternation in the brain system and the cognitive function.

One of these systematic errors of individuals with dyslexia has been observed in the assignment of the lexical stress, evidenced in various languages such as English and Italian. In these languages, although there is stress assignment impairment when reading aloud, there is no mark indicating the correct syllable. Nevertheless, the Greek language includes a diacritic mark highlighting where the stress should be assigned. However, according to previous research (e.g., Protopapas & Vlahou, 2009), Greek dyslexic children faced difficulties in the assignment of the stress pattern, an aspect which is considered one of the symptoms of dyslexia, although the Greek language is considered simpler in phonological structure than other languages as well as consistent in orthography-phonology relation (Douklias et al., 2009). For this reason, a visual deficit is assumed to impede the reading performance of dyslexic individuals. Based on the above, this study will investigate the stress assignment of dyslexic children in the Greek language and whether visual or auditory introversion will lead to an improvement on stress assignment. The design of the experiment involves a training program in which non-linguistic tasks (visual and auditory tasks) were administered, and a pre-test on reading performance which was provided again (post-test) after the implementation of the training program.

When it comes to English, developmental dyslexics have also been found to differ in their performance on phonological awareness tests that acquire overt sensitivity to the sounds in words. Van Wassenhove, Grant and Poeppel (2005) found that visual speech information speeds up the processing of auditory speech information in the English language. Based on the above, another experiment took place to identify whether stress pattern deficit exists in English as L2 and whether the training influences the performance of the participating children to the same extent as in their L1. Similar tasks and procedures were applied with the only difference being that the pre-test and post-

test assessments were in English. Considering that students with dyslexia perform worse than normally developed individuals, it was expected that Greek dyslexics would not be as good as normally developing readers at decoding real words in the English language (Douklias, 2009; Nikolopoulos, Goulandris & Snowling, (2003). Thus, a control group of the same year was recruited to examine whether a difference in performance would be found.

Alongside reading performance-related matters among dyslexic children, the influence of emotions on reading was also examined. Students with dyslexia often experience higher levels of emotions, and especially anxiety (Paget & Reynolds, 1984; Rodriguez & Routh, 1989). Students with dyslexia are strongly and deeply influenced by their emotions. As noted in the literature review, several studies tend to relate positive emotions to positive outcomes and negative emotions to negative outcomes (e.g., DeCuir-Gunby, Aultman & Schutz, 2009). Focusing on the emotions of dyslexic students and their impact on their reading performance was seen as a promising research trajectory and a link that is missing from existing research.

The above considerations were taken into account for the design of this study. To investigate these issues, a questionnaire on anxiety, an interview and observations were used as instruments of the present project. Before the stress assignment training, participants were asked to fill in the questionnaire including a question with emojis and after the linguistic training the emojis were again administered followed by the interview. During the stress assignment training, observations were collected.

3.3. Mixed-Methods Research

For the last 25 years, the combination of quantitative and qualitative methods has been increasingly used as a third approach in research methodology (Tashakkori & Teddlie, 2003). The most settled term is 'Mixed Methods Research' which has been endorsed by many methodologists in social sciences. Specifically, quantitative and qualitative methodologies are interrelated as they support and inform each other (Miles & Huberman, 1994, p. 310, as cited in Dornyei, 2007). The quantitative component adds meaning to numbers and the qualitative component adds precision to words (Dornyei, 2007) in a circular and evolving process.

Using both qualitative and quantitative approaches, research strengths are reinforced and some weaknesses of each method are overcome. Although these methods often fall into comparison, it is imperative not to decide whether to use one method or another but how they could coexist in research (Dornyei, 2007). Quantitative research focuses on an overall understanding of the sample while qualitative research follows the in-depth understanding of the particular. However, mixed methods research also comes with certain disadvantages. For example, Hesse-Biber and Leavy (2006) have raised the issue that 'the sum may be better than the parts' is not by definition true. Rossman and Wilson (1985) stated that research should be situated in a solid qualitative or quantitative approach. Yet this has been dismissed by those who argue that epistemology does not indicate the method of data collection or analyses (Cohen, Manion, & Morrison, 2007; Onwuegbuzie & Leech, 2005).

In the case of studying a complex phenomenon such as the one discussed in this thesis, a better understanding can be gained by the adoption of a mixed-methods approach. As the choice of research tools is crucial to every study (Mackey & Gass, 2005), a mixed-

method approach was used for this project as well, and both qualitative and quantitative instruments were administered to answer the research questions. The quantitative tools included a questionnaire and tests, and the qualitative tools were interviews and observations. Their differentiation was well explained by Lichtman (2014, p. 17) who stated that while ‘quantitative research attempts to answer, “how many” and “who” questions, qualitative research aims to respond to “why” and “what” questions’.

Specifically, in the present study, regarding the stress pattern assignment, quantitative instruments were chosen as the goal was to count the number of errors made by students. Furthermore, regarding students’ emotions, instruments such as an open-ended question, an interview and observations were employed. Therefore, although qualitative instruments could be considered ideally suited to explore topics, quantitative measures are needed to conduct more rigorous tests of the hypotheses (Pekrun et al., 2002b). In total, particularly in educational contexts in which the exploration is centered on both cognitive and affective aspects of the learning experience, using more than one method has strong potential to address the complexity and versatility of the topics under investigation.

3.4. Participants

Data from a total of 130 children, aged between 8 to 12 years old (mean age= 9.89, SD=1.104, range=4) were analyzed in the present study (Male=72, and Female= 59). From the sample, 110 of the participants were children with developmental dyslexia (Male= 63, Female= 47) and 20 were normally developed children (Male= 9, Female= 11) attending primary school grade3 to 7. Moreover, all children were L1 Greek speakers and had normal non-verbal ability, hearing and vision ability, as well as no reported psychiatric or neurological disorder, based teacher’s report and the diagnosis

criteria. They had a typical educational career, regularly attending school, and they were in the school year that corresponded to their chronological age. During the training, all students with developmental dyslexia were undergoing special teaching for children with learning difficulties, were assessed in SEN support and presented low levels of curriculum achievement.

Diagnosis of developmental dyslexia

Formal diagnosis of developmental dyslexia had been given to participants from official special education services prior to this study. The interdisciplinary diagnostic team of these centers comprises of a child psychiatrist, an educational psychologist, a special educational needs teacher, a speech and language therapist and a social worker (Law 3699/2008) (Anastasiou & Polychronopoulou, 2009). The assessment of learning difficulties is a complex task and requires an interdisciplinary approach (Tzouriadou & Barbas, 2003). The combination of two diagnostic approaches is followed, the causal and the symptomatic, to ensure more valid results (Tzouriadou, 1995). The causal approach includes study of the individual's history, medical examination and psychometric tests, such as IQ measurement and personality tests. The symptomatic approach includes a neuropsychological examination with the aim of evaluating learning parameters process such as cognitive and perceptual functions. Lastly, the pedagogical diagnosis in terms of reading and writing skills is also examined.

1. History study examines the following: a) the heredity factor in the existence of dyslexia in the family tree, b) the biomedical history, pregnancy, birth, diseases, etc. c) development of the child both emotionally and socially, d) the development of core movements (crawling, walking, running) and fine movements (holding a

pencil, drawing, cutting with scissors), e) language development and development at the level of spontaneous communication and f) the school prehistory.

2. Medical examination: a) The function of vision and hearing are examined to rule out any other version of some abnormality, b) electroencephalogram mapping for any possible lesion or functional damage of the Central Nervous System (Karpathiou, 1987), c) child psychiatric examination (general assessment of personality and levels of development).
3. IQ measurement and personality tests: a) WISC-III (Wechsler Intelligence Scale for Children) is used which has been adapted in Greek by Georgas et al. (1997) and provides detailed information of the child's mental potential. It is part of the Wechsler test and is suitable for children from 6 to 16 years old, b) personality test such as the Thematic Apperception Test (T.A.T.) in which 31 black and white cards are given to the examinee to make one story. In these stories, imagination, thought, feelings, and previous experiences are depicted. The test is given to people over 7 years old but there are adaptations for younger children as well (Bellock, 1975).
4. Neuropsychological examination: a) Through the Developmental Test of Visual Perception by Marianne Frosting, brain functions are examined at their level mobility, visual perception and lateralization, psycholinguistic abilities, the ability of auditory perception and discrimination and the development of speech, b) the Illinois Test of Psycholinguistic Abilities (ITPA) by S. Kirk και J. McCarthy (1961) to examine the cognitive functions consisting of 12 tests and adapted in Greek by I. Paraskevopoulos (1973). Another test which is used is the Learning Disabilities Diagnostic Test "*Athina Test*" (Paraskevopoulos et al., 1999). It consists of fourteen tests with the form of developmental psychometric scales

assessing aspects of the child's development that are considered critical for school learning and adjustment.

5. Pedagogical diagnosis: The special education teacher will attempt to establish a) in which subjects the child presents latency, b) the exact kind of problems the child presents in these subjects, e.g., reversals, mirror writing, confusion of numerical symbols, etc. c) to what extent the child falls behind academically in comparison with their age and grade level. The special education teachers can also provide information about the child's emotional state, any behavioural problems, or their interpersonal relationships at school.

The certificate of diagnosis of dyslexia is given to individuals when they present significant discrepancy between cognitive ability and standard educational attainment. Also, the multidisciplinary expert assessment excludes the role of other factors such as low intelligence, sensory handicap, emotional disorders, family problems or poor reading, mental retardation, general low performance which is associated with insufficient school attendance or adverse environmental conditions, sensory disorders, chronic diseases and severe emotional disorders.

Regarding the participants that were tested in the L2 task, for second language learning, the recognition of possible reading difficulties in a foreign language is important as well, from the very first stages of learning, since they affect a student's progress to a great extent. However, an issue that arises is whether the diagnosis should be carried out by testing in the foreign language or in the examinee's native language (Cummins, 1984; Damico & Hamayan, 1991). In the case of foreign language tests, particularly in English, tests are standardized and more valid. However, the difference between people

learning a second language and native speakers concerns the level of frequency of the language use, at least at beginners' level (Cummins, 2002). Moreover, it is crucial to consider that some of the skills thoroughly examined in some languages, such as phonological awareness in English, may not be as diagnostically indicative of dyslexia in some other languages such as Greek (Smythe & Everatt, 2000). For the above reasons, participants with dyslexia were not tested in yet another diagnostic test in the English language but instead were required to have a written proof of diagnosis by the official centers, which constitutes a nation-wide reliable form of measurement. Besides, there is a moral reason why an additional diagnosis was not conducted or sought, as over-testing or re-diagnosing non-typical, dyslexic children would overburden them cognitively and performance-wise. Thus, such a test was intentionally avoided.

L1 Assessment

Seventy students with dyslexia aged between 8 to 11 years old (mean age= 9.26, SD=1.073, range= 3, Grades 3rd to 6th) participated in the Greek assessment. Children were recruited in this research to complete tasks on the phonological error assignment and their emotions. This age group was chosen for the following reasons. Descriptive statistics for the total number of groups of participants can be found in Table 1.

First of all, it should be taken into consideration that, in order to achieve a complete and accurate diagnosis of dyslexia, all mental, biopsychosocial, environmental and educational factors that affect learning should be significant in the child's diagnosis. Apart from this, individuals lag behind at least 1.5 - 2 years in literacy skills compared to same aged children (Calet et al., 2019; Douklias et al., 2009; Goswami, Gerson & Astruc, 2010). Having in mind that in Greece, the earliest diagnosis which can be considered reliable is from Grade 2 onwards, this means that students that are below

Grade 2 do not yet have formal diagnosis of dyslexia and thus could not participate in the present study.

Vocabulary continues to grow throughout the school years, and especially it changes rapidly in later primary school (Hoff, 2014). Thus, knowledge of language morphology and spelling has been found to be attained after the 10th year of age. Specifically, after the age of 10, children's awareness of morphological level is actively developed as it is supported by Bryant, Nunes, and Aidinis (1999) who tested children from 2nd to 5th grade and noticed that children in the 4th and 5th grade showed a systematic use of morphological knowledge in their writing and spelling. Moreover, Anglin (1993) found a significant development of derivational vocabulary knowledge after the 3rd Grade. For these reasons, students older than 10 years old, were specifically chosen, including 3rd to 7th graders to test the hypothesis that stress assignment makes independent contribution to students' reading. For these reasons, other studies such as Retelsdorf, Köller & Möller (2011) and Winner, Rosenstiel and Gardner (1976), examining reading performance in elementary school, have chosen systematically participants from Grade 3 and above, since the choice of participants in Grades 1 and 2 might affect the explanatory value of the stress assignment tasks.

L2 Assessment

In the English assessment, 40 students with dyslexia aged 10 to 12 years old (mean age= 10.68, SD=.572, range=2, Grades 5th, 6th and 7th) who were learning English as a second language, participated. Students were in level B1 in their English level. The selection of the age group was made as students in Greece start to learn English at Grade 2 and by Grade 5, they have adequate reading ability. Since students with dyslexia lag behind by 1.5- 2 years, the 5th and 6th graders were considered the most suitable

participants in this task. Moreover, it is worth noting that, in Greece, children are studying English at their regular, everyday school and in private language institutes as well. In particular, English is a compulsory school subject at elementary school (6-12 years old) and secondary school (13-18 years old). In addition, in secondary school, they have the option to study an additional foreign language of their choice – either French or German.

Children with dyslexia that were assessed in the English training were compared to a control group representing normal development, to ensure comparability in curriculum levels. In the dyslexia field, studies include control groups to be compared with the group with students with dyslexia (Calet et al., 2019; Douklias et al., 2009; Goswami, Gerson & Astruc, 2010). For example, Castles and Coltheart (1993) focused on surface and developmental dyslexia using 53 typically developing readers matched in age with the group with dyslexia. They found that in lexical and sub-lexical reading skills, typically developed students performed better than individuals with dyslexia. In another study, Mannis et al. (1996) examined the level of word recognition of students with dyslexia by using words and nonwords tasks. To meet this aim, they recruited reading age control children and found that they present better results than individuals with dyslexia.

A methodological issue in the study of developmental dyslexia is whether control groups should be chosen taking into account the chronological age or the reading age of participants (Adinis & Nunes, 2009). There are studies that have used reading level controls such as Manis, Seidenberg, Doi & McBride-Chang (1996) and Stanovich, Siegel & Gottardo (1997) and have found significant differences between the control and experimental groups. However, there are researchers who have argued that reading age is defined as the number of real words that can be read accurately (Greenberg, Ehri

& Perin, 2002; Snowling, 2001). For this reason, it would be difficult to uncover different cases and subtypes of dyslexia. Thus, it is important to note that another reason why a control group was chosen in the present study is due to the fact that standard and expected errors that occur during the initial stages of learning a foreign language might bear similarities with the errors that can be found and are due to reading difficulties. By presenting the differences in errors between dyslexics and control groups, the assumption that dyslexics are making errors according to normal development is rejected.

This helps to explain why in the present study, a chronological-age-matched control group was selected. Twenty typically developing children who were learning English as a foreign language were also included in this study to compare their reading skills with to the dyslexic group in the English training. The control group students had not reported reading, or any other difficulty and the researcher asked the teacher to select those students based on their curriculum scores to ensure that similar curriculum levels are met. Participants had a typical educational participation and attended school regularly.

Since age is known to affect reading abilities (Gathercole, 1998; Hales, 2008), groups were matched and did not differ in chronological age, although they did differ in their reading accuracy and reading speed confirming the classification between the group with dyslexia and without dyslexia. Specifically, an independent t-test was used for group differences between the dyslexics and the control group (mean age= 10.52, SD=.512, range=1) for the demographic characteristic of age and it was found that there were no significant differences ($t(59) = 1.015, p = 0.157$). Furthermore, the control group was matched for schooling to the group with students with dyslexia.

	<i>N</i>	<i>M</i>	<i>SD</i>	Male	Female
All Participants	130	9.89	1.104	72	59
L1 group	70	9.26	1.073	37	33
L2 group	40	10.68	0.572	26	14
Control Group	20	10.52	0.512	9	12

Table 1. Groups of participants

Moreover, a further analysis concerned participants' gender. Studies in the dyslexia field have consistently demonstrated that males present higher levels of learning difficulties than females (e.g., Swan & Goswami, 1997, Snowling, 1987). Specifically, Shaywitz (1996) found a surprising difference between men and women in the locus of phonological representation for reading. In men, phonological processing engaged the left inferior frontal gyrus, whereas in women it activated not only the left but the right inferior frontal gyrus as well. In the present project, regarding the L1 group, a chi-square analysis of the total numbers of males ($n=37$) and females ($n=33$) was found to be non-significant ($\chi^2(69) = 70.000, p = .444$). Regarding the L2 group, for those with developmental dyslexia, males ($N= 26$) were more than females ($N= 14$). A chi-square test showed that the difference was significant ($\chi^2(80) = 114.000, p = .008$). In the control group, the chi-square analysis of the total numbers of males ($N=9$) and females ($N=12$) again showed a significant difference ($\chi^2(42) = 70.000, p = .004$). Based on these results, statistical analyses indicated evidence of difference between gender however, it is notable that although there is difference between men and women still further research need to be conducted to investigate this relation and the possible causes of this differentiation.

This procedure involved the assessment of other children than those that are reported but the final selection of sample was completed based on the described criteria. 10 participants were not included in the study as they were characterized as outliers and there was no attempt to choose participants based on socioeconomic status.

Gathering this sample of participants is a difficult task taking into consideration the particularities of a dyslexic group. This fact could be attributed as one of the reasons that the majority of studies in the dyslexia context include small number of individuals with developmental dyslexia. However, this is not the case for the present study as the sample size of participants that was gathered was enough to run statistical analysis. For example, studies like (Kormos et al., 2009, Everatt et al.,) include less than 100 participants. Including a small number of participants significantly affects the statistical power of the analysis. In theory of analysis, the bigger the sample size of participants, the bigger the significance of the statistical test. Moreover, studies have led to overestimation and based on one assessment (more on Peters & Ansari 2019) also leads to overestimations of effect sizes. For these reasons, and in order to prevent statistical ambiguity, 110 students with developmental dyslexia were selected for the present project.

3.5. Data collection instruments

To answer the research questions of this study, a variety of both qualitative and quantitative instruments was used. Mixed methods approach and the adoption of a variety of research tools allows for the triangulation of data and reinforces the reliability of the findings (Dornyei, 2007). In this section, I will first present the training programme and secondly, the instruments to investigate emotions. In addition, this study has adopted an independent measure design. According to this design, separate

sets of participants of the same group are exposed to different experimental conditions (Dornyei, 2007). In the present thesis, different participants were used in each condition (i.e., visual-auditory) of the independent variable (i.e., dyslexia).

3.5.1. The Sensory Training

As discussed in the literature review, individuals with developmental dyslexia are not able to acquire standard reading skills due to an underlying visual and/or auditory deficit (Goswami, 2015). Studies (Goswami et al., 2009; Stein, 2018; Goswami et al., 2013) have indeed found a relationship between visual and/or auditory processing and reading ability in dyslexics. In the present study, a training on sensory deficits was conducted, which is described in detail in what follows (research question 1).

As Stein (2018) suggested, the most powerful way to show that there is indeed a deficit would be to argue that by improving the performance of individuals with dyslexia, their reading would be improved too. A similar idea was put forward by Lawton (2017), who trained dyslexics' functioning by making them decide which is the direction of motion of progressively moving gratings. While the contrast sensitivity started to be improved, the researcher reduced the contrast of grading, and this affected children's reading. Chouake et al. (2012) trained participants in faster movements and the participants presented improved lexical decision and reading accuracy. These research results support the need for a training programme in the current study too, which helped towards answering the research questions.

Specifically, the total number of participants was divided into two groups. One of the groups was assessed in visual tasks and the other group in auditory tasks. The purpose of these tasks was to train the participants' perception of sound structures and to attend

to both visual and auditory patterns, in order to be able to analyze and then match their similar element structure in time and space. Additionally, not only a visual but an auditory training was also conducted, for the purposes of first exploring the effect of these deficits on stress assignment, and second confirming the role of visual impairment on the reading performance of students with dyslexia as a control group. The efficiency of the training should be tested in relation to the students' reading performance and thus, in the present study, this was done through the stress pattern assignment.

Stress pattern sensitivity of students with developmental dyslexia has been the focus of attention in a number of studies. For instance, Goswami et al. (2013) and Paizi et al. (2011) found an impaired perception of syllable stress in children with developmental dyslexia in relation to an auditory deficit. However, as yet there is no research that examines the direct relationship between sensory deficits and reading performance, as studies have mostly investigated stress errors with respect to phonological awareness (Cutler & Mehler, 1993; Wood, 2006; Wood & Terrell, 1998). This could be explained by the fact that other languages do not assign a marker to visually indicate the stress pattern. In addition, in the present study, apart from stress assignment, phonological errors were assessed as phonology and reading have been proposed to be highly connected with literacy deficits especially among dyslexics (Snowling, 2000).

In order to assess reading performance, participants were asked to read two meaningful passages, one before the training (pre-test) and one following the training (post-test). This was intended to record the performance of each child before and after the intervention to check for potential improvement in stress patterns as a result of the training. Both texts were of the same level of difficulty and length. The participants were instructed to read aloud the first passage within a 5-minute time limit; speed

(minutes per syllable) and accuracy (number of errors adjusted for the amount of text read) were scored.

To compare the performance of participants in both the L1 and L2, the same instrument was administered and is going to be described in the following sections. Instead of the stress identification tasks in Greek, passages in English were given to students so as to test their stress performance. This enables a homogeneous comparison between the languages and their differences. Although there are a number of standardized English materials available, using these would not permit an objective comparison to answer the research questions.

3.5.1.1. Lexical Stress identification task in L1

Two passages were administered in L1 (Greek), and participants were assigned to read the text. The texts were selected based on their vocabulary, length, type of grapheme-phoneme correspondence, and familiarity with the words. The set of passages contained the same number of high frequency and low frequency words to allow for checking for a variety of errors. In both passages, the selected words contained 2-10 letters and ranged from one syllable to five-syllable words. Both texts were of the same level of difficulty. They were downloaded from the webpage of 'The Centre of the Greek Language' at <https://www.greek-language.gr/greekLang/index.html> and specifically from the 'Text Corpora' page. Moreover, this site was selected as a means of reinforcing the validity of the task because the selected passages were appropriate and recommended for students on the above-mentioned website, and they are often used by teachers for supplementary material during tutorials.

On the website, the available texts were divided according to the level of difficulty and the corresponding schooling level. Taking into consideration the age spectrum, one of

the aims of choosing the appropriate text was for children of all ages to face an average level of difficulty including both high and low frequency words, that is being neither too difficult for the younger participants nor too easy for the older ones. As Protopapas et al (2007) also used this measure of frequency in their study to including high and low frequency words varying in length and orthographic complexity.

Passage 1 was written by Georges Sari with the title ‘The maypole’ (see Appendix E). The text consisted of 254 words containing words from one to five syllables written in font Calibri and size 15. Passage 2 was ‘One neighborhood, two seasons’ written by Anna Kokkinidou (see Appendix E). The text included 259 words of one to five syllables words, written in font Calibri size 15.

The above tasks were assessed in terms of reading fluency (phonological errors in words, letters, stress and punctuation) and reading speed. In order to reduce variability, randomization and counterbalancing was applied. Hence, the texts were presented interchangeably to students. For example, a student would read the Passage 1 and after training the Passage 2, while another student would start with Passage 2 and after training would read the Passage 1. Participants were asked to read aloud the texts as clearly as possible. The instructions were: *‘Now I would like you to read a passage for me’*.

3.5.1.2. Lexical Stress Identification task in L2

The Greek language system is simpler in phonotactic structure than other languages and includes high consistency between orthography and phonology (Botinis, 1989; Douklias et al., 2009). The Greek phonotactic system includes prevalence of consonant-vowel syllables making it less complex than English and other non-transparent

languages (Douklias et al., 2009). However, this is not the same for other languages such as English which is considered a non-transparent language. For this reason, it was interesting to test the relationship between stress assignment and visual/auditory deficit in dyslexia in a language other than Greek (transparent) and that could be in English as L2, also given the obligatory status of English in the Greek education system.

Regarding the L2 task, the same procedure as the L1 task was followed, with the only difference being that the passages were in English. In particular, in the phase of pre- and post-test, texts were administered to examine the stress assignment of children with dyslexia and compare the scores of stress errors after the training session. Two passages in English were used and participants were asked to read the texts as they would normally do. Both texts were of the same level of difficulty and length. The texts were also matched with their level of proficiency in English. The aim was for children of all ages to face medium difficulty including both high and low frequency words.

Both texts were sourced from the coursebook 'Cool English' by Annette Sullivan and Susan Newton, which is used with students that are learning English at level Junior B in Greece. Passage 1 was written by Charles Dickens and its title is 'Oliver Twist' (see Appendix F). The text consisted of 200 words containing words from one to five syllables written in font Calibri and size 15. Passage 2 was untitled (see Appendix F). The number of words was 189; the text contained one to five syllables words, written in font Calibri size 15.

3.5.1.3. Training

According to Stein (2018), training can be considered the best way to test if dyslexic deficits affect reading fluency. Therefore, training on visual and auditory tasks was used

in the present research. A training of non-linguistic tasks, in visual and auditory modalities, was set to examine if there will be an improvement in the stress assignment. The same training was administered to both groups in the Greek and the English assessment, and each participant was trained to one category only, either visual or auditory. Each category was administered alternately as one participant would be practiced on the visual training and the next participant would be practiced on the auditory training.

As there is growing interest in the multidimensional nature of reading difficulties, Wright, Bowen and Zecker (2002) suggest that nonlinguistic perceptual testing in reading difficulties is very crucial in order to identify the level of pervasiveness of impairments in nonlinguistic perception. Moreover, they suggest that various aspects of auditory/visual perception and linguistic performance should be tested in individuals. By using this method, the understanding of the multidimensional nature of these deficits will be enlightened and different hypotheses that have appeared in the dyslexia literature will be reconciled (Wright, Bowen & Zecker, 2002). Based on their suggestions, this training was constructed following this structure.

Visual Discrimination Task

Recent research shows that visual training regimes, such as regular video game playing, can dramatically alter one's psychophysical abilities (Green & Bavelier, 2003). Several studies have been conducted to find if there is indeed a difficulty in visual perception. For example, Lawton (2016) focused on magnocellular function and trained children with dyslexia by instructing them to decide which is the direction of motion of progressively moving gratings. He found that the magnocellular sensitivity was progressively increased, and as a consequence, the reading of children improved.

Similarly, Chouake et al. (2012) conducted a training to detect if there is relationship between magnocellular activity and reading abilities. They found that visual training is possible to improve lexical decision. Likewise, Franceschini et al. (2015) found that by getting dyslexic children to play video games that are action themed helped to improve both their visual perception and reading.

To train participants on visual processing, a task with pictures was designed (see Appendix G). Similar tasks have been administered in previous research such as in the study of Fukuba al. (2009). Researchers were presented 3 groups of visual stimuli with two similar illustrations per turn including 5 or 9 differences. Moreover, in the study of Hansen & Hansen (1988), researchers displayed happy faces and the task was participants to find the angry face and vice versa. In the present study, twenty (black and white) pictures were presented to participants individually. The task was to look at a booklet of pictures and then follow the game *Find the differences*. The researcher said: ‘We are going to play a game in which you have to look carefully at some pictures. In every sheet there are two similar pictures, which have some differences. Can you notice what these differences are?’. In particular, they were instructed to indicate and circle differences between two similar pictures. In these two images, some details were altered, for example the number of petals in a flower or the presence or not of a small animal, differing in minor visual details.

The purpose of this visual search was similar to other studies; the participant would get used to finding small differences and the visual deficit would be improved. Detailed comparison of these pictures requires visual attention such as the selection of visual input for the processing of detailed information. In general, not everyone can notice the differences in the two pictures. Noticing these differences presupposes visual awareness. Thus, during this training, the person who detects a difference will start

looking for other differences, while someone that would not find the difference will continue to search for it. In this way, the participants need to have employed visual attention and awareness, functions that are impaired in students with dyslexia. Moreover, 'serial search requires sequential allocation of attention mediated by the dorsal stream, hence dyslexics have repeatedly been shown to face difficulties at it' (Stein, 2018, p.5).

In total, twenty pictures were shown: ten original images were presented and ten images similar to the original ones. Moreover, the task included a scale of difficulty. In particular, the assignment was divided into three parts. The first part consisted of two sets of paired pictures depicting big visual details and participants were advised to find seven differences. In the second part, two sets of paired pictures were administered, and participants had to find fifteen differences in total. The third part consisted of two sets of pictures and participants were assigned to find nineteen differences. As tasks were going on, depictions were becoming more complex and detailed, making it harder for participants to recognize differences. The task lasted for as long as the participant could find all of the differences in the picture. If the participant was facing difficulties to find differences, guidance was provided by the researcher. In both tasks, before the training there were two practice trials, in which the participant received feedback and explanation. The full set of training lasted around 15 minutes.

In other studies, eye movements were recorded or trained. For example, Leong et al. (2014) used saccadic training with elementary students, which helped to improve their reading fluency. According to Stein (2018), eye movement training has been found to improve vergence and accommodation in both increments in reading comprehension and decrements in errors. However, in the present study, due to Covid-19 and since the

researcher had permission to stay with students for only a very limited amount of time, this could not be achieved.

Auditory Discrimination Task

The majority of studies on auditory deficits have provided support to the hypotheses that individuals with dyslexia have impaired auditory processing particularly on source sounds and fast transitions (Ramos, 2003). One of the first studies was Talla (1980) who created an auditory temporal order judgment (TOJ) task to prove that dyslexic children need more time to determine which is the correct order of tones than the control group. Although criticized excessively (Mody, Studdert-Kennedy & Brady, 1997), her research paved the ground for replications of her study (e.g., Hood & Conlon, 2004; Landerl & Willburger, 2010; Steinbrink, Zimmer, Lachmann Dirichs & Kammer, 2014). In addition, deficits have been found through other auditory tasks too such as repetition tasks (Rey, De Martino, Espesser, Habib, 2002; Share, Jorm, MacLean, Matthews, 2002) and discrimination of frequency and intensity (France, Rosner, Hansen, Calvin, Talcott, Richardson, & Stein (2002). Moreover, the sensitivity to frequency and amplitude alterations that characterize word syllable and phonemic boundaries is another technique to test auditory temporal processing. McAnally and Stein conducted the first study on adults with dyslexia (1996). However, all these research tools could provide hypothetic relations between auditory sensitivity and stress pattern.

The training in the present study depended on these tasks but with some adaptations to meet the research aims. Melodies were chosen as the best option for the training. Gordon et al. (2015) and Thomson et al. (2012) have shown that musical rhythm training can contribute to improving dyslexics' morphological abilities (Stein, 2018).

In another study, Goswami, Huss, Mead, Fosker, & Verney (2012) found that musical beat perception and amplitude rise time discrimination were significantly poorer in students with dyslexia than younger reading-level matched controls (Goswami et al., 2013). Based on this evidence, a training on music rhythm and melody discrimination was designed. This oddity task can be applied to syllable and phoneme tasks (Aidinis & Nunes, 2001) and can relate to reading.

Detailed comparison of these melodies requires auditory attention such as the selection of auditory input for the processing of detailed information. In general, everyone can hear the melodies and differences, however, not everyone can notice them. Noticing these differences presupposes auditory awareness. Thus, during this training, the person who detects a difference will start notice other differences, while someone that did not find the difference will continue to not detect that. In that way, the participants need to have employed auditory attention and awareness, functions that are impaired in students with dyslexia.

A battery of tasks was designed to examine children's performance in discrimination auditory training. Melodies were played on a Yamaha piano and were recorded by a microphone (M-audio, Microtrack II). The methodology of the task was similar to the visual task as it was an adaptation of the game 'Find the Differences' in melodies. The researcher said: *'We are going to play a game in which you need to listen carefully to some melodies. At the beginning you will hear the 'correct' sound and after that, a second sound that is different. Can you notice what that the difference is?'*. Children were asked to hear and detect differences between two similar melodies. They would have to assess the highest peak as it happens with stress pattern in language. First, a melody was listened to and secondly another one was played including some changes in the musical notes, for example a higher or lower note than the original one.

In total, thirty melodies were played; fifteen melodies were the original melodies, and fifteen similar melodies were included with small changes. These sequences are composed of beats with short or long-time intervals between them: $\frac{1}{4}$ s or 1s. Participants were required to listen to each set and then decide in which part they detected a difference in the melody. Both verbal responses and points with pencil were accepted as responses. In this production task, participants were instructed to use their pencil and tap the difference in the melody they detected or the sequence of notes that were reproduced by the device. In the sound pairs there was a scale of difficulty, as well. As the participants were succeeding in the task, the sounds were becoming more and more difficult. In particular, the sequence difficulty was increased progressively: they were designed with similar sounds and a quicker rhythm. Regarding the changes in the melodies, there were three levels of difficulty. The first level included one different note in each melody. The second level included two different notes in each melody and the last level three different notes in each melody. In both tasks, before the training there were two practice trials, in which the participant received feedback and explanation. The set of the training lasted around 15 minutes and the practice items were repeated until the child correctly produced the test items.

3.5.2. Instruments on Emotions

To successfully study emotions in educational settings, a combination of methods and well-structured instruments is required. Specifically, Linnenbrink-Garcia and Pekrun (2011, p.1) highlighted that ‘it is essential that research in this area defines and assesses emotions in a clear and consistent manner’. In particular, the approaches on emotions that were discussed in the Literature Review section have important methodological implications for research of emotions in educational settings.

In the study of emotions, insights from fields such as anthropology, psychology and philosophy have been involved in the debate of whether emotions involve mind or body, meaning or feeling (Lupton, 1998; Williams et al. 2006). These debates are also crucial for educational research as these theoretical assumptions have certain methodological implications (Schutz & DeCuir, 2002). For example, if emotions are considered private, bodily phenomena, they can be studied through a universally psychodynamic framework. On the contrary, if emotions are perceived as culturally related, public performances or power relations, it is more likely to be researched in a specific sociocultural context (Zembylas, 2007). Furthermore, other assumptions such as the belief that the researcher is capable to distinguish their emotions (Craib, 1995), or that research topics are emotionally loaded having an emotional impact on the researcher (Rager, 2005) may undoubtedly influence the design of the research, the collection of data or the analysis.

Emotions are a complex phenomenon and constitute a multifaceted construct. This construct consists of a range of dimensions that makes it difficult to measure it only through one instrument. For example, quantitative methodology could be considered insufficient to approach feelings and states while qualitative research helps towards researching aspects of emotions that would remain unknown if just questionnaires were administered. At the same time, quantitative tools are needed to highlight evidence of the functions and origins of emotions, and qualitative interviews have been thoroughly used in exploratory research to investigate the subjective phenomenology of emotions. Moreover, dyslexia research has focused particularly on the cognitive and linguistic characteristics of students with learning difficulties and its methods of research have been quantitative in nature (Kormos et al., 2009). On the other hand, qualitative research is focused on exploring attitudes, behaviours and experiences. Thus, as both

approaches have particular strengths for the examination of emotions, a mixed-methods approach was chosen as the most appropriate for the study of emotions of students with dyslexia (research questions 4,5).

The research strategy involved systematic search using a questionnaire, a follow-up interview and observations to provide an insight into students' emotions with dyslexia. The combination of a questionnaire with interviews was chosen so that the two instruments support each other and help to achieve a fuller, in-depth analysis. In particular, the purpose of the questionnaire was to help students who may feel shy or reluctant to express themselves in front of others to disclose emotions and beliefs in writing and in a rather anonymous way. Interviews were conducted to gather further information and more analytic statements of the emotional experiences of students. Observations were undertaken to elucidate the data of both questionnaires and interviews, and emojis were also applied in a post-test form to examine participants' emotions after their completion of the tests. Thus, a mixed-methods approach including both quantitative and qualitative tools was applied for the purpose of providing a holistic picture of what students with dyslexia feel and how emotions affect their reading fluency. All dyslexic children completed all research instruments (apart from the control group).

3.5.2.1. Questionnaire

The use of questionnaires in Emotions Research

Questionnaires are one of the most widely applied research tools in the history of research on emotions (Cohen et al., 2007). One of the strengths of questionnaires is that they are considerably easy to construct and efficient in gathering large amounts of information quickly (Dornyei, 2007). Moreover, they elicit information that students

are reluctant or shy to share out loud. However, some issues may arise while using this instrument. For example, in language education it is important to avoid culturally biased questions (Nunan, 1992). Moreover, Dörnyei (2010) stated that questionnaires may result in fictional data because their nature does not permit in-depth probing into an issue; this may occasionally be augmented by the fact that since respondents may be young in age, they are often unmotivated or tend to leave out or misread questions.

Within education, a number of questionnaires have been devised to research the emotions of students. Most of these instruments are measuring test anxiety due to anxiety's long-standing prominence. The first questionnaire designed to systematically assess test anxiety was developed by Brown in the 1930s (Pekrun, Muis et al., 2018). Brown wanted to investigate the frequency and group differences of university students anxiety which was related to exams. He designed 70 items representative of anxiety indicators with answers on a five-point scale. However, back at that time, Brown's questionnaire did not receive a widespread acceptance.

Different pattern was followed for the Test Anxiety Questionnaire of G. Mandler and S.B. Sarason (1952). These researchers argued and wanted to prove by this questionnaire that anxiety has an influence on cognitive performance. In order to test this proposition, they developed a 37 items scale approaching cognitive, affective and other components of test anxiety. Regarding reliability, this scale proved to be strong, and it was validated by linkages between scale scores and level of intelligence from intelligence test performance. Thus, this questionnaire was evolved as a progenitor of many other following instruments (Pekrun, Muis et al., 2018).

Moreover, another known and widely used questionnaire is the Achievement Emotions Questionnaire AEQ. Related to the control-value theory, an aggregate of questionnaires

about emotions was developed (Pekrun, Goetz, & Perry, 2005; Pekrun et al., 2011). This instrument examines relatively stable emotional responses in education and assesses achievement emotions across different educational achievement situations. A considerable number of research has been conducted using this tool and have shown that achievement emotions were predicting student's achievement, course participation and dropout numbers (Pekrun et al., 2004; Pekrun et al., 2005; Pekrun et al., 2002). The scale includes, depending on its version, from 77 to 80 items instructing participant to report emotions before, during or after class. Moreover, Pekrun et al., (2011) proved that the AEQ is a valid, reliable, and internally instrument. Thus, the development of anxiety measurements has opened the way of research to identify the emotions of students successfully and efficiently, its development trajectories and its outcomes.

Developing the 'Reading Anxiety Questionnaire' for the present study

Although questionnaires have been designed to measure anxiety in educational settings such as languages classes (FLCAS; Horwitz et al., 1986) and mathematics (Mathematics Anxiety Rating Scale; Richardson & Suinn, 1972), research lacks a questionnaire that tests the relationship between anxiety and reading performance amongst dyslexic children. The only exception is Saito, Horwitz and Garza's (1999) Foreign Language Reading Anxiety Scale (FLRAS), which does not however address young learners-participants with any form of special learning difficulties, as is the case of students in the present sample. Thus, a questionnaire was specifically constructed to address the needs and requirements of the current study's participants. This questionnaire was inspired by content from the previously mentioned related standardized questionnaires as well.

The questionnaire was created, piloted and refined for this study to gather data on how students perceive anxiety and how and to what degree it affects their reading performance. Specifically, the questionnaire consisted of two parts. Part one was about children's anxiety and Part two concerned their reading performance. The items of these two parts were jumbled up (see Appendix H). Brown (2001) stated that the answers that questionnaire respondents give to one question are likely to affect their response on subsequent questions. Therefore, randomization was adopted to minimize this effect and increase reliability.

The final questionnaire consisted of 10 closed items and 1 open-ended question. The close ended items were measured in a Likert scale which is the most famous type in this category. It consists of characteristic statements and respondents are asked to choose the extent to which they agree or disagree (Dornyei, 2007). After the items are administered, every answer option is assigned to a number and all scores of the same items are summed up. A number of researchers have endorsed the use of Likert Scales in anxiety research. For example, in the study of Jordan, McGladdery & Dyer (2014), they administered a 5 points Likert Scale to investigate mathematics and statistics anxiety in students with dyslexia. Moreover, in the study of Novita, Uyun, Witruk & Siregar (2019), they studied students with dyslexia in Germany and Indonesia by using the Spence Children's Anxiety Scale (SCAS) which is a Likert Scale consisting of four points in the format answer.

In the present questionnaire, an even number of choices (4) was given (Strongly Agree – Agree- Disagree- Strongly Disagree). The choice of 4 instead of 5 options which is the most common one was selected, and particularly the neutral choice was not included in the options. This was done intentionally in order to not make participants to “sit on the fence” and take the neutral non-opinion option given to them (Cohen et al., 2007;

Dörnyei, 2010). Through this strategy, participants are obliged to think and decide which answer they prefer, otherwise they are given the option to leave their answer blank.

Brown (2001) stated that closed-response questions provide a limited range of answers and are less exploratory in nature than open-ended questions. To address this limitation, question 10 ‘Can anxiety affect your reading of a text?’ was followed up by explanatory question 11 ‘How can anxiety affect your reading performance?’. This structure of items was chosen for students to expand their answers and further explain their experiences. This was also done in cases where students are shy during the interview to express their thoughts and emotions. As Dörnyei (2007) stated, open-ended questions allow for freedom of expression and greater richness of responses.

3.5.2.2. Emojis Task

Nowadays, because of digitization, emojis have been utilised as reaction categories to the item on the scales in recent years. As a result, the growing relevance of emojis in social settings and communication has been recognised, and emojis have become a new spelling code (Danesi, 2017). These faces are present more and more often in the everyday life to depict reactions and emotions of individuals without the expectation to have to write using words. In addition, the number of emojis is so high that they can depict most possible expressions of human emotions due to its popularity more and more emojis are being created annually.

The last few years, researchers have employed faces/ emojis to explore children’s attitude to various emotional states. For example, Pexman & Glenwright (2007), in order to investigate ironic criticisms and ironic compliments, administered to children 6-10 years old a nice/mean scale with 5 points. These points were labelled ‘Very nice’,

'Nice', 'Not nice' but 'Not mean', 'Mean', and 'Very mean' and they were depicted by nice and mean faces. In other studies, Alismail and Zhang (2018) investigated the usage of emoji in electronic user experience. Deubler, Swaney-Stueve, Jepsen, and Su-Fern (2020) investigated the effect of using emojis instead of verbal response categories in consumers' emotional responses to products, and Marengo, Giannotta, and Settanni (2017) investigated the effect of using emojis instead of verbal response categories in personality assessment.

Ekman's (1993) goal was to demonstrate the universal of distinct emotions by pointing the facial movements associated with them. Thus, adopting this view, emojis were adopted as the best way to represent emotions and students to identify what they feel. As such, a new approach was employed in the present study in order to capture and explore children's perceptions of emotions. Additionally, emojis were selected because at this age, students are more familiarized with these faces, from receiving it as a sticker by the teacher to seeing it in books and media. Thus, the purpose of these was participants to identify themselves and their feelings easier than by explaining these difficult for this age, states.

As such, a new approach was employed in the present study in order to explore the variety or diversity of students' emotions. Emojis were selected because at this age, students are familiar with these faces, from receiving them as a sticker by their teacher to seeing them in books and media. Thus, the purpose of using emojis was for participants to identify their emotions easier than by explaining them in words at such a young age.

Before and after the training, a handout with 34 emojis was given to the children. It aimed to examine to what extent their emotions had remained the same or had changes,

and to add validity to the study's results. Another reason was that the experience of a task is more recent during the training compared to general, emotion-related questions that could be asked any time. This could help make the results as accurate as possible.

Following the training and reading of the text, children were asked to circle again the emojis that they felt right at that moment. In the pre-test, children were asked how they believed they would feel but because this might not be accurate or precise, a post-test was also used. This would enable participants to have a fresher memory of their emotions and be able to imprint them better. Therefore, the purpose of the post-test emojis was to see exactly what emotion they were feeling and not what they could remember from previous experiences.

Participants were asked to circle up to four emojis/emotions that they felt when reading a text. The emojis were divided into happy and sad faces, and a line was inserted between them. This happened because as also discussed in the pilot study section, the emojis were too many thus making it difficult for the reader to decide which ones to choose. The emojis were based on Plutchik's (1991) wheel of emotions, according to which primary emotions can be mixed for the production of other, secondary emotions. The emojis were administered in a jumbled order to different students to reduce the possibility of choosing only the first few emojis that they would see on the list. Moreover, for half of the participants, positive emojis were shown first on the task, whereas for the remaining half it was negative emotions that were shown first. This was done for the purpose of reassuring that the line drawn between positive and negative emotions would not influence their choice (see Appendix H).

3.5.2.3. Interviews

Using interviews in Emotions research

Questionnaires are only one way of collecting information from people and ideally can be used in tandem with other research tools (Gillham,2007). Although a questionnaire is considered a versatile instrument which allows for the collection of large amounts of data in a short period of time, it comes with some weaknesses. The engagement of the participant tends to be characterized as shallow and potentially also superficial. Moreover, in case some unexpected results are found, the researcher will find it difficult to interpret them. Therefore, by adding a subsequent qualitative component to the research design, this weakness can be remedied. Creswell et al. (2009) have named the combination of a questionnaire and a follow-up interview as ‘a sequential explanatory design’.

According to Gass and Mackey (2005), interviews are a very important qualitative tool as they help the researcher to study phenomena which otherwise might not be observable. In particular, in measurements of psychosocial sciences, the issue that arises is that psychosocial attributes are difficult to be directly measured (Bartolucci, Bacci & Gnaldi (2015). Asking individuals questions is a natural way to talk about and explain matters of everyday life (Dornyei, 2007) and thus, according to Nunan (1992), interviews are used widely for research. In the present study, semi-structured interviews were selected, because although a guide of questions is followed, there is also room for deviation and for probing into interesting points made during the interview conversation.

The interview protocol

In the present study a semi-structured interview was crafted. Although the order of the interview was prearranged, depending on the direction of the discussion, there was space for deviation. In this interview type, researchers have a specific framework to be answered and invites an open resource. With this type, researchers have specific questions that can follow and enables an open answer (see Appendix M)

Having in mid that ‘the fundamental principle of qualitative interviewing is to provide a framework within which respondents can express their own understandings in their own terms’ (Patton, 2002, p. 348).’, researcher created this framework. Particularly, a follow up interview was crafted after the questionnaire to investigate not only anxiety but other emotions that are related to reading performance of students with dyslexia. Interview questions focused on personal goals, feelings about and experiences of these students. to provide an inside into educational emotions.

The interview guide included 10 questions which focused on the following broad topics: language learning experiences and anxiety/emotion coping strategies. Since in the research field, there was not interview framework to answer the research questions of the study, the questions were based on similar studies and sources such as Kormos et al., (2009), Stampoltzis & Polychronopoulou (2009), Gkonou (2015). The interview guide (Appendix M) includes a variety of questions. In particular, first questions were general, and participants were asked what they think about the whole experience and whether they faced any difficulty with the texts. Followingly they were asked what kind of emotions they usually feel during reading and especially if they feel anxiety or confidence, focusing on self-expectations of a possible poor performance. In the cases where students answered anxiety questions such as ‘When you are reading a text and

you get stressed, what is it going to happen? For example, do you make a few mistakes or are you becoming more careful, and you don't?' were applied. Similar questions were asked when participants answered that they are feeling positive emotions. Children were also asked how they thought their emotions may affect their reading performance. Moreover, ice-breaking questions were introduced at the start of the interview to make students feel more comfortable. The interviews were conducted in Greek and each interview lasted approximately 10-15 minutes. Participants were interviewed individually, since the aim was to talk about personal experiences and emotions.

3.5.2.4. Observations

From a research perspective, observations are used to understand the context within which people interact and provide a clear description of the actions and attitudes of the observed person. They are differentiated from questionnaires since they provide 'direct information' rather than self-reported data and enable observers to analyze directly what participants do without relying on what they express verbally (Dornyei, 2007). Another strength is that they offer an objective view of events and behaviours adding value to the research (Bryman, 2016). In this way, the researcher learns about things that people may be unwilling to discuss in an interview or disclose in a questionnaire.

Observations have been thoroughly conducted in ethnography and teaching (classroom observations). However, as Ahmed (2004) has stated, emotions are located in movement and can be externalized. This can be considered useful source of information for researchers who are studying vulnerable groups such as students with dyslexia. Especially, this group's emotions are very fragile as they have weak verbal skills and might be unable to articulate how they feel (Rajabion Esgandani, & Panahali, 2020).

Therefore, the process of investigating their emotions becomes more reliable through observations. In addition, through observations the researcher is able to see things that participants are not consciously aware that are happening. With respect to anxiety in particular, observations can help to see certain physiological symptoms too such as sweating and fidgeting, which constitute useful data too (de Gelder & Hadjikhani, 2006).

On the other hand, one of the disadvantages of observations is that if one is studying mental processes, these are difficult to be observed (Dornyei, 2007). Moreover, recording and observing a phenomenon doesn't automatically explain the reasons why something happened (Dornyei, 2007). However, assumptions are difficult to be made by just observing someone once. Therefore, the role of the observations in the present research is to support the data collected through the other research instruments, allow for triangulation and improve the reliability of the data.

As Linnenbrink-Garcia and Pekrun (2011, p.2) have stated, 'the assessment of emotions needs to move beyond self-reports to consider physiological markers and facial as well as postural expressions'. Understanding the fact that in this stage, the research on emotions requires more precise evidence, observations were included in the present methodology. As Zembylas (2011, p.152) argued, 'emotions do not come from inside us as reaction but are produced in and circulated between others and ourselves as actions and practices'. Specifically, in this project, dyslexic students were observed during the linguistic task (reading assessment) to identify the embodied expressions of emotions as revealed through their bodily dispositions during reading.

Data from observations can be collected in various ways such as participant or non-participant and structured or non-structured observations (Dornyei, 2007). In the

present study, non-participant observations were employed as the researcher did not take part in the tasks/ activities. This enabled her to detect signs and changes in students' body language. Additionally, the observations were naturalistic as the aim was to depict the spontaneous behaviour in natural settings, and overt because participants were aware that they were being observed (Cohen, Manion & Morrison, 2011). However, during the reading the child did not have eye contact with the researcher, which gave the researcher the opportunity to make notes and to prevent the Hawthorne effect (Adair, 1984; McCambridge et al., 2014), according to which the behaviour of a participant may change because they are aware of the fact that they are being observed.

The observations were conducted through notes in the form of a checklist with basic ideas, which was used to record the findings. After each observation, the researcher expanded on notes to describe in detail what she saw. These included information on body language, physical characteristics, facial expressions, reactions, behaviours or gestures that the participants were making while reading.

All of the above were useful strategies for recording if reading is a moment of discomfort or it brings confidence to students. In the case of the present study, it adds to our understanding of data collected through other tools and offers additional insights into aspects that these children might have been unwilling to discuss in the interview or write about in the questionnaire, thus offering a rounded picture of the participants' reading performance and emotions in dyslexia.

3.6. Pilot Study

Piloting data collection instruments is a vital stage in research in order to create reliable tools and “any attempt to shortcut the piloting stage will seriously jeopardise the psychometric quality of the study” (Dörnyei, 2010, p. 54). Therefore, all of the instruments were piloted before the main collection of data. Gass and Mackey (2007, p. 3) warned that the piloting stage ‘can reveal subtle flaws in the design or implementation of the study – flaws that may not be readily apparent in the plan itself, but that could otherwise prove costly and time consuming, perhaps even leading to the loss of valuable and irreplaceable data’.

Specifically, Sensory training was piloted with a similar sample ($N=5$). After obtaining consent from the Ministry of Education, the training was administered to the students of the first school I approached. None of the students that participated in the piloting of all the instruments were recruited in the main study.

The pilot study of a questionnaire can indicate questions that have ambiguous wording, unclear meaning or questions that are difficult to answer as well as issues with the administration and layout of the questionnaire (Dörnyei, 2010). Therefore, the questionnaire was piloted with a similar sample with the one of the main study ($N=10$). Moreover, the number of emojis was higher in the pilot study than the main study but as it was noticed that participants faced difficulty with deciding which emojis to choose, the final number of emojis was reduced to 30.

Regarding the interview guides, they were tested with three students. Their responses and actions were considered in the final adjustment of the interview protocol. Their answers and reactions were accounted when adjusting and refining the format, order

and wording of the questions and minor changes were made for the final interview guide.

3.7. Procedure

Ethical approval for the research was obtained by the Ethics Committee of the University of Essex, and permission was also obtained by the Greek Ministry of Education to conduct the research in schools. All interviews were conducted in winter 2021 at a time that was convenient for participants. The participants were recruited from 50 schools in Athens, Thessaloniki and Mykonos, Greece. All participants had to be L1 Greek speakers and it was required to not have repeated grades. After the approval of the director of the school and staff, teachers were asked to nominate students. Parents of the participants were contacted, and participant information sheets and consent forms were distributed to obtain prior parental consent (see Appendix C).

To examine the sensory deficit that affects the stress pattern, two different groups of dyslexics were created. The first group was trained on a visual task and the second group was assigned the auditory training. For the L1 task, each group consisted of 35 participants and for the L2 task, 20 students were assigned to each group. The total duration of the study was 1 hour.

The reading tasks were presented in a fixed randomized order. The order of the texts was counterbalanced across the participants. In other words, the first participant read text 1 and after the training they read text 2, while the second participant was trained in the opposite way (in the first reading task text 2 was assigned and then text 1). After the pre-test, the nonlinguistic task was presented. A small break of 10 minutes was set in order for the child to rest. Last, the second reading task was administered. The purpose of this was to minimize the chance that maybe one of the passages is easier

than the other and thus increasing the reliability of results. Before the training and the task, the questionnaire with the emojis was administered, and after the training the post-test emojis were given and the interviews were conducted. During the interview, observation notes were also made. Children were also observed while reading out loud. During the practice period, instructions were given by the researcher in Greek. Feedback was accompanied by further verbal explanation and reinforcement by the researcher. Participants were tested individually in a quiet and separate room in the school, and they were asked to read the texts as they would normally read. The experiment was conducted during regular school hours and participants were seated in a comfortable seat. Participants took a break of 15 minutes after the training and additional breaks were provided when children became tired. The assessments were carried out in a fixed order, and they were asked to read aloud as accurately and fast as possible. The students participated voluntarily without any form of compensation or payment. It is worth noting that when participants would self-correct, the final response was used for scoring and analysis. Participants could refuse to continue with the experiment and withdraw from the study and they were encouraged to respond even when they were unsure about pronunciation.

During the procedure, stimuli were presented printed in A4 photocopies, font Calibri, size 16. Responses were recorded using the M-audio, Microtrack II. Visual stimuli were presented in A4 sheets of paper based on the level of difficulty. Photocopies were selected as the preferred mode based on the research of Protopapas & Skaloumbakas (2007, p. 18) who argued that 'it is possible that a child is very distracted when carrying out the computer-based tasks, leading to poor performance' and based on their findings they discussed their concerns on computer-based tasks. All auditory stimuli were presented at a comfortable volume. At the end of the experiment, children were invited

to ask questions. Additional breaks were given in case children became tired. The training and materials were controlled by the researcher. Participants were asked to read aloud the items as quickly and as accurately as possible.

When the teacher was bringing the child in the room, they would usually explain that I am also a teacher, or a friend of their teacher, in order for the child to feel comfortable and willing to participate. Or she would say that I needed their help to complete some tasks I had to do. The researcher was present during the administration of all instruments to ensure the correct distribution of the research and to deal with any participant queries.

3.7.1. Recording

All vocal responses were automatically recorded and timed. The audio recordings were made using a solid-state compact flash recorder (Olympus WS-806) and a condenser microphone. The microphone was placed in a shock mount and positioned at about 10cm from the mouth of the speaker. Samples were directly digitized and stored as WAV files. The audio recordings were copied to a laptop computer as MP3 files and re-sampled for acoustic analysis in the acoustic software package Praat, version 5.3.39 (Boersma & Weenink, 2012). The purpose of the recordings was to save and analyze the data provided by the participants at a later stage.

3.8. Data Analysis

The quantitative data were analyzed through descriptive and inferential statistics and the qualitative data were analyzed through thematic coding. Findings that derived from the collection of data and especially the assessment reports were used as the source of

analysis. Data from 10 participants were discarded due to insufficient responses or poor adjustment of the microphone. The data analysis is discussed below.

3.8.1. Stress Assignment Data

In order to examine group differences on reading efficiency, data on reading accuracy and reading speed were obtained. Moreover, comparisons were made between the two groups (visual and auditory). Two separate analyses were also conducted on the two distinct parameters of accuracy scores and reading speed. These reports provided evidence of literacy difficulties in terms of poor reading accuracy. In addition, particularly in transparent languages such as Greek, reading speed is a good source of information on dyslexia.

3.8.1.1. Reading Accuracy Evaluation

Reading errors and systematic reading failures may reveal aspects of cognitive functions of reading and learning to read. Moreover, reading errors are thought to be strongly related to the orthographic system of a language and the individual's level of competence. The classification of errors should be established to evaluate the performance of participants. The simpler way to evaluate reading is to note whether words have been pronounced correctly or not (Protopapas et al., 2013).

Most error classification schemes concern English words. Moats (1995) was one of the first attempts to classify errors into orthographic, phonological and morphological categories. In the category of phonological errors, words were characterized as legal or illegal based on phonemic accuracies. In the present study, only wrong spelling was considered as indication of deficit in learning the phoneme-grapheme correspondences. However, other studies (Bruck & Waters, 1988; Siegel, Share & Geva, 1995) have included letter overlap between the correct letters, and other studies (Target & Blachman, 1992, 1995; Treiman & Bourassa, 2000) have included some other features

of the words such as spelling and sound-based errors. In other more transparent orthographies than English, studies have focused more on orthographic, morphological or grammatical errors than phonological errors (Caravolas and Violin, 2001 in Czech and Hoefflin & Frank, 2005).

In general, lexical stress is characterized by changes in pitch, duration and intensity (Arvaniti, 2000). However, the importance of these cues may vary across different languages. For example, alternations in pitch are significant for cueing lexical stress in English, while syllable duration is more significant in German (Dogil, 1999). In the case of Greek, lexical stress is acoustically signaled by a combination of factors (Papakyritsis, 2013). According to Arvaniti (2000), in order for a syllable to be heard and considered stressed, this syllable has to be more prominent than the other unstressed syllables and more prominent compared with the same syllable in the case where it is unstressed. In the Greek language, this translates into longer duration and higher intensity and amplitude (Botinis, 1989; Arvaniti, 2000). This means that if these acoustic cues are not the highest ones in the stressed syllable compared to the other syllables of the word, it means that it is possible for listeners to not consider it as such. Therefore, regarding of acoustic stress cues, the difference between signaling the incorrect stress position OR signaling the stress position in an unusual form is likely to be up to the difference of the direction and degree of change of the acoustic stress responses (Papakyritsis, 2013). Moreover, both duration and amplitude of stressed vowels are not significantly and consistently greater than the unstressed vowels (Papakyritsis, 2013).

For the above reasons, for the evaluation of correct or incorrect stressed syllables, it was decided to compare the duration, internal amplitude and intensity. This was achieved through Praat, but resulted to wrong results as in some cases there were words

that although acoustically were considered as correctly stressed, frequency and intonation rates of the participants' reading were not valid. As such, these criteria were not viewed as the best option. This is supported by other studies with students with dyslexia who found that these measures were not reliable (Behrman, 2005; Leong, Hawkshaw, Dentchev, Gupta, Lurie & Sataloff, 2013). Moreover, according to Dauer (1980), only high Greek vowels are decreased and unstressed vowels are not phonetically reduced (i.e. centralized) making it difficult to analyse it in PraatSoftware. It is also subsequently stated in Dauer (1987) that languages are distributed over a rhythm continuum and that a language cannot be rhythmically categorized simply on acoustic measures of syllable durations. Last but not least, in a study of Greek stress, Arvaniti (1991) replicates the acoustic results of Dauer (1980) and reports that reduction is more likely for vowels next to voiceless consonants, or word final vowels.

In the past, because of lack of technical facilities, most of the studies on Greek intonation were not based on experimental analysis but on auditory observations by the authors themselves (e.g., Setatos, 1974). On the other hand, there is research that does not centre on how stress was assessed. In other studies regarding stress pattern and languages other than Greek (Burani & Arduino, 2004; Dulay et al., 2015), it was either that researchers noted down the responses during the experiment or they noted down the responses and verified them by comparing them with the auditory records (Douklias et al., 2009; Bonifacci, et al., 2017). This could be critiqued as it violates the validity criteria of research, and there are indeed other studies that do not specifically explain how errors were classified and evaluated (Douklias et al., 2009). To reassure the reliability of the current study, the identification of errors was made by trained evaluators.

For the judgement task, ethical approval was obtained from the Ethics Committee of the University of Essex and before the trial, all participants signed a written consent and information sheets were given (see Appendix B, D). Participants were not informed at length about the background study but only about the task that they were selected for. If participants were aware of the goal of the study, their judgement might have been affected. They were informed that they will listen to some audio files and their task would be to judge whether they hear reading errors.

The passages were presented on a computer screen and were displayed in Arial Greek and at the same time the answers of dyslexics were listened to. Reading responses were transcribed based on the audio. They were assigned to mark with colour all the errors that they heard in the audio file and if there was an error that could not be assigned to the given categories, to write down the error. Furthermore, participants were allowed to hear the audio file as many times as they needed or to turn back to listen to a specific part again. Reading accuracy, and especially stress pattern assignment, was assessed during the test. Self-corrections were considered as a correct word. An example of the task was provided to the evaluators.

Having transcribed the results of the evaluations, results are listed in Table 3. The total number of errors that children made was divided in stress errors, pronunciation errors, punctuation errors and others. In particular, stress errors were categorized as those errors with incorrect placement of stress by assigning dominant stress to non- dominant stressed words or to a word which is not stressed (for example *τερμά* [te'rma] instead of *τέρμα* ['terma]). Since the main area of interest was stress assignment, this separate category was created. Errors were classified as pronunciation errors when the participant did not pronounce accurately at the segmental level. In particular, these kinds of errors are categorized by omitting phonemes or syllables (e.g., *εγονός*

[eɣo'nos] instead of εγγονός [ego'nos] or μία ['mia] instead of καμία [ka'mia]), substituting (e.g., νοτιά [noti'a] instead of νιάτα ['niata]) or inserting phonemes (e.g. και [kai] instead of κι [ki]). Punctuation errors were classified when participants were omitting or substituting the punctuation marks. For example, in many cases dyslexic children were using full stop instead of comma or did not generally use the full stop.

L1 Assessment

Three native speakers of Greek were recruited, working in education and who had experience working with dyslexic children. Therefore, each passage was judged 3 times to increase the validity of results. Judgement by native speakers was the most appropriate form of evaluation in order to ensure reliability.

The classification was mainly based on the classification that Porotopapas et al. (2012) followed. Individual errors were classified into 8 major categories. These categories were defined based on the type of errors that they described. In a confirming classification and analysis of participants' errors, the question 'What errors can you recognize in this reading passage?' was addressed. The goal was to listen to the child read and at the same time to note in the text the mistakes they made when reading. The judgment task was transcribed into Excel and one point was given for each wrong response even if a word contained more than one error. The types of errors were divided as follows and marked in the text with different colours:

- Wrong word: purple
- Wrong letter: pink
- Word addition: green
- Letter addition: light blue
- Punctuation: grey
- Letter omission: blue
- Line omission: cypress
- Stress: yellow

L2 Assessment

Three proficient speakers were recruited to assess the errors in the assessment of the English language. To increase the validity of results, a native speaker of English was asked to record themselves while reading the two passages of the assignment. The recording was then given to the evaluators so that they base their evaluation on that. They were further instructed while they were marking the errors to trace back to the recording of the native speaker if they were unsure about pronunciation. A word considered to be accurately pronounced would also have to include correct stress assignment.

The same classification was followed as in the Greek assessment with the only exception being that in English, students were making pronunciation errors and therefore, this category was added too.

Wrong letter pronunciation: red
 Wrong word pronunciation: blue
 Skip letter: blue
 stress errors: yellow
 wrong letter: pink
 wrong word: purple
 add letter: light blue
 add word: green
 wrong punctuation: grey
 wrong row: cypress

All these errors were asked to be assigned in order to reassure that evaluators will not have in mind only the stress and to be more reliable. The judgment task was transcribed into Excel and one point was given for each wrong response even if a word could have more than error. Monosyllabic words were excluded from the L1 assessment because

children did not make mistakes with those as they did not require stress assignment. On the other hand, monosyllabic words were kept in the English text because they formed the majority of the text and it would be interesting to examine how children would read them in the L2. Separate groups were created for each kind of errors. In particular, the major categories were (1) stress errors, (2) pronunciation errors, (3) punctuation errors and (4) identification errors.

3.8.1.2. Reading Speed

Apart from reading accuracy, reading speed was also measured to evaluate the significance of the training. Reading speed was chosen on the assumption that after the training, reading speed will be lower than before the training. In particular, in transparent languages, the evaluation of speed is particularly important as reading speed is possible to be more sensitive to difficulties. For example, in Spanish, Calet et al., (2019) found a correlation between speed and learning difficulties. In the case of Greek, dyslexia was associated with slow reading pace (Nikolopoulos, Goulandris, & Snowling, 2003). In addition, previous studies in Italian have reported that individuals with developmental dyslexia are mainly impaired in reading speed (Zoccolotti et al., 1999).

According to Franzen et al. (2021), frequently, researchers who investigate the reading strategies and skills of individuals with dyslexia during sentence reading, have centered their attention on reading speed in order to measure the performance of participants. These studies report that readers with dyslexia read at a slower rate (i.e., fewer words per minute) compared to readers without dyslexia. The difference in reading rates between individuals with dyslexia and normally developed individuals can be found to be similar to the difference observed in early readers. However, reading speed measures

do not provide insight into cognitive functions nor the visual attention strategy which readers with dyslexia employ written text differently.

In order to have the highest accuracy possible, the stopwatch method was performed as follows: The vocal onset was anticipated by looking for the initial pre-movements of the participants' lips when the reading was initiated, and the end of the text was determined accurately by the last pronounced word of the text. To confirm the reliability of the stopwatch measurements, the reading performance of all participants was double checked based on the recorded audio.

3.8.2. Questionnaire Data

Quantitative data were transcribed into Excel and analysis was performed using the Statistical Package for Social Sciences (SPSS) version 18.0. First, descriptive statistics were used to present and describe data in terms of summary frequencies, means and standard deviations. Then, inferential statistics were run to make inferences and predictions of the data gathered. These included correlations and difference testing, that is one-way analysis of variance and factor analysis.

Each of the 110 questionnaires received a code that was given to each participant as well in order for all materials from the same child to be connected if and when needed. One of the first steps was to convert the answers of the Likert scale to numbers. The questionnaire was answered on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). However, negatively worded items, such as 'I am anxious when I read a text.' and 'I am bored reading a text.', were reversed and recoded. By way of example, if a student selected option "4" for the item "I feel self-confident when I read a text", then s/he would receive four points. On the other hand, selecting "4" for the statement "I am bored reading a text" would be assigned 2 points

since these items were reversed. The total score was derived by summing the students' responses to respective items.

3.8.3. Qualitative Analysis

Preparation of the data

After conducting the interviews, the recordings were manually transcribed verbatim by the researcher and were stored in one file. Some of the interview's extracts were translated for citation purposes.

First of all, the researcher read the transcripts several times to achieve a general comprehension of the data and get an overall idea of the participants' viewpoints alongside their responses via the other instruments. As Richards (2003, p. 273) suggested, "while it is possible to approach the task by coding paragraphs or even larger sections of data, the most productive approach is probably to work on a line-by-line basis, leaving any winnowing and sorting until later".

The second step was to scan the written texts in order to develop a coding scheme, grasp the basic themes in the data and form general categories. Different colours were used to denote a change of topic. Moreover, there were cases where the focal points were noticed to appear sparsely in the text.

Developing a coding scheme

The interview and the open-ended question data were coded using first and second level coding. First, the codes were created and defined. Inductive analysis was employed. This involves discovering patterns, themes and categories in the data. Next, deductive analysis was applied, and the data were analysed according to existing frameworks from the literature (Strauss & Corbin, 1998). Some examples of codes from the existing

literature included emotions, phonological errors, fear of negative evaluation, self-concepts. An example of the suggested codes that were assigned to 7 student interviews can be found in the Appendix N.

Secondly, pattern codes were created as meta codes and different categories were used and integrated in the core categories. Moreover, topics that presented similarities merged together to achieve coherence. The procedure ended when the categories became saturated, resulting in repetition from new sources, as well as when analysis began to "expand" further than the boundaries of the concerns and issues guiding the investigation (Patton, 2002). Furthermore, major themes such as the most commonly referred emotions were quantified as well. Quantifying the data allows comments to be made about the percentage of respondents who raised a particular issue, and it is then possible to make inferences about the extent to which an issue is important.

Regarding the open-ended item, the question 'How can stress affect your reading of a text?' was coded according to thematic analysis and was considered as a guideline for the scheme. In particular, this is a clarification question to further explain the previous question 'Can anxiety affect the reading of a text?' which was of great importance. The themes emerged in the open-ended question found to present similar pattern to the coding scheme of the interview data. As Gillham (2007; p.) stated 'open ended questions can lead to a greater level of discovery'. Moreover, subsequent discussion with a second researcher resulted in modification of the categories, and also provided a means for increasing validity and inter-researcher reliability.

3.9. Quality of research- Measures of Reliability and Validity

In the scientific research, it is imperative to ‘assess and document the legitimacy of the findings’ of a study (Dornyei, 2007, p48). This can be achieved through ‘validity’ and ‘reliability’, which have already been mentioned throughout this chapter. However, both quality criteria will be discussed in more detail in what follows. Validity ‘has to do with the extent to which a piece of research investigates actually what the researcher purports to investigate’ (Nunan,1999, p.14). Reliability ‘indicates the extent to which our measurement instruments and procedures produce consistent results in a given population in different circumstances’ (Dornyei, 2007, p;50). In this study, validity and reliability were considered at all levels to ensure the study’s quality.

Mixed methods research can create evidence for the sake of validity of research outcomes via the corroboration of the outcomes (Dornyei, 2007). The strengths of one method can contribute to overcome the weaknesses of the other method that was used in the study. For example, in the present study, the qualitative component (interviews and observations) added depth and context-specific data to the quantitative results (questionnaire). Moreover, developmental dyslexia and emotions are quite complex phenomena, and their relation can be studied by a multi-level analysis. Words can add meaning to numbers, and numbers can add precision to wording. Thus, through the convergence and corroboration of results that are provided through a mixed-methods approach, quality of the research outcomes can be achieved. Therefore, quality criteria will now be discussed in terms of quantitative and qualitative research respectively as they both contribute to the overall data.

3.9.1. Quality in Quantitative Research

Although concepts of validity and reliability are related, they express different properties of the research instrument. Especially in the case of validity, this scientific conceptualization of measurement has undergone some changes over the years. Three types of validity have emerged and distinguished: ‘criterion validity’, ‘content validity’, and ‘construct validity’ (Dörnyei, 2007).

First, criterion validity examines whether a particular instrument can be related to an external source such as scores in a similar instrument (Creswell & Plano Clark, 2011). There are two types of criterion validity: predictive and concurrent validity (Cohen et al., 2007). Predictive validity is about whether the test predicts with accuracy what it was intended to predict, and concurrent validity tests whether the results are correlated with other results found by using another tool (Cohen et al., 2007; Creswell, 2009). Regarding predictive validity, the final results of the tests were used to answer the research questions set at the beginning, and statistical tests could also mean that the findings could apply to a wider population. For concurrent validity, regarding stress assignment, pre-test and post-test was deployed in order to examine possible differences, as well as in the emotional factor part, three different data collection instruments were deployed in order to further explain and triangulate data and confirm whether the final data converged.

Content validity, according to Bollen (1989), evaluates whether the parameters contained in the research instrument represent the phenomenon intended to be investigated. Taking into consideration that there are still aspects of dyslexia that are unknown, the present research and training aimed to offer a representative depiction of dyslexia difficulties, incorporating areas that had not been researched together before.

Moreover, in obtaining objective results for determining content validity, the quality of experts involved in a project is particularly important (Ayre & Scally, 2014). All measurement instruments that were used in this study were approved by two researchers in the department that are experts in the field.

Construct validity refers to the degree to which the instrument provides measurements for the concept that it is supposed to measure. One way of doing this is by explaining the researcher's rationale through a detailed literature search that would explain all its aspects (Cohen et al., 2007). The findings of this project were not only obtained through a sequential explanatory design and triangulation, but most of the results were compared and contrasted with existing findings in the literature. Nevertheless, comparisons should not be decisive, as new approaches and examinations of dyslexia and emotions were offered in this project. Moreover, another method to ensure the construct validity of the research was by including in the study only those participants with a written diagnosis of dyslexia issued by official, authorised centers. This helped to achieve homogeneity of the sample.

Moreover, variability is distinguished as 'research validity' by internal and external. Out of the six validity threats that Dornyei (2007) named, only two could be applied in this study. The first is the Hawthorne effect (Adair, 1984; McCambridge et al., 2014) according to which participants are behaving differently when they know that they are being researched. The second threat concerns maturation, in which case the development process affects the target variables of the project.

Lastly, reliability of a study refers to the stability of the instruments which were used and their consistency over time (Creswell & Plano Clark, 2011). It is rather unlikely that the exact same results will be produced every time an instrument is used due to

variances at the time the measuring instrument was applied and alternations in the population. However, there are different methods to determine the reliability of scales used in empirical research. Among these, the most frequently applied method is the internal consistency coefficient, the Cronbach's alpha coefficient or the Cronbach's α . Its value ranges between 0 and 1, and when it approaches 1, internal consistency is high. This test was also run in the present thesis and the questionnaire rendered an internal consistency coefficient of .708. This α value means that it is very highly reliable (Cohen et al., 2007; Dörnyei, 2007).

3.9.2. Quality in Qualitative Research

Assessing quality in qualitative research is less straightforward than quantitative research (Dörnyei, 2007). For this reason, over the years, researchers proposed taxonomies and criteria of assessing quality in qualitative research (Guba & Lincoln, 1989; Lather, 1993; Tracy, 2010). As such, in qualitative research, validity is renamed as trustworthiness by Guba and Lincoln (1989) and is discussed in terms of credibility, transferability, dependability and confirmability. Each of these components has an equivalent term in quantitative research.

The criterion of credibility is considered the equivalent of internal validity in quantitative research and considers whether the research outcome is plausible and convincing. As Stenfors et al. (2020, p.598) have pointed out, there should be calibration among 'theory, research question, data collection, analysis and results' while the 'sampling strategy, the depth and volume of data, and the analytical steps taken' have to be appropriate in that framework. Credibility can be enhanced by the use of various methods in order to collect the data (Lincoln & Guba, 1985), a process followed in this project through triangulation and the use of multiple sources of data

collection. A second way of assessing credibility is through the sample strategy. Specifically, the present research included a large number of participants to account for variability and good coverage of different responses and viewpoints.

Transferability is the equivalent of external validity in the quantitative approach and refers to the extent to which the research could be replicated in similar conditions. Ritchie et al. (2003) argued that the findings of qualitative research can be generalized, however the framework within which they occur requires greater clarification. Considering that meanings and behaviours are context bound, extrapolation may be possible under specific circumstances. As Lincoln and Guba (1985) stated, transferability of the research can be increased by providing a thick description of how the research was conducted to enable readers to determine whether the findings are transferable. To this end, I have taken every effort to describe the research methodology with as great transparency as possible. Another means of increasing transferability is by comparing results with previous studies, which was done extensively in the Discussion chapter.

Dependability is 'the extent to which the research could be replicated in similar conditions' (Stenfors et al. 2020, p.598). This component is the equivalent of reliability criterion in quantitative research. Therefore, the researcher should provide adequate information regarding the design and how the research was conducted so as another researcher could follow these the same steps in their study. However, due to the context-specific nature of qualitative research, sometimes researchers faced difficulties to demonstrate which features of the qualitative data should be expected to be consistent, dependable or reliable. For this reason, in the Methodology and Results Chapter, detailed description was given of how the collection and analysis of the data was conducted. Moreover, to reinforce dependability, another researcher from the

department who is familiar with the literature on emotions and emotion words in English and Greek, was asked to assign codes to a sample of the transcripts. The level of inter-coder agreement was above 90%, meaning that agreement on the majority of codes was reached.

Finally, confirmability is considered as equivalent to objectivity in quantitative research. For example, researchers should evidence their claims through the use of quotes from the data. This is evidenced throughout the Findings chapter, where quotes from the data were included to reinforce the trustworthiness of the research. In the same chapter, it was also intended to demonstrate how the research findings relate to the wider body of literature and to answer the research questions.

Summing up, good quality research yields solid, ethical, impenetrable evidence that can be utilised to guide further research and practical implications. Apart from the criteria that were adopted throughout the research to maximise validity and reliability, piloting the research tools and using triangulation are some of the measures that were taken to strengthen the quality of the present study.

3.10. Conclusion

The chapter provided a detailed description of the methodological decisions that were made in relation to the empirical study that is reported in this thesis. The rationale for this study and a critical overview of the mixed-methods approach were presented. Furthermore, information regarding the participants, data collection procedure and analysis of the data was provided. In the following chapter, Chapter 4, the results of the project are presented.

Chapter 4: RESULTS

4.1. Introduction

As explained in the Methodology chapter, the study implemented a mixed-methods design, using both qualitative and quantitative research instruments to address the research questions. Quantitative data were analysed through the Statistical Package for Social Sciences (SPSS) version 18.0., RStudio and Praat. The qualitative data were analysed through NVivo 12.

This chapter reports the results of this project, and it is organised into two main strands: the analysis of the reading performance and the analysis of students' emotions. All quantitative data underwent descriptive statistics which is 'the first stage of analysis' (Dornyei, 2007, p. 213) as well as inferential statistics in order to examine relationships among the variables. For the L1 and L2 linguistic training, the first section presents the descriptive statistics of the phonological errors, stress errors and reading speed while the second section details the inferential statistics used to show if there is a significant improvement in the participants' reading performance.

The qualitative section concentrates on the analysis of the open-ended item of the questionnaire and the findings from the interviews and observations. The original transcripts are presented in this chapter by using quotes of relevant participants' statements, accompanied by observation notes to corroborate the results. Although the two parts are presented separately, they are complementary and will be integrated in the Discussion chapter.

4.2. Linguistic Task in L1

To study reading performance of students with dyslexia, pre and post-test texts of two types of training (visual and auditory) were compared in terms of students' reading

accuracy and reading speed. The group which was instructed the auditory training was chosen as the control group. Two separate analyses were conducted on these two distinct parameters. Regarding phonetic accuracy, each response was rated with one point for each incorrect phoneme produced or missing. Reading speed was measured first as syllables per second and transcribed later by minute, that is the overall number of syllables of the words read by the child divided by the available time (60s).

4.2.1. Descriptive Statistics

4.2.1.1. Reading Accuracy

Analysis of Phonological Errors

The following analysis is based on 3,645 individual reading errors. As previously explained, phonological errors were classified into 9 categories. Table 2 presents the descriptive statistics of these categories according to the training that participants underwent. During analysis, these categories were overcategorized to examine the overall results of the bigger strands. The total number of errors was divided into pronunciation, punctuation and stress errors. Errors were classified as pronunciation errors when the participant failed to accurately pronounce the word at the segmental level (for example, by substituting, omitting or inserting words and letters). Stress errors were classified when stress was omitted or errors made in the incorrect syllable (by either assigning dominant stress to a non-dominant syllable, or no stress assignment to dominant stressed syllables), whereas punctuation errors occurred when participants failed to accurately pronounce or omit the punctuation marks. This classification was based on the categorization of Protopapas et al. (2013) and Paizi et al. (2011) aiming to disentangle errors at the segmental and the supra-segmental level, since they can provide important information about different constituents of reading accuracy.

Particularly, although stress assignment and punctuation belong to the greater category of supra-segmental level, two separate categories were created to examine their similarities and differences.

	VISUAL						AUDITORY					
	Pre-test			Post-test			Pre-test			Post-test		
Phonological Errors	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Pronunciation Errors	592	16.91	10.39	529	15.11	12.69	552	15.77	9.55	556	15.88	9.64
Punctuation Errors	157	4.49	2.874	133 ^a	3.8	3.53	154	4.4	3.318	154	4.4	2.714
Stress Errors	234	6.69	3.315	181 ^a	5.17	3.185	191	5.46	3.081	212	6.06	3.489

Table 2: Central Tendency of Training Groups.

Table 2 lists the frequency, mean and standard deviation of the three main categories for the two phases of the visual and auditory training. Data suggest that group performance offer evidence of selective impairment of word reading. As it was demonstrated in the matching process of comparing the groups, the measurements of pre-test and post-test for each category revealed some differences. Regarding the visual task, it is notable that the errors in the post-test phase present lower proportion in all categories than the errors in the pre-test phase. This observation indicates an improvement in the performance of the participants after the visual training. The category Pronunciation Errors presents the higher values of errors both in pre-test and post-test phase (pre-test *M*;16.91, *SD*;10.39/ post-test *M*; 15.11, *SD*;12.69) and the Punctuation Errors category presents the lowest values (pre-test *M*;4.49, *SD*;2.87/ post-test *M*;3.8, *SD*; 3.53).

The table also presents the descriptive statistics of the errors that participants who were trained on auditory training made. In this group, a different pattern is observed in the measurements as categories present lower scores in post-test than in pre-test, apart from

the Punctuation Errors where the proportions are exactly the same for the two phases. These measures indicate that there is no improvement after the auditory training on participants' performance. The category of Pronunciation Errors presents again the higher rates (pre-test M ; 15.77, SD ;9.55/ post-test M ;15.88, SD ; 9.64) while the lower rates are detected in the category of Punctuation Errors (pre-test M ;4.4, SD ;3.318/ post-test M ;4.4, SD ; 2.714), presenting a similar pattern to the visual training.

Overall, it is notable that participants of the visual training present lower values in the post-test than in the pre-test and this indicates an improvement in their performance as a whole. On the other hand, in the auditory training no category presents an improvement and participants performed poorer in the post-test than the pre-test. Thus, participants of the visual tasks performed better than participants who trained on the auditory tasks. Furthermore, having in mind that punctuation marks are small elements in the text and so is the Greek stress mark, a similar pattern is observed in the visual group. Both categories which belong to the suprasegmental level performed better in the post-test with lower values than before the training. As far as stress errors are concerned, which is the main area of interest, these will be discussed in the following section thoroughly.

	VISUAL						AUDITORY					
	<i>Pre-test</i>			<i>Post-test</i>			<i>Pre-test</i>			<i>Post-test</i>		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>S</i>	<i>M</i>	<i>SD</i>	<i>S</i>	<i>M</i>	<i>SD</i>	<i>S</i>	<i>M</i>	<i>SD</i>
Phonological Errors												
Wrong word	178	5.09	4.705	163	4.66	5.127	166	2.31	2.494	177	2.57	2.581
Wrong letter	77	2.2	2.576	88	2.51	3.266	81	4.74	4.307	90	5.06	4.297
Word addition	17	0.49	0.919	9	0.26	0.611	11	0.31	0.676	7	0.2	0.406
Letter addition	175	5	3.208	133	3.8	3.513	154	4.4	3.021	149	4.26	3.052
Punctuation Errors	157	4.49	2.874	133	3.8	3.53	154	4.4	3.318	154	4.4	2.714
Letter omission	103	2.94	3.244	84	2.4	2.746	92	2.63	1.848	88	2.51	2.267
Line omission	18	0.514	0.7811	27	0.771	1.4417	19	0.543	1.0173	19	0.51	0.818
Word omission	24	0.69	1.078	25	0.71	0.987	29	0.83	1.654	26	0.74	1.172
Stress errors	234	6.69	3.315	181	5.17	3.185	191	5.46	3.081	212	6.06	3.489

Table 3: Central Tendency of all categories of Errors.

Analysis of stress assignment

Stress Errors are categorized as those errors with incorrect placement of stress by assigning dominant stress to non- dominant stressed syllables or to a syllable which is not stressed (for example $\tau\epsilon\rho\mu\acute{\alpha}$ [te'rma] instead of $\tau\acute{\epsilon}\rho\mu\alpha$ ['terma]) and is the main area of interest in this project. The results of the analysis of the stress assignment for all participants are summarised in Table 4 in which the frequency, mean and standard deviation of pre-test and post-test are presented. First of all, students with dyslexia presented impairments in detecting syllable stress. For all participants, the post-test phase presents lower measures than the pre-test as is shown in Table 3, which means that they performed better and there was improvement overall. The words where stress was not placed on the correct syllable in pre-test cover 425 of the total number of words of the text ($M= 6.07$, $SD=2.236$). The words which were not stressed on the correct syllable in post-test cover 393 ($M= 5.61$, $SD=3.346$) of the total number.

All Groups	Pre-test	Post-test
Sum	425	393
Mean	6.07	5.61
Std. Deviation	3.236	3.346
Variance	10.473	11.197
Range	15	13

Table 4. Central Tendency of the overall Stress Assignment errors

Dividing the participants based on the visual and the auditory training they completed, Table 5 plots the descriptive statistics of stress assignment for both trainings. Regarding the visual training, in the pre-test, the mean of the errors that participants made is higher than in the post-test (pre-test; $6.69(M)$, post-test; $5.17(M)$). It is therefore notable that the errors are substantially fewer in the post-test than the errors before the training. In

addition, in the pre-test of the auditory training, the mean of the errors that participants made is lower than in the post-test (pre-test; 5.46(*M*), post-test; 6.06(*M*)). This means that children performed poorer in the post-test than in the pre-test after the auditory training, indicating an improvement in the performance of the participants who trained on the visual training and not in the sounds training.

As our hypothesis is that visual impairments affect reading performance and specifically indiscernible elements in the text, these results confirm the hypothesis that training on visual stimuli will improve the stress assignment of students with dyslexia. Particularly, a closer look at Table 5 reveals that in contrast to the test before the training, children who trained on the visual task were now more accurate in stress assignment than children in the auditory task.

	VISUAL		AUDITORY	
	<i>Pre-test</i>	<i>Post-test</i>	<i>Pre-test</i>	<i>Post-test</i>
Sum	234	181	191	212
Mean	6.69	5.17	5.46	6.06
Std. Error of Mean	0.56	0.538	0.521	0.59
Std. Deviation	3.315	3.185	3.081	3.489
Variance	10.987	10.146	9.491	12.173
Skewness	0.576	0.512	1.078	0.245
Std. Error of Skewness	0.398	0.398	0.398	0.398
Kurtosis	-0.185	-0.901	2.708	-0.719
Std. Error of Kurtosis	0.778	0.778	0.778	0.778
Range	13	10	15	13
Minimum	2	1	1	0
Maximum	15	11	16	13

Table 5. Descriptive statistics for stress errors of the training groups.

The above observations are captured in Figure 1 as well. Figure 1 presents these measures and shows a big difference between the bars of pre-test and post-test. In the

visual task, there is a decrease in the number of stress errors that participants made while in the bars of auditory training there is an increase. For both phases of auditory task, the values are lower overall compared to the measures of the visual task. Also, observing the bar chart, the difference between pre-test and post-test of the auditory task is smaller than that of the visual task.

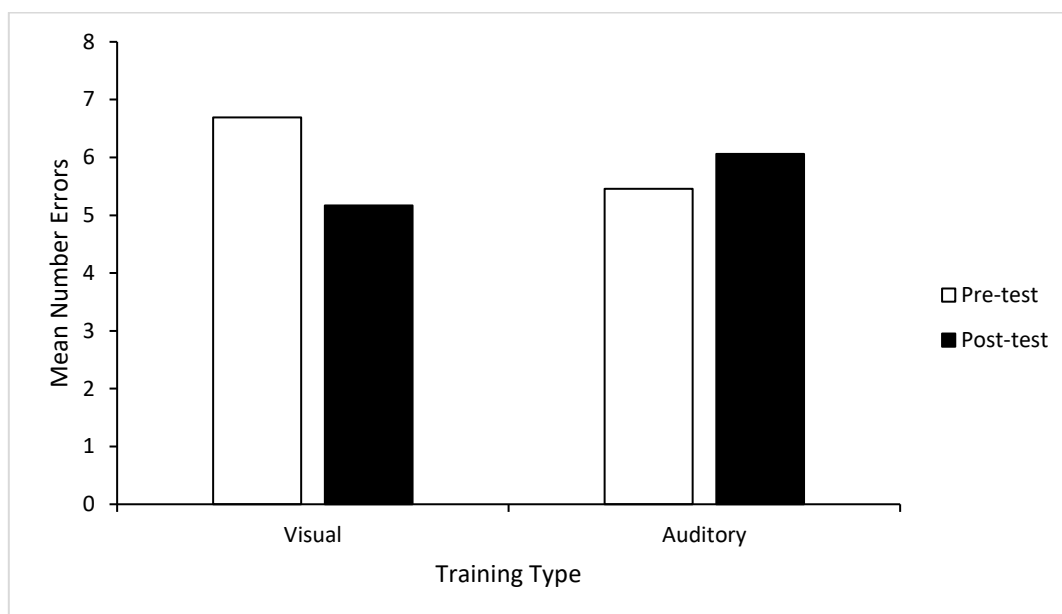


Figure 1. Mean Number of Stress Errors for L1.

Before moving to the inferential statistics, the data were tested for normal distribution. Figure 2 represents graphically the normality of the data. Overall, the distribution is symmetrical, and the width corresponds to the general width of normal distribution apart from the post-test of the visual task. In this case, the distribution is not symmetrical.

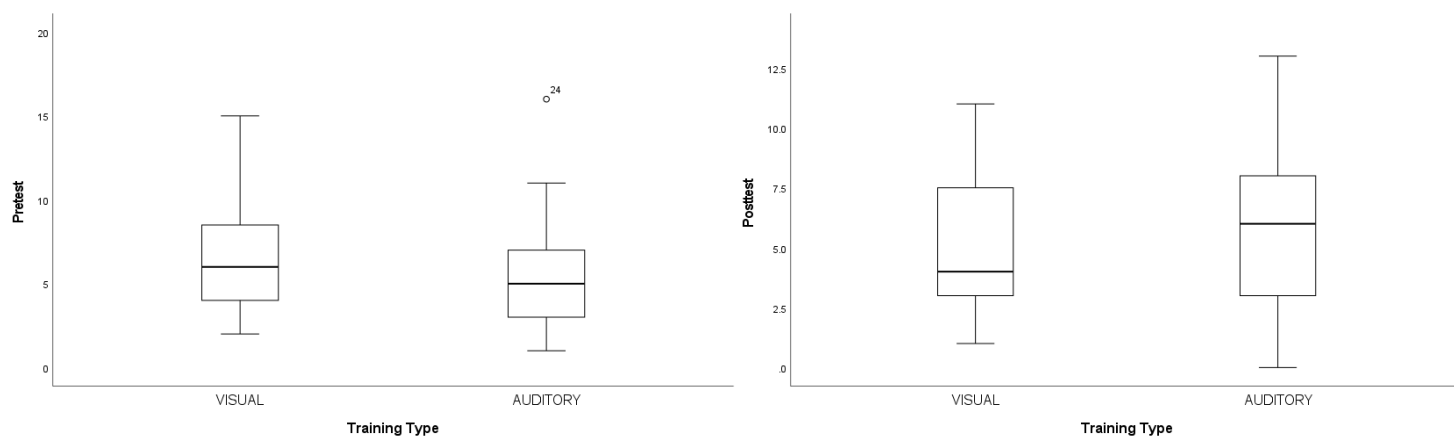


Figure 2. Normal Distribution of the Training Groups.

These findings are also supported by the results of the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov test is appropriate to define whether a sample derives from a population with a particular distribution. Therefore, it is used here as the numerical means for assessing normality. As Table 5 shows, the p value of the tests is greater than .05 apart from the post-test of the visual training, which allowed me to conclude that the data came from a normal distribution.

Tests of Normality

Kolmogorov-Smirnova				
	Stimuli	Statistic	df	Sig.
PRE-TEST	Visual	0.125	35	0.185
	Auditory	0.119	35	.200*
POST-TEST	Visual	0.215	35	<.001
	Auditory	0.105	35	.200*

* This is a lower bound of the true significance.

Table 5. Tests of normality for the tests

4.2.1.2. Reading speed

Apart from reading accuracy, this study assessed participants' reading speed to examine whether there is an improvement after the training. Based on the descriptive statistics in Table 6, it can be observed that in both trainings, children present lower values in the post-test than in the pre-test. In the visual training, the mean reading speed of pre-test is $M=5.39$ and for the post-test this is $M=5.52$; in the auditory training the mean speed is $M=5.91$ and $M=6.35$ respectively. Based on that, it can be concluded that participants performed worse in the post-test than in the pre-test. However, comparing the two phases, their difference is smaller in the visual training than in the auditory training. In the visual training, the difference is 0.13 and in the auditory training it is 0.44.

	VISUAL		AUDITORY	
	Pre-test	Post-test	Pre-test	Post-test
Mean	5.3976	5.52	5.9195	6.3571
Std.Deviation	2.09715	2.15755	3.00823	4.48893
Variance	4.398	4.655	9.049	20.15
Range	8.57	9.23	16.37	23.08
Minimum	2.73	2.56	2.22	1.54
Maximum	11.3	11.79	18.59	24.63

Table 6. Descriptive Statistics of reading speed

Figure 3 illustrates in bar charts the mean of reading speed in each training. This figure also shows that the post-test bars are higher than the bars of pre-test for both trainings. However, the largest increase can be noted in the auditory trainings between the bars of pre-test and post-test. Nevertheless, for both phases of visual tasks, the values are lower overall compared to the values of the auditory tasks.

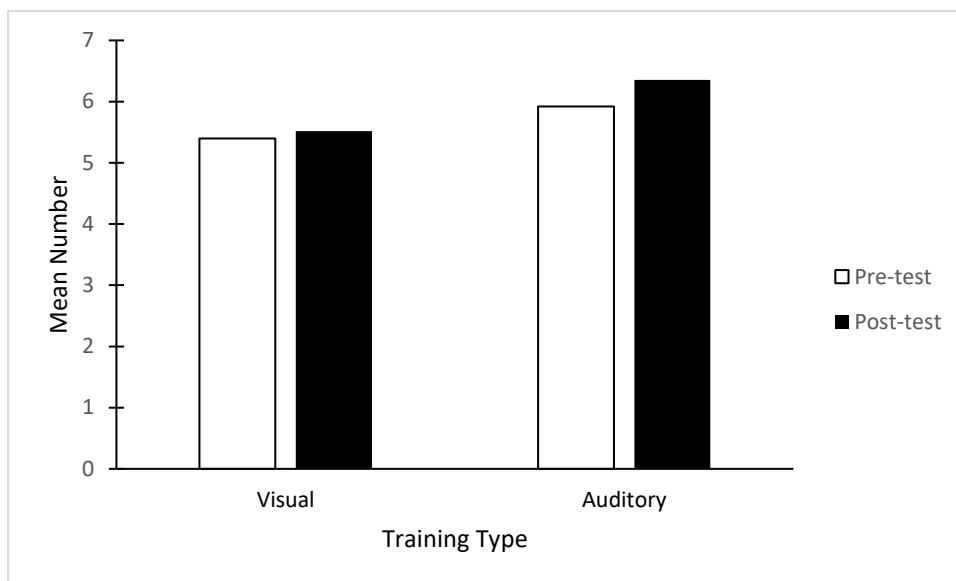


Figure 3. Mean Number of reading speed for LI.

Data were tested for normal distribution as well. Figure 4 illustrates graphically the normality of the data. In all cases, the distribution is symmetrical and the width matches the width of the normal distribution.

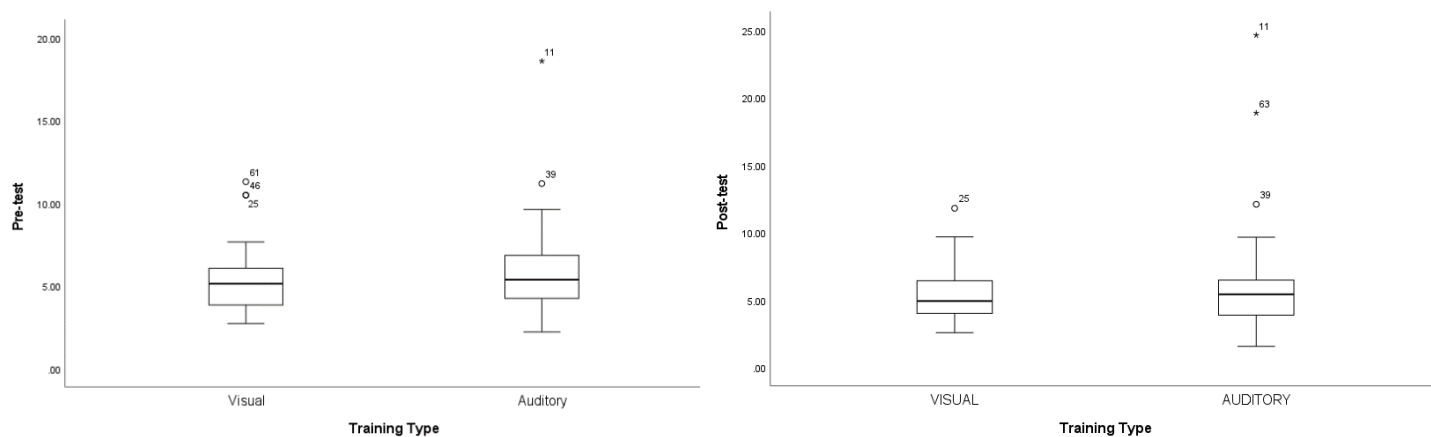


Figure 4. Normal Distribution of the reading speed

4.2.2. Inferential Statistics

The procedures conducted for inferential statistics purposes are presented in this section. Two separate analyses were conducted on the two parameters of accuracy score and reading speed in order to answer research question 1.

In order to examine group performance on reading accuracy in L1, a repeated measures ANOVA was performed on these scores. Stress Errors was the dependent variable and Training Type (Visual/ Auditory) was the between-subject factor to allow for estimation of the difference between the two phases. The analysis showed a significant main effect of Training and Time interaction, $F(1) = 7.25, p < .009, \eta^2 = .96$ because of the visual training's better performance in reading accuracy scores. Time variable was not significant, which also indicates that training affects performance. The Greenhouse–Geisser estimates of the departure from sphericity was $\epsilon = 1$. The null hypothesis in this model is that there will be no difference between the two tests and this hypothesis is rejected since $p < 0.05$. The analysis indicates that dyslexic children do improve overall after the visual training.

Furthermore, to examine group performance on reading speed, a repeated measures ANOVA was carried out using scores of all the children who got tested on Greek texts. Reading speed score were the dependent variable and Training Type (visual/auditory) the between-subject factor. The results revealed a nonsignificant relationship between the tests and the training $F(1) = .908, p > .344$.

As the research hypothesis is that visual impairments affect reading performance and specifically indiscernible elements in the text, it was of interest to explore whether participants who practiced on the visual training performed significantly better after the training. On the other hand, although in the auditory task participants were likely to

perform better in the post-test, the statistical analysis showed that there was no significant improvement in their overall performance.

4.3. Linguistic task in L2

In the above section, the analysis of the effect of the training tasks on participants' L1 reading performance was presented. This section addresses the analysis of the L2 training task. An age-matched control group (CG) was used here, which was compared to the dyslexic participants. It was found to be different from the group of dyslexic participants ($p=0.157$).

To examine the performance of students with dyslexia in the reading process, two groups of training (visual and auditory) were compared in total number of words accuracy and reading speed. Two separate analyses were conducted on these two distinct parameters. Each response was rated for phonetic accuracy, receiving one point for each incorrect phoneme produced or missing. Reading speed was measured first as syllables per second and transcribed later by minute, that is the overall number of syllables of the words read by the child divided by the available time (60s). In other words, the same procedure as for the L1 task was followed in the case of the L2 task as well.

4.3.1. Descriptive Statistics

4.3.1.1. Reading Accuracy

Analysis of Phonological errors

The following analyses are based on 2,571 individual reading errors. As explained in the methodology chapter, phonological errors were classified into 11 categories. Table 9 presents the descriptive statistics for these categories as per the training that participants underwent, and for the control group. As with the L1 study too, these

categories were overcategorized to examine the overall results of the bigger strands. The total number of errors was divided into pronunciation, punctuation and stress errors including identification errors. Errors were classified as pronunciation errors when participants failed to accurately pronounce the word at the segmental level (for example, by substituting, omitting or inserting words and letters). Stress errors were classified when stress was omitted or errors were made on the incorrect syllable (by either assigning dominant stress to a non-dominant syllable, or no stress assignment to dominant stressed syllables), whereas punctuation errors referred to when participants failed to accurately pronounce or omit the punctuation marks. Identification errors were classified in the L2 study, as those cases where participants did not recognize the English letter that they read. This classification was based on the categorization of Paizi et al. (2011) and was used to disentangle errors at the segmental and the supra-segmental level, since they can provide important information about different constituents of reading accuracy. Specifically, although stress assignment and punctuation belong to the greater category of supra-segmental level, two separate categories were created to examine their similarities and differences.

In Table 8, the central tendency is displayed such as the frequency, mean and standard deviation of the errors' categories by group (training group/ control group). Specifically, as demonstrated in the matching process, the measurements of pre-test and post-test of each category demonstrated some differences with the measurements to the control group as well. In the visual training group, punctuation errors and identification errors seem to have the sharpest decrease after the training (for the identification errors, pre-test: $M=16.05$, $SD=10.288$; post-test: $M=14.45$, $SD= 7.647$; and for punctuation errors, pre-test: $M=3.35$, $SD=2.581$; post-test: $M=2.55$, $SD= 2.212$). This can suggest

that there are some improvements rates. Moreover, the highest numbers in both pre-test and post-test can be spotted in the category of Identification Errors with 321 errors ($M= 16.05$, $SD=10.288$) in the pre-test and 289 errors ($M= 14.45$, $SD=7.647$) in the post-test, while the lowest figures can be found in the category of Stress Errors: 18 errors ($M= 1.1$, $SD=1.071$) in the pre-test and 22 errors ($M= 0.95$, $SD=0.945$) in the post-test.

In the auditory training group, a different pattern was observed as in the post training test, students performed poorer in all categories apart from stress errors. Nevertheless, in the stress pattern category, the difference between pre-test and post-test is not significant because in the pre-test, learners made 22 errors ($M= 0.9$, $SD=0.788$) and in the post-test 19 errors ($M= 1.1$, $SD=1.021$). Furthermore, in this training group, the identification errors category presents the highest errors with 324 ($M= 16.2$, $SD=12.22$) in the pre-test and 371 ($M= 18.55$, $SD=13.709$) in the post-test; the stress errors category had the lower number of errors too.

Moreover, in the control group, similarities in the measurements before and after training can be observed as the rates were not significantly different. The higher numbers in both pre-test and post-test can be noted again in the category of Identification Errors with 135 ($M= 6.43$, $SD=5.827$) and 136 ($M= 6.48$, $SD=7.047$) errors respectively, while the lower rates can be found in the category of Stress Errors with 9 errors in the pre-test ($M= 0.43$, $SD=0.598$) and 8 errors ($M= 0.38$, $SD=0.74$) in the post-test.

An in-depth examination of the descriptive statistics revealed that there are some categories that showed improvement while in some others the post-test presents higher values. In the case of L2, participants of the visual training presented in some categories lower values in the post-test than in the pre-test and this suggests an improvement in performance. Overall, it is notable that most children, even without any reading problems, make at least some errors in the main categories. On the other hand, in the auditory training no category presents significant improvement as participants performed poorer in the post-test. Thus, overall, participants of the visual tasks performed better than the participants who trained on the auditory tasks indicating an improvement in performance. The identification errors present the highest rates with all different groups presenting a noticeable difference compared to the other categories. Furthermore, having in mind that punctuation marks are small elements in the text and so is the Greek stress mark, a similar pattern was observed in the test after the visual training. These kinds of errors provide information about different components of reading accuracy offering various results. Stress errors will be discussed thoroughly in the following section.

	Visual						Auditory						Control Group					
	Pre-test			Post-test			Pre-test			Post-test			Pre-test			Post-test		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>S</i>	<i>M</i>	<i>SD</i>
Phonological Errors																		
Pronunciation errors	193	9.65	6.499	231	11.55	7.924	256	12.8	13.085	269	13.45	11.372	92	4.38	3.694	103	4.9	4.403
Identification errors	321	16.05	10.288	289	14.45	7.647	324	16.2	12.22	371	18.55	13.709	135	6.43	5.827	136	6.48	7.047
Punctuation errors	67	3.35	2.581	51	2.55	2.212	49	2.45	1.932	69	3.45	2.373	4	0.19	0.402	6	0.29	0.463
Stress errors	18	1.1	1.071	22	0.95	0.945	22	0.9	0.788	19	1.1	1.021	9	0.43	0.598	8	0.38	0.74

Table 7. Central Tendency of major categories of phonological errors for L2.

	VISUAL						AUDITORY						CONTROL GROUP					
	Pre-test			Post-test			Pre-test			Post-test			Pre-test			Post-test		
Phonological Errors	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Wrong word	71	3.55	3.561	73	3.65	3.631	128	6.4	10.308	106	5.3	7.491	34	1.61	2.234	38	1.8	2.422
Wrong letter	29	1.45	1.317	40	2	1.522	35	1.75	2.049	47	2.35	2.498	17	0.8	0.987	17	0.8	0.935
Word addition	5	0.25	0.55	4	0.2	0.523	7	0.35	0.988	6	0.3	0.571	4	0.19	0.287	4	0.19	0.287
Letter addition	22	1.1	1.071	34	1.7	1.809	17	0.85	1.137	11	0.55	1.276	9	0.42	0.881	13	0.61	1.991
Letter omission	37	1.85	1.694	57	2.85	2.159	50	2.5	1.792	72	3.6	3.218	13	0.61	0.615	13	0.61	1.083
Line omission	9	0.45	1.791	12	0.6	1.957	1	0.05	0.224	4	0.2	0.696	2	0	0	2	0	0
Word omission	20	1	1.451	11	0.55	0.945	18	0.9	1.373	23	1.15	1.226	13	0.61	0.655	16	0.76	1.15
Letter Pronunciation	189	9.45	5.186	171	8.55	4.334	205	10.25	7.1	212	10.6	7.25	95	4.52	2.886	87	4.14	2.926
Word Pronunciation	132	6.6	6.142	118	5.9	4.909	119	5.95	5.88	159	7.95	7.207	40	1.9	2.328	49	2.33	3.17
Punctuation Errors	67	3.35	2.581	51	2.55	2.212	49	2.45	1.932	69	3.45	2.373	4	0.19	0.44	6	0.28	0.44
Stress errors	18	1.1	1.071	22	0.95	0.945	22	0.9	0.788	19	1.1	1.021	9	0.43	0.598	8	0.38	0.74

Table 8. Central Tendency of minor categories of the phonological errors for L2.

Analysis of stress assignment

Stress pattern errors is the focal point of this project and are categorized as those errors with incorrect placement of stress by assigning dominant stress to non- dominant stressed words or in a word which is not stressed (for example the word police, they articulated /'pəli:s/ instead of /pə'li:s/). The results of the stress assignment overall are summarised in Table 9, where the sum, mean and standard deviation of pre-test and post-test are presented. First, supporting the existing literature, students with dyslexia presented impairments in detecting syllable stress taking into account the high numbers of errors.

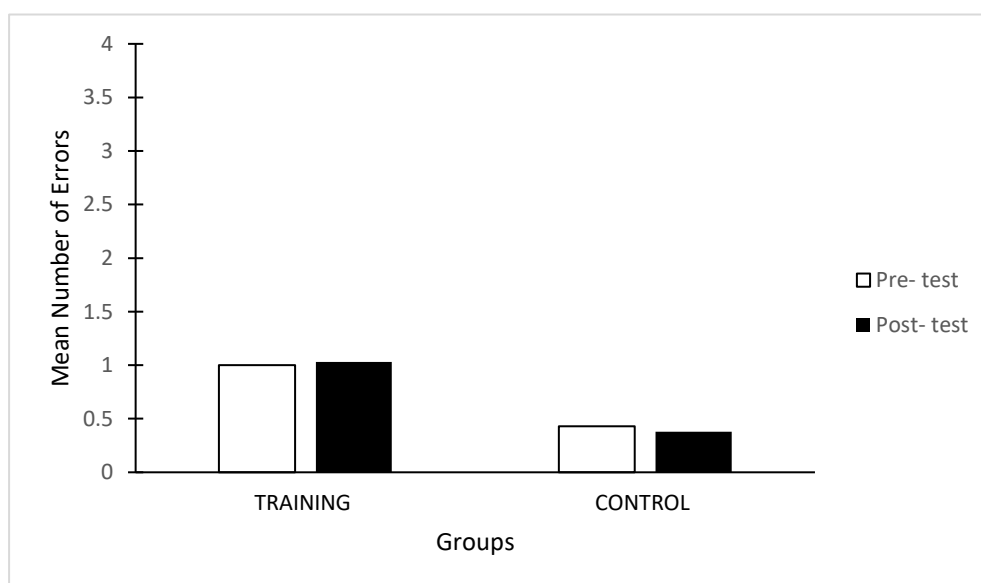


Figure 5. Mean Number of Stress Errors for L2.

As for the control group, participants performed better than participants with dyslexia. Moreover, pre-test and post-test errors seem balanced. A closer look at Figure 5 reveals

that even though the children with dyslexia were aged matched, for these reading tasks related to reading performance, they clearly performed worse.

	TRAINING GROUPS		CONTROL GROUP	
	Pre-test	Post-test	Pre-test	Post-test
Sum	40	41	8	9
Mean	1	1.03	0.43	0.38
SD	0.934	0.974	0.598	0.74
Range	4	3	2	3
Variance	0.872	0.948	0.357	0.548

Table 9. Central tendency of all Groups for L2.

Based on Table 10 and with respect to the effect of training, overall, the results seem to be similar between pre-test and post-test for both training groups. Participants who trained on the visual stimuli seemed to have performed rather worse in the post-test while participants of the auditory training performed better, but through inferential statistics, the significance of these small differences will be tested. It is notable that most children, even without any reading difficulties, make at least some errors. Moreover, it is worth noting that in the English training phase, participants seemed to make errors repeatedly and only in specific words such as ‘upset’, ‘policeman’, ‘police’, ‘Pauline’.

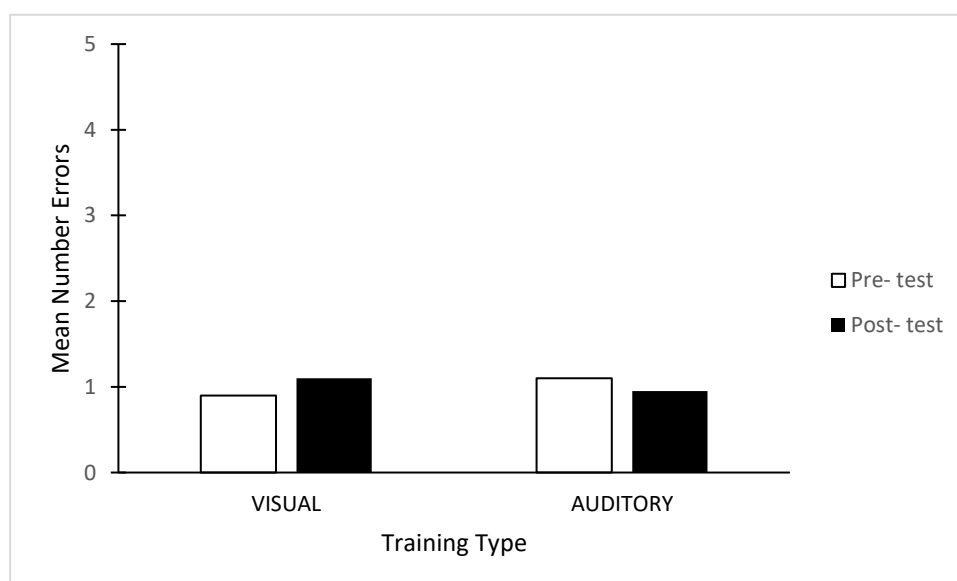


Figure 6. Mean Number of Errors for L2 training.

	VISUAL		AUDITORY	
	<i>Pre-test</i>	<i>Post-test</i>	<i>Pre-test</i>	<i>Post-test</i>
Sum	18	22	22	19
Mean	0.9	1.1	1.1	0.95
Std. Deviation	0.788	1.021	1.071	0.945
Variance	0.621	1.042	1.147	0.892
Skewness	0.186	0.442	0.925	0.94
Std. Error of Skewness	0.512	0.512	0.512	0.512
Kurtosis	-1.308	-0.905	1.12	0.405
Std. Error of Kurtosis	0.992	0.992	0.992	0.992
Range	2	3	4	3

Table 10. Descriptive Statistics of the training groups for L2.

Before moving to the inferential statistics, the data were tested for normal distribution. Graphically in Figure 7. As it can be noted, the distribution is asymmetrical and the width does not correspond to the width of the normal distribution. Based on the above histograms, we can assume that the data are not normally distributed.

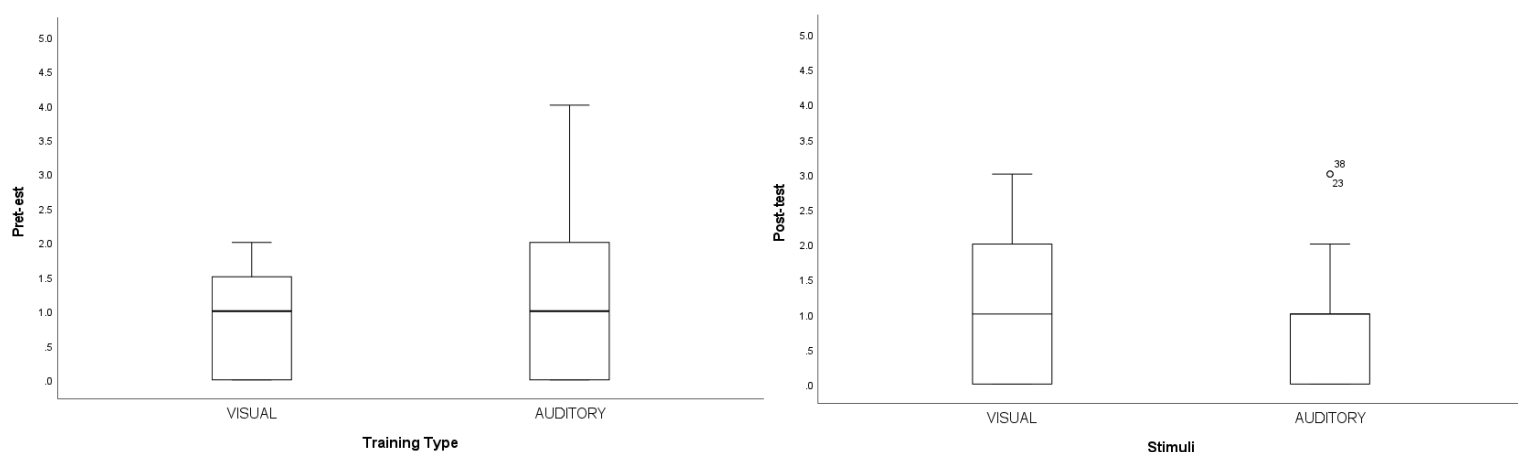


Figure 7. Distribution of the stress errors in L2.

4.3.1.2. Reading speed

In the L1 study, apart from reading accuracy performance, this section of the study assessed students' reading speed, examining whether an improvement in students with dyslexia can be traced. Table 11 shows the reading time by group. In the visual training, the mean reading speed in the pre-test is $M=3.23$ and in the post-test it is $M=3.30$; in the auditory training, it is $M=3.24$ and $M=3.19$ respectively while in the control group it is $M= 2.31$ and $M=2.23$. In both trainings, there are some fluctuations between pre-test and post-test, and inferential statistics are about to show whether the difference is statistically significant.

	IMAGES		SOUNDS		CONTROL GROUP	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Sum	64.63	66.14	61.7	60.67	48.59	46.88
Mean	3.2314	3.3068	3.2474	3.1932	2.314	2.2325
Std. Deviation	1.24735	1.12737	1.50541	1.37109	0.72261	0.75237
Variance	1.556	1.271	2.266	1.88	0.522	0.566
Range	5.33	3.76	5.77	4.69	2.26	2.7
Minimum	1.9	1.88	1.6	1.51	1.52	1.46
Maximum	7.23	5.64	7.37	6.2	3.79	4.16

Table 11. Central Tendency of the reading speed for L2.

Graphical representations of the reading speed produced by the groups are presented in Figure 8 as well. Moreover, the graph reveals that even though the children with dyslexia were aged matched, they clearly performed worse in reading speed.

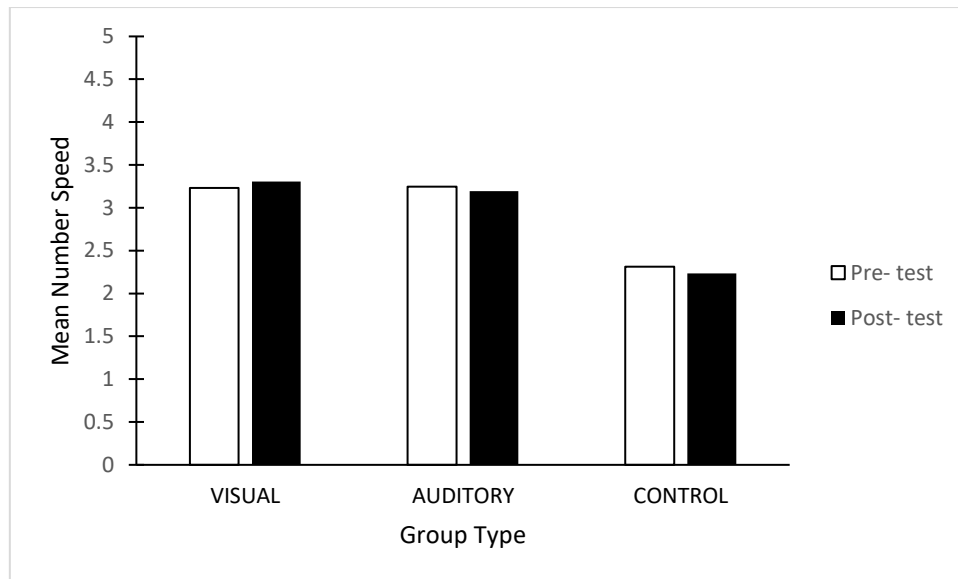


Figure 8. Mean Number of reading speed.

Data were tested for normal distribution as well. Figure illustrates graphically the normality of the data. The distribution is symmetrical, and the width corresponds to the width of the normal distribution.



Figure 9. Distribution of the mean for the training groups.

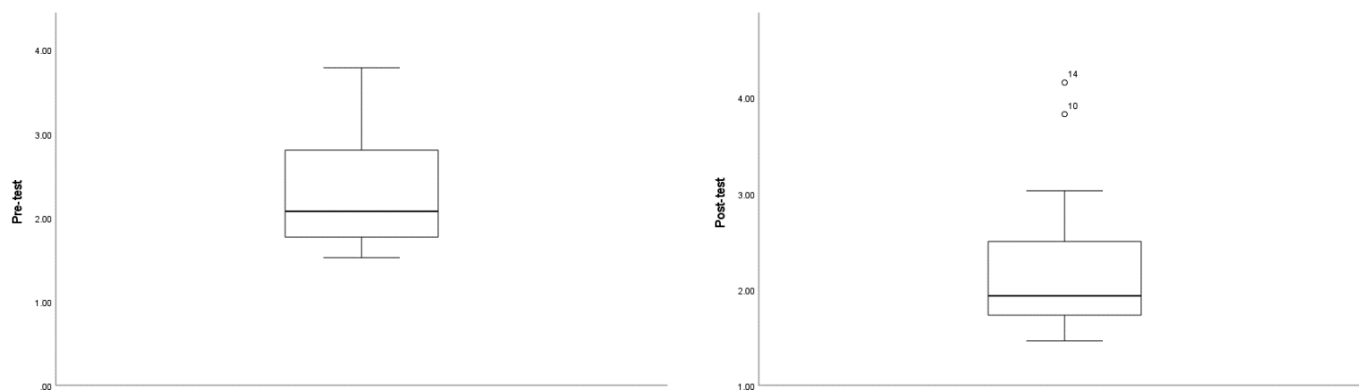


Figure 10. Distribution of the Control Group

These findings are also supported by the results of the Kolmogorov-Smirnov test. The Kolmogorov-Smirnov test is appropriate to define whether a sample derives from a population with a particular distribution, therefore it is used here as the numerical means for assessing normality. As Table 9 shows that the p value of the tests is greater than .05 apart from the post-test of the auditory training which allowed me to conclude that the data came from a normal distribution.

Kolmogorov-Smirnov				
	Stimuli	Statistic	<i>df</i>	<i>Sig.</i>
VISUAL	Pre-test	0.151	20	.200*
	Post-test	0.147	20	.200*
AUDITORY	Pre-test	0.137	19	.200*
	Post-test	0.203	19	0.037
CONTROLGROUP	Pre-test	0.165	21	0.138
	Post-test	0.178	21	0.08

* This is a lower bound of the true significance.

Table 9. Tests of normality for the tests

4.3.2. Inferential Statistics

In this project too, the procedures conducted for inferential purposes are presented in this section. Although more tests were initially conducted, only those tests with statistically significant results appear here as these are generalisable.

In order to examine group performance on reading accuracy in L2, a repeated measures ANOVA was performed on these scores. Stress Errors was the dependent variable and Training Type (Visual/ Auditory) the between-subject factor to permit estimation of the difference between the two phases. Pre-test and Post-test were the within-subject factors. The Greenhouse – Geiser estimate of the departure from sphericity was $\epsilon = 1$. The difference between pre-test and post-test was not significantly affected by the training, $F(1) = 0.12, p > .05$. The null hypothesis in this model was that there would be no difference between the two groups; this hypothesis was not rejected since $p > .05$.

Furthermore, to examine group performance on reading speed, a repeated measures ANOVA was carried out using scores of all the children who got tested on English texts. Reading speed score was the dependent variable and Training Type (visual/auditory) the between-subject factor. The results revealed a nonsignificant relationship between the tests and the training $F(1)=.168, p > .05$. There was no difference in mean response time between training and no significant interaction of condition with groups.

Further analysis was conducted to examine group performance on punctuation errors, a repeated measures ANOVA was carried out using scores of all the children who got tested on English texts. Punctuation errors score was the dependent variable and Training Type (visual/auditory) the between-subject factor. The Greenhouse – Geiser estimate of the departure from sphericity was $\epsilon = 1$. The results revealed a significant

relationship between the tests and the training $F(1) = 8.364, p > .006$. The null hypothesis in this model was that there would be no difference between the two groups; this hypothesis was not rejected since $p > .05$.

Finally, a third analysis was carried out to find out if the performance of the participants with dyslexia is different from the performance of the control group. For this reason, a t-test was performed. As expected, students with dyslexia presented impairments in detecting syllable stress. Indeed, the data suggested that children with developmental dyslexia performed worse than the age-matched control group. Group performance was investigated using the number of errors as the dependent variable and the Group (students with dyslexia and control group) as independent. We can reject the H_0 (null hypothesis) that the two groups are equal. For the pre-test, the observed $p < .014, t = -2.53$ difference is statistically significant at the 99% level. For the post-test, the observed $p < .010, t = -2.65$ difference is statistically significant at the 99% level.

A further analysis was conducted to examine if there is a difference between students with dyslexia and the control group in the reading speed. The independent t-test showed that students with dyslexia are slower readers than the control group. Group performance was investigated using the reading time as the dependent variable and the Group (students with dyslexia and control group) as the independent variable. We can reject the H_0 (null hypothesis) that the two groups are equal. For the pre-test, the observed $p < .003, t = 2.89$ difference is statistically significant at the 99% level. For the post-test, the observed $p < .001, t = 3.44$ difference is statistically significant at the 99% level.

4.4. Questionnaire

This section presents the analysis of the questionnaire and includes analysis of the survey questions, emojis question and the open question analysis. Both descriptive and inferential statistics were conducted, while for the open question the results of qualitative data analysis are presented.

4.4.1. Questions 1-10

4.4.1.1. Descriptive statistics

In this section, measures of central tendency, such as the mean (M) and the frequencies as well as measures of variability which is the standard deviation (SD), of language anxiety variables will be presented. The aim of this section is to provide a rough overview of the participants' conceptualizations of anxiety and reading.

The main descriptive statistics of the data collected through questions 1-10 of the questionnaire are presented in Table 9. First, as can be observed in the means column, item 1 ('I like reading a text') has the highest mean value ($M= 3.17$) with 90 out of the total 110 students agreeing or strongly agreeing with this statement. Thus, one of the findings is that the reading performance of students is not related to whether they like to read or not. Moreover, similar results were found for item 3 ('I feel confident when I read a text') and item 9 ('Reading a text is a challenge that I like'), which had a considerably higher mean than the other items (i.e., $M= 3.05$ and $M= 2.98$ respectively). Therefore, these findings suggest that although most students with dyslexia realize that the reading process is a challenge for them, it is a process that they enjoy doing and feel confident about their performance.

On the other hand, in the frequencies of Table 9, the majority of students disagreed or strongly disagreed with item 7 ('I get bored when I have to read a text. '; $N= 90$). This

again confirms that reading a text is an activity that is not coercive for students but a natural part of the learning process. Furthermore, the variables which concentrated the majority of students responses are item 1 ('I like reading a text') with $N= 49$ and item 2 ('I make errors when I read a text') disagreeing ($N= 64$). In conclusion, although students realise that during their reading they may make errors, reading a text is something they enjoy doing and they are not afraid or bored of.

In item 4 ('I read a text easily'), students' response was somewhere in the middle as 42 participants reported that they agree and 39 that they do not agree. This implies that they recognize that reading is a difficult process for them and sometimes they do well and some others they do not. This is also supported by the interviews. In item 5 ('When I read a text, I feel anxious'), the majority of participants answered that they disagree ($N=43$) and that reading a text is something they like. A similar answer was provided for item 6 ('I feel anxious when I have to read a text aloud in class.') in which they reported that they were not anxious when they knew that other people were hearing and watching them. They report in item 10 that indeed anxiety is something that concerns them but not to a large extent as they manage to perform successfully. On the other hand, in item 3, they agreed that they feel confident. Nevertheless, they found it is a challenge and were willing to participate in it.

Overall, it can be observed that the higher rates can be found in the middle choices of the Likert scale and not at the strongly agree/disagree choices. This finding will be supported by further information about these students' emotions from the interviews and observations, where it was found that children were self-restrained, and they did not always express in excess their wills and preferences.

No.	Variables	<i>M</i>	SD	Frequencies			
				SD	D	A	SA
1	I like reading a text	3.17	0.765	2	18	49	41
2	I make errors when I read a text	2.37	0.664	5	64	33	6
3	I feel confident when I read a text.	3.05	0.817	1	30	39	37
4	I read a text easily	2.75	0.833	5	39	42	22
5	When I read a text I feel anxious.	2.2	0.964	28	43	24	13
6	I feel anxious when I have to read a text aloud in class.	2.52	1.042	19	40	24	26
7	I get bored when I have to read a text.	1.84	0.919	45	45	8	10
8	I feel comfortable when reading a text.	2.85	0.955	11	25	41	31
9	Reading a text is a challenge that I like.	2.98	0.958	10	21	40	39
10	Can anxiety affect you when reading a text?	2.31	1.011	26	42	24	18

Table 9. Means, standard deviations, and frequencies for the items of the anxiety questions

4.4.1.2. Factor analysis: Intraconstruct relationships

Factor analysis was performed in order to examine whether one or more factors underlied a number of variables. Specifically, exploratory factor analysis is a type of multivariate statistics which identifies the number of factors as well as which of the variables make up which factor and therefore aims at reducing data by extracting factors from the variables (Dörnyei, 2010). For factor analysis to produce a reliable result, a sampling adequacy should be guaranteed. This could be detected using the following two tests:

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, an index used to examine the appropriateness of factor analysis. Large KMO values (i.e., between 0.5 and 1.0) are good because they show that correlations among pairs of variables (i.e., potential factors) can be explained by other variables. On the contrary, values below 0.5 imply that factor analysis may not be appropriate.

The Bartlett's test of sphericity was used to test the hypothesis that the correlation matrix is an identity matrix, that is, the variables are uncorrelated in the population;

each variable correlates perfectly with itself ($r = 1$) but has no correlation with other variables ($r = 0$). If the Bartlett's test of sphericity is significant, then factor analysis is feasible.

Considering the above assumptions, the present study is appropriate for a factor analysis of anxiety questionnaire. Tables 15 presents the results of the KMO and Bartlett's tests.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.669
Bartlett's Test of Sphericity	Approx. Chi-Square	219.749
	Df	45
	Sig.	<.001

Table 11. KMO and Bartlett's test for anxiety questionnaire

Therefore, the anxiety questionnaire was subjected to exploratory principal components analysis with varimax rotation in order to identify those components that best define the anxiety measures. What follows are general guidelines of the analytical approaches adopted to investigate the component structure of both scales.

Selection of the best rotated solution was based on several considerations. First, an important guideline for the selection of the number of components to be extracted was the scree plot. Extraction of components that were one above and one below the solution suggested by the scree plot was also examined in order to choose the solution that accounted for as much total variance as possible, and which would help me to retain an interpretable component structure. Second, following the suggestions made by Cheng et al. (1999), an item could be included in a factor if it had a primary loading of a minimum of .50 and no secondary loadings within .20 of the primary loading. This

second criterion was applied to establish a cutoff point for inclusion of a variable in a factor for interpretation purposes.

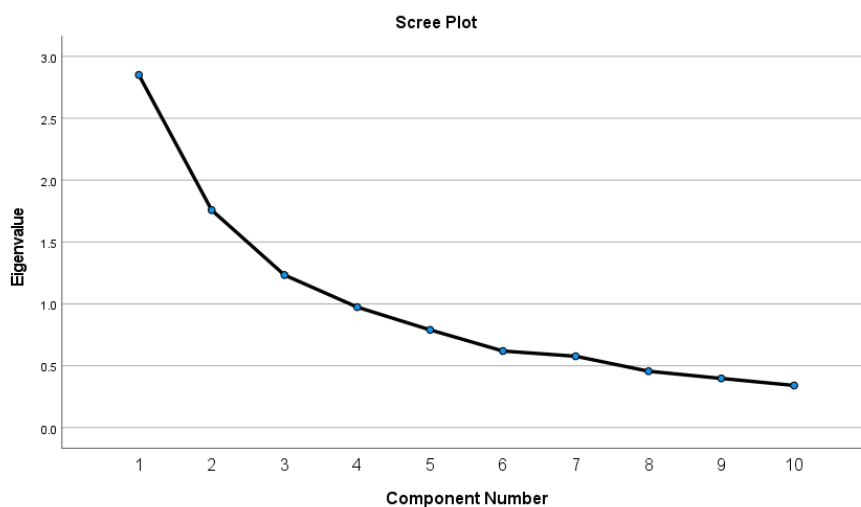


Figure 11. Component Factors.

Specifically, the initial run of the questionnaire produced three factors with eigenvalue greater than one. Based on the criteria listed above, a three-component solution, was selected. Table 16 presents the loadings of variables on factors and the percentage of the variance for each factor.

Label	Anxiety towards reading and its affects	Positive emotions reading a text	Attitude towards reading
Item:	Factor 1	Factor 2	Factor 3
10. Can anxiety affect you when reading a text?	0.787		
5. When I read a text I feel anxious.	0.737		-0.397
6. I feel anxious when I have to read a text aloud in class.	0.707		
2. I make mistakes when I read a text	0.626		
3. I feel confident when I read a text.	0.508	0.427	
1. I like reading a text		0.773	
9. Reading a text is a challenge that I like.		0.748	
8. I feel comfortable when reading a text.		0.678	
7. I get bored when I have to read a text.		0.348	0.818
4. I read a text easily		0.421	-0.576

Table 15. Factor loadings of the questionnaire items and percentage of variance

The first component (Factor 1) consisted of five items accounting for 50% of the total variance. These items are sharing the same factor as their topic is about anxiety during reading and impacts such as errors and negative evaluation by students' classmates. Specifically, the two items with the highest loadings on this factor (items 10 & 5, loadings = .787 and .737 respectively) address anxiety during reading and if it affects students' performance. Similar feelings are expressed through items 2 and 6. A positively worded item (item 3), referring to self-confidence with respect to reading, was also loaded on this factor. This last item was rescaled in order for all questions to represent the same side of the coin. This first component (Factor 1) was labeled Anxiety towards reading and its effects.

The second component (Factor 2) explained 70% of the total variance, included 3 items and described that reading is a positive experience for students. In particular, items 1 and 9 depict that reading is something that students like. This factor was named Positive emotions for reading.

Last but not least, two items comprised the third factor accounting for 20% of the total variance. The items included here indicate attitudes of students with dyslexia towards reading and their performance. This factor was named Attitudes towards reading.

4.4.1.3. Missing Values

In the present study, some of the values were missing. As a rule of thumb, 0,4% to 10% is considered normal (Hair & Anderson, 2010). According to Tabachnick and Fidell (2007), missing data analysis is a process of assessing the amount of missing responses of the questionnaire. They also suggested that missing values should be checked for their randomness. Values in a data set are missing completely at random (MCAR) if

the events that lead to any particular data-item being missing are independent both of observable variables and of unobservable parameters of interest, and occur entirely at random.

Based on the missing value analysis, only question 3 and question 12 were reaching 2.7% (3 missing values) of missing data and according to Little's MCAR test $DF=79$, $p= .348$, which is nonsignificant as it exceeds the $p\text{-value}<.05$. This proves that the values are missing completely at random.

4.4.2. Emojis Task

4.4.2.1. Descriptive Statistics

The main descriptive statistics for the data collected through emojis are presented in Table 16. Because of the big number of demonstrated emojis, they were divided into positive and negative emojis- emotions.

As it can be noticed, the emotion of 'joy' was the one that was chosen by the majority of participants before the training (pre-test, $N= 61$). Other emotions that received high preference during the pre-test was serenity ($N=59$), interest ($N=45$) and trust ($N=42$). After the training (post-test), serenity was chosen by the majority of participants ($N=60$) followed by joy ($N=51$) and interest ($N=42$) but with a lower rate compared to pre-test. Regarding the minimum numbers, pleased, surprise, anger and disgust in the pre-test were the less frequently chosen emojis while on the post-test anger, boredom and surprise.

As for negative emotions, the emotion of fear received most of the participants' responses in both pre-test ($N=27$) and post-test ($N=38$). The least chosen emotions were anger, disgust and rage for both negative and overall emotions. To conclude, the

majority of participants chose positive emotions for both pre-test and post-test while out of the negative emotions, the most widely chosen one was fear. Positive emotions were therefore largely preferred by the participants as opposed to negative emotions.

Positive Emotions					Negative Emotions				
Emotions	Pre-test		Post-test		Emotions	Pre-test		Post-test	
	N	%	N	%		N	%	N	%
Joy	61	14%	51	12%	fear	27	6%	38	9%
Serenity	59	13%	60	14%	pensiveness	17	4%	20	5%
Interest	45	10%	42	10%	distraction	13	3%	17	4%
Trust	42	10%	39	9%	annoyance	12	3%	11	3%
ecstasy	29	7%	16	4%	boredom	10	2%	1	0%
Anticipation	26	6%	19	4%	grief	9	2%	9	2%
Acceptance	19	4%	21	5%	sadness	4	1%	4	1%
Admiration	18	4%	13	3%	terror	3	1%	6	1%
apprehension	17	4%	17	4%	loathing	3	1%	3	1%
Vigilance	7	2%	9	2%	rage	2	0%	0	0%
Surprise	2	0%	2	0%	disgust	1	0%	5	1%
Pleased	0	0%	6	1%	anger	0	0%	2	0%

Table 16. Emotions of participants

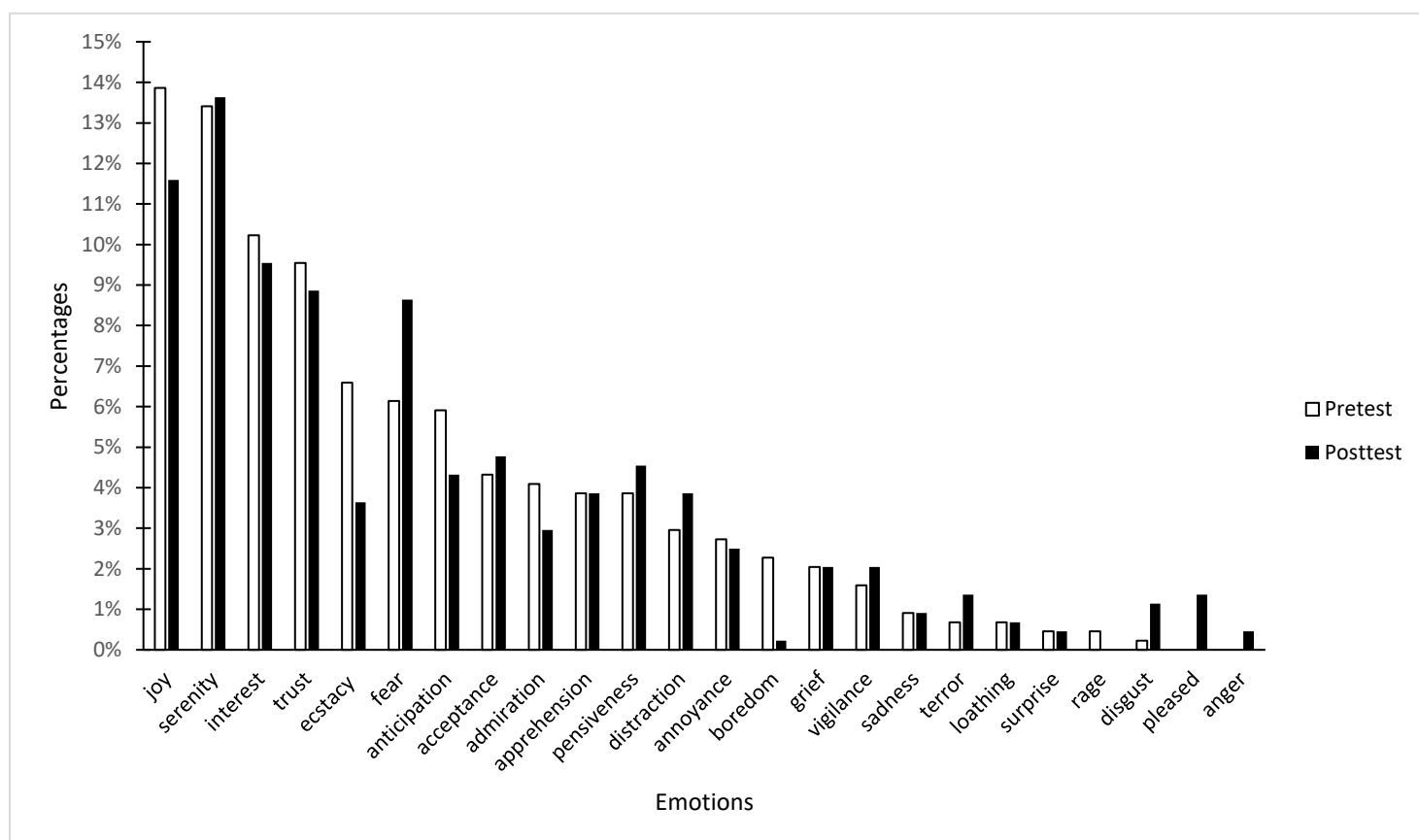


Figure 12. Percentages of all the emotions.

However, gathering together the positive and negative emotions and looking closely at Table 17 below, it is noticeable that positive emotions in the post-test are lower than in the pre-test, and negative emotions are higher in the post-test than in the pre-test. This means that the training and the reading process affected the emotions of students and made them choose more negative emotions. This will be discussed in the inferential statistics below and can be observed in Figure13 as well.

	Positive Emotions	Negative Emotions
Pre-test	74%	23%
Post-test	67%	26%

Table 17. Percentages of Emotions

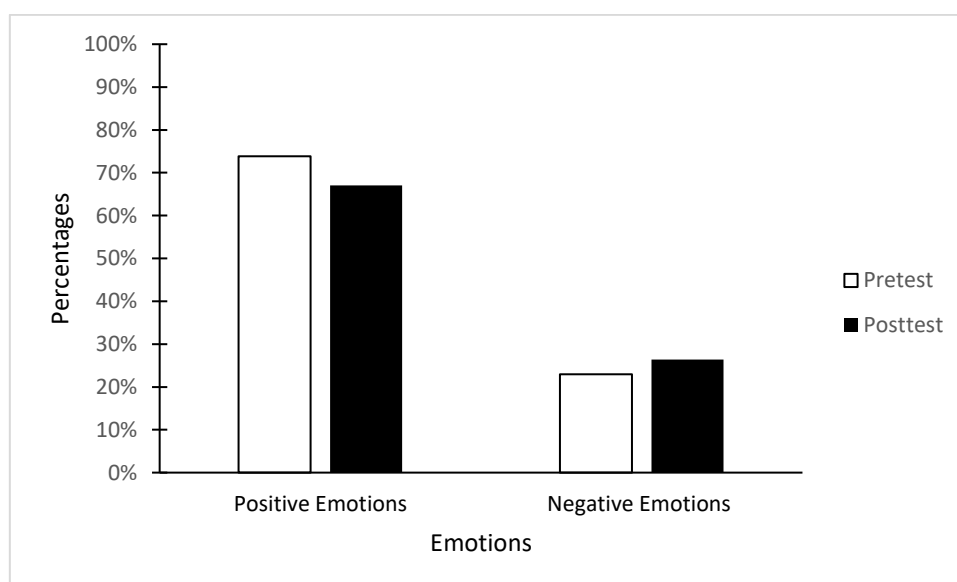


Figure 13. Percentages of Positive and Negative emotions

4.4.2.2. Inferential Statistics

In order to examine the relationship between positive and negative emotions, a chi-squared analysis was conducted. Chi-square test of independence compares two variables when the data are nominal.

First, the relationship between the number of positive emojis that students chose in the pre-test and the number of positive emojis in the post-test was examined. A significant effect was found between the two phases ($\chi^2(1) = 4.59, p < 0.03$). The null hypothesis in this model is that there will be no difference between the two tests; this was rejected since $p < 0.05$. Based on the analysis, there was a significant decrease in the number of positive emotions after the end of the training.

Furthermore, the relationship between the number of negative emojis that students chose in the pre-test and the number of negative emojis in the post-test was examined. A nonsignificant effect was found between the two phases as $p > 0.05$. The null hypothesis in this model is that there is no difference between the two tests, which was confirmed. This analysis suggests that there was no significant difference in the negative emotions that students felt during the training.

4.4.3. Open ended question – Question 11

Question 11 (*‘How can anxiety affect you in the reading process?’*) is an open-ended question and, as such, the responses were subjected to thematic analysis. It was answered by less than the half of the 110 total participants with dyslexia since it was optional for those who agreed or strongly agreed with question 10 (*‘Can anxiety affect you when reading a text?’*) that anxiety can affect them when they read a text. The extent of the responses/data ranged from a few words to a full sentence resulting in a

data corpus of 633 words (minimum 1, maximum 21). Four main themes emerged from the analysis, which are described below.

Effect of Anxiety: Positive/Negative

In the open-ended question, students mentioned that anxiety would influence them significantly. Specifically, they referred to several consequences of anxiety on themselves and their reading performance that are categorized as either positive or negative.

The majority of participants ($N=38$) reported that anxiety would lead to negative effects on their emotional state and their performance. In particular, the most common negatively oriented answer was that they would make errors. Students referred to negative results in their reading fluency and they were aware that this performance was due to their anxiety levels. For example, participant G27 reported that '*I make errors*' and participant E29 said that '*I may forget to stop in the full stops and read the words wrong.*'

Furthermore, apart from the effects on their reading, students confided that the realization of not reading well was affecting them emotionally as well. Anxiety would make them feel more and subsequent emotions, which could be characterized as negative. E27 participant wrote that '*I will make a lot of errors and I will be ashamed*'. In this answer, it is not only noticeable that the student feels that they would make errors but apart from that they report their fear of being ashamed, which is a negative emotion as well. As evidenced by the data, students with dyslexia had a strong fear of what would consequence in the case of not reading well. Their fear would make them become pessimists and think of the worst-case scenarios. Other participants also wrote that (G39) '*I am scared*', or (E02) '*I feel that I can't make it*' and '*I sometimes feel shy*'

(G13) indicating that anxiety would lead to experience other emotions which would not reinforce their reading performance. However, as in the above quote of G13, students reported often the word ‘sometimes’, which means that negative effects did not universally apply and were not always the case.

The above examples are not the rule. There were students who acknowledged that anxiety is an emotion which has an influence on them but not in every case. Some comments were accompanied by words such as ‘may/maybe’ and ‘possibly’. For example, participant (G35) reported that ‘*I may make errors*’, while participant (G37) said that ‘*I may get confused*’. The adverb ‘maybe’ and the modal verb ‘may’ are mostly used for the probability of an action that is happening or may not be happening, indicating that the action is likely to happen or may not happen. Negative experiences because of anxiety are indeed a possible scenario, but as students stated, it was not a predetermined or certain outcome although it happened repeatedly when reading a text.

Apart from negative effects, positive effects were also reported by students with dyslexia. Participant (G11) reported that ‘*I like it although I may get shy*’, ‘*I will read better, and I will be careful*’. Although anxiety is expected to influence students negatively, it may have opposite results too. As derived by the participants’ responses, reading is an activity that students like and enjoy and they do not let anxiety interfere to make them stop reading. Other participants reported that ‘*I may read something wrong, but I will read it again and I will read it better*’, (G12) ‘*I will have to be more conscious and not get anxious*’(G23). Thus, they are determined and self-confident that they will perform well in the tasks.

It is noticeable that these responses mostly concern participants’ emotions and that they have developed self-strategies to perform more efficiently. Since they recognized that

anxiety might lead to negative results, students have found ways to prevent it by realizing that making errors is natural and can happen to anyone and at the same time it should not affect how they feel about reading because it is a task that enjoy. This evidence is also supported by the analysis of emojis task and item 1 (*'I like reading a text'*). The data revealed that most common emotion was joy followed by other positive emotions and in the question most students agreed or strongly agreed that they indeed like reading.

Characteristic Errors of Dyslexia

Due to dyslexia, students were facing many difficulties in their reading fluency. In the open-ended question, many characteristic errors were reported by the participants. The most common negative effect of anxiety that students reported were phonological errors while reading. Students mentioned that they would make errors when they would get anxious. For example, they said that *'I will make errors in reading'* (G39) *'when I will make some errors'* (G45), *'I may say something wrong'* (E33), *'I may make some errors'* (E8). Moreover, participants reported that anxiety would affect the number of errors that they were making (*'I will make more errors'*, (G04) *'many errors'*(G53)). This means that students recognize that by getting anxious they are making more errors than usual, and this may affect them considerably.

In addition, some specific phonological errors were reported by participants. Students wrote that while they read a text, they might not read some words or letters because they would get anxious. Among the phonological categories, errors in words or letters were the most common comment. Students said that e.g. *'I confuse letters-words'*(G03), *'I may read a word wrong'* (E17) or *'I will say other words or words that do not exist'* (E03), *'I will face difficulties in some words'* (E17). Just like words, there

were cases in which students reported that they may forget to read some letters if they get anxious e.g. (G03) *'I confuse letters-words'*, (G63) *'I will not read some letters'*. Another characteristic error that students with dyslexia made was skipping lines, which was also reported through this question. Participant (G34) reported that when they got anxious, they could not see the lines clearly and thus skipped the one which they would read next. e.g., *'I will lose my line'*.

Other reported errors that can be found generally among students with dyslexia were errors in punctuation and in stress pattern. Regarding punctuation, these students were facing difficulties to see or identify the full stops and, as a result, they forgot to pause. For example, participant (E29) wrote that *'I may forget to stop in full stops'* or participant (E13) said: *'I do not take breaths'*. Teachers in the first stages of primary school teach students that when they see full stops, they have to stop and take a breath to continue to the next sentence. However, it is difficult for them to notice them and pause.

These reported errors seem to be in accordance with the reading errors discussed in the literature review. Apart from phonological errors, another characteristic of dyslexia, which is also studied in this project and is reported by students, is time speed. As it was discussed in the previous chapters, students with dyslexia read slower than normally developed students. This may be affected by anxiety too as is supported by the comments of participants in this question. For example, participants (G04) wrote that *'I will read slower, and I will make more errors'* and (G69) *'I will syllabize'* which means that for readers with dyslexia, it will take them more time to read a text if they start feeling anxious.

Emotional Conditions

During reading performance, emotions are also highly affected by anxiety. Students reported many emotions that they feel when they realize that they were getting anxious. Specifically, the most common emotional state was being afraid. Participants were feeling fear ($N=4$) that their anxiety would lead to other negative results such as errors. e.g. *'I am afraid of making errors during the lesson'*, (G39) or *'maybe say something wrong'* (G45). They started being pessimists, which led to negative thoughts and fears. Participants reported comments like e.g. *'I feel that I cannot make it'* (E02), *'I think that I will make an error'* (E15). Thus, students started to think of the possibility of a bad, unwanted outcome and this discourages them and makes them think that they will not be able to read fluently.

Other emotions that participants reported were shame and shyness. Participants were conscious that if they got anxious they would start becoming shy because of making errors. These emotions were highly related to the view that others such as their classmates may have for them. This fact suggests that they were highly concerned with the opinion of others regarding them and the fact that they do not want to be judged. As participant (E16) reported, *'I will make errors and I will be ashamed'*. Additionally, students reported that if they got anxious while they read, they would feel shy: *'I am starting to get shy'* (E16), *'I feel shy sometimes'* (G13). They could be negatively affected by the idea that they would perform in front of others and of the lack of understanding by their peers. For this reason, they thought that if they made an error, they would be filled with uncertainty and insecurities (*'To get better and be careful'* (G15), *'I will have to be very careful'* (G23)).

Although some students would realize that they start getting anxious, they would present self-regulation characteristics and self-regulatory behaviour. In particular, students were decisive to not let anxiety overwhelm them and create a negative experience. They reported that although they understood that they were most likely feeling anxiety, they did not want that to affect them and instead tried to reverse the outcome. A positive effect of anxiety in this case was that several students were encouraged to take action to overcome it. For instance, they said: *'I will take strong breaths'* (G06), *'I will have to very careful'* (G23), *'I will try to get better'* (G12).

Confusion

Among the utterances describing the effects of anxiety on reading performance, some comments related to confusion were found. Confusion has a crucial role to play in the learning process and can be experienced in many ways. A large number of responses ($N=10$) referred to confusion in multiple ways. In particular, participants reported that *'If I got confused I will make errors'* (G07) or that *'I may get confused'* (G08), students therefore realized that if they got confused, they would be led to making errors. While other participants reported that *'I may confuse the words'* (G54), *'I get anxious and I confuse the words or the letters'* (G03). Based on that, confusion might have a dual function in these circumstances: the confusion that manifests itself and affects students' emotional and mental condition, which influences the action and students' reading fluency. Students get afraid that if they read a text and become anxious, they will be confused and will also confuse words or letters. For the above reasons, confusion was described in a separate category and not in the emotional category or the category of errors.

Another similar condition is stuttering. Students, for example, said: *'I will stutter and I will make errors in reading and I will not take breaths'* (G06). Stuttering is also affected by anxiety. This is another state that students will feel unsure about their performance and uncertain about their abilities and will also start feeling that they may make errors. Such errors can be depicted and reflected in their fluency as by stuttering, their reading of the text will take longer. In these two conditions, students are unable to think clearly or quickly as normal and they are afraid that this may be reflected in their reading.

Circumstances

Students associated particular conditions with starting to feel anxious. In particular, students stated that they got anxious when they were in class: *'I am afraid of making errors when I am in the class'* (GR39), *'when I read a text out loud'* (E27), *'I will be ashamed'* (E06), *'since I knew that I would read the text out loud, I got anxious'* (E30). Anxiety would affect those students only if they were in an environment with other people, their teacher or classmates, who would pay attention to them and notice whether they are making errors or not. Students with dyslexia seemed to be very sensitive of the opinion of their peers and their evaluations.

A second condition that was protruded was the possibility of having to or being asked to read a new text. For example, student G02 commented that *'when the text is new and when I make errors'*. This means that they are afraid of the unknown, are not willing to take risks, and feel less confident and more anxious of how they will perform on something that they were not trained on before.

4.5. Interviews

Interviews were employed in this study to provide an insight and to examine unanticipated ideas and points of view that would not have been revealed only through

the questionnaire. Their purpose was to find which emotions students with dyslexia feel and how these are related to their reading performance. Deductive and inductive methods were thus combined to analyse the data. Specifically, a categorization framework proposed by the analysis of the open-ended question and by the body of existing literature was used. Every point of view presented in this qualitative section was valued as a source of subjective meaning that added to the overall comprehension of the issue being researched.

Thus, four themes were derived from the analysis of 13,295 words through thematic analysis; (1) emotions of students with dyslexia, (2) reading errors and their relation to anxiety, (3) aspects of self-regulation, and (4) effect of positive and negative emotions on students' reading performance. These themes were further sub-divided into other sub-themes, which are presented in what follows.

Emotions of students with dyslexia

Students were questioned particularly about their emotions and the conditions in which these emotions emerge. The findings reflect the complex connections between academic emotions and reading performance. Participants expressed various emotions, both positive and negative, and discussed their effect on their performance. In Table 18, reported emotions and the number of their mentions are listed.

Emotions	Number of mentions
Anxiety	44
Confidence	24
Both confidence and anxiety simultaneously	12
Confusion	6

Table 18. Emotions of students and number of references

Anxiety is an emotion that has been frequently mentioned by the participants of this study, both in the questionnaire and in the interview. Indeed, anxiety concerned most students with dyslexia as observed in Table 18 as well ($N=44$), making it clear that this is a complex emotion with many varying subjective components and outcomes. As participant E22 admitted, *'I was anxious'*, and this state is also supported by student E7, *'Yes, I am very anxious'*. These quotes confirm that indeed anxiety is experienced by many students with dyslexia, not only in the academic environment more generally, but in the reading process too. Participant (G7) adds to these arguments that *'I was anxious because I did not know what we would do and if I will do well'*, which means that often the emotion of anxiety is experienced because of the fear of the unknown.

As anxiety is an emotion that congests many students especially those that face learning difficulties, different levels of anxiety were observed in the interview. For example, student E30 *'I am always anxious'* expressed high levels of anxiety and another participant, E23, explained that he is experiencing anxiety in most occasions (*'Most of the time I am anxious'*). Other students admitted to experiencing anxiety but to a smaller scale. For example, Participant E59 expressed that *'I was a little stressed'* like G9 and G2, while G10 commented that *'I might get a little stressed'* and G9 said that *'Sometimes I am anxious'* indicating that they are feeling anxiety occasionally. These interview data indicate that emotions and especially anxiety are experienced in the school setting, but their degree may be differentiated in accordance with each individual child's mindset and experience.

Although anxiety is considered to be the most common and frequently mentioned emotion, students in this study described other emotions too that could be considered negative emotions. Specifically, participants confided that they felt **Fear**. Students are

afraid of the possibility of not performing well and not succeeding in the task. By thinking about these negative scenarios, they become insecure about their reading skills and afraid of the outcome. For example, student G7 admitted that *'I was a little bit afraid'* (G7) while G32 said *'I will not' make it'*. Fear is an emotion experienced by the anticipation of a threat, which in this case is the possibility of performing poorly. However, it is an emotion about an action that is potentially going to happen in the future and not in the actual time of the experience of this emotion. These comments could suggest that students might have had negative experiences from the past and were afraid of possibly experiencing them again (*I was again a little bit anxious because I did not know what will happen and if I will be good.'*, G7)

Similarly, another emotion that was reported often by learners was **Disappointment**. This emotion can be described as a displeasure caused by the non-fulfilment of one's hopes or expectations. For example, participant G22 said that *'I was disappointed because I can't read the words'*. Indeed, after the training, some students were not content with their performance and they expressed their disappointment later in the interview, which was accompanied by thoughts such as not performing well or that they would be judged by their classmates. For example, Participant E7 said that he was not satisfied, feeling disappointed of his reading (*'I didn't read well'*). Moreover, these quotes indicate that students are aware of their difficulty to read as well as they would anticipate or want, and this realization made them feel sad and disappointed that they did not manage to achieve their goals. They dreaded the possibility of failing and, therefore, thought that they would not read fluently.

The second most frequently reported emotion was **Confidence**, which is categorized as a positive emotion. Similar to anxiety, confidence is an emotional state that is highly discussed in the literature on dyslexia. Students in this project reported that they felt confidence when they read a text: *'I feel confident about myself'*(G55), *'I feel that I will perform nice and correctly'* (E02) and G14 said that *'I am never anxious for a text I read'*. Moreover, throughout the interviews, participants expressed that they were eager to read and compared the texts to short story books, where they wanted to know what happens next. For this reason, the emotion of confidence was accompanied by comments about enjoyment since for them, the reading process was a task that they found interesting. For example, student AG6 said that *'I like reading texts'* and *'I want to learn more and that I will continue and I will be very good'* (EL12). Thus, confidence was accompanied by feelings of and thoughts around success and trust in themselves and their abilities (*'I believe in myself'*, G54).

Nevertheless, there were students who reported that they were feeling **both Anxiety and Confidence** at the same time. Based on these answers, for many students, reading was a task which was neither necessarily abundantly enjoyable nor bad. Therefore, students might have felt mixed emotions; this phenomenon was expressed by participant G5 who was feeling quite anxious but said that she was also feeling happy of reading a text (*'I didn't feel very anxious but ok I was also happy'*), and G11 explained that she was happy because she was learning a new story. A similar response was provided by E11: *'Basically all the time I am feeling both anxious and sure of myself'*. Thus, it can be argued that emotions can coexist and are neither only positive or negative. As reported above, although the reading process for dyslexic students is a

difficult task, at the same time they also felt enjoyment and tried to perform at their best.

However, as was also evidenced through the open-ended question of the questionnaire, students expressed that they experienced **Confusion** (N= 6). Confusion is an emotion that impacts not only the emotional state of students but their intellectual ability too. Participant G1 was asked about the reading process of the experiment and replied that he got confused, while G25 replied that '*I get confused with the big words*'. Such an emotion also affects their performance. The following short interaction is illustrative of this point.

Researcher: *Were the words more difficult or were you tired?*

G1: *I do not know... not the words, I just got a little bit confused.*

Reading Errors and their relation to anxiety

Apart from expressing their emotions, students explained the reasons why they felt those emotions as well. Specifically, one of the most common sources of anxiety for these students was the text itself. As discussed in the literature review and the questionnaire section, students with dyslexia were making phonological **errors** in reading which was evidenced in the training process of this study too ('*I will get anxious and make more errors*'; G21). Moreover, as they explained during the interview, they were highly concerned with the errors as they were one of the most common attributions of anxiety. For example, G9 said that '*I'll make a few errors when I'm anxious*' and G8 said that '*I am a little bit worried that I may make an error*'.

In addition, the interview data suggested a two-way relationship between errors and anxiety, which may not only lead to phonological errors but at the same time, the fact that students are making errors may lead them to start feeling anxious. In particular, they said that *'I am more anxious because I don't want to make errors'* (G23). They felt demotivated of how they would perform and if they would pronounce the words or sentences accurately. For example, G24 started panicking when she realized that it was possible for her to make errors. Indeed, students stated that they were knowledgeable that when they would start feeling anxious, they would make more errors (*'I am a little more stressed so as I won't make errors in reading and copying'*, EL23). This relationship is illustrated in Figure 15 as well.

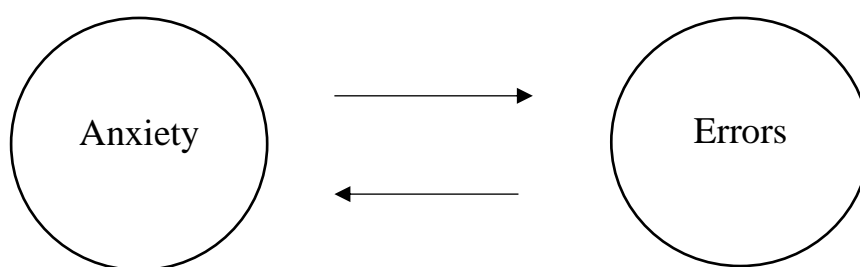


Figure 14. Relation between Anxiety and Errors

Students were also able to understand that their errors were not always affected by emotions like anxiety. For example, when student E2 was asked *'were you anxious?'*, she replied *'No but I made errors'*. She knew that although she was not anxious, she would still make errors, but it was not necessarily something that affected her since she was trying to do her best. Other participants such as E6 admitted that *'I don't know why I am anxious, this is how I am used to feeling'*. Some students also recognized that the emotion they experienced was anxiety but as school is a difficult environment for them,

there were cases where they felt anxiety constantly and would overgeneralize. Thus, for these students' anxiety was more like a stable personality trait.

Regarding phonological errors, students reported that they were making errors with words and letters of the text (*'there where some difficult words and names'*, E2) (*if the words are large and the letters are difficult*, G15). Students were getting scared of the words or letters that they saw in the text, and this started to affect their emotions. Oftentimes, they read something else than what was written. For example, two students said that *'I believed that something else was written and I read something else'* (AG10 and G50). They argued that they may not see some letters or thought that although they recognized a word, they pronounced it differently (*'the letters were small, and I hadn't noticed them, and I got confused and I said summer instead of good heart and I got confused'*, G20). Moreover, these comments provide evidence of the existence of the visual deficit which was examined in the experiment of this study. Moreover, another student stated that for him it also mattered if the words were familiar to him or not (*In general, I don't make errors, in these words that I know I don't make errors, in those that are more difficult I make errors.* (E5); *I will mix up my words, he will say one word and I might say a different one and mix up the order of the words and the line* (E20).

Furthermore, students referred to another characteristic of students with dyslexia which is skipping lines during reading. Specifically, they said that when they were about to start a new line, they started reading the next one. (*I'm a bit more careless... I always read the text at home, and I always go to the upper or lower row so that in some texts I don't read them, 2-3 rows, because I'm bored at home, I'm a little bored to do it while I stop playing*, E23).

Another cause of emotions related to text factors was the length of a text. Interviewees said that *'when we have long texts, it is very difficult for me'* (E11) and *'in short texts, I am not anxious in long ones I am'* (E5). These quotes illustrate that students had concerns about how long a text was. If they considered the text which they were about to read as long, they automatically thought that it would be difficult for them and they might get anxious (*'if I am about to read 5-6 paragraphs by only looking at the letters I get anxious.'*). If they saw that the text they had to read was short, they made the association that it would be an easy text and they were confident and relieved (*'I like it when I read texts but texts that are not very long'*; G14). Another student said that *'If the text is short, I am sure of myself, if it is a long one I am completely anxious'*; E24).

Secondly, another commonly referred reason was **the presence of other people**. Reading while other people are around made students with dyslexia feel uncomfortable. *'Now we were two people and I didn't get anxious, when we are more people I feel different'* (G27). They are highly concerned by a possible disapproval from peers or their family members. *'children in my class are 12 and you are 1 that's why it is more anxiety-provoking, the number of people matters to me'* (E5). Also, E5 explained that the number of people around her was very important, as in the experiment it was just us but in class there are a lot more people.

Reading in front of classmates was an experience very often mentioned ($N= 19$) throughout the interviews. For example, G2 participant said: *'In our class I was also feeling anxious there because I would read something and I didn't know if I would make*

any errors'. Interviewees stated that they would get embarrassed by saying something wrong and this experience made them anxious. They were afraid that they would hear that they were not good enough because they felt that they lagged behind others; this constant sense of failure in a group might finally result in giving up. Moreover, in the classroom, there were friends observing them too, whose opinion also mattered ('*when my friends are hearing me read I am anxious, when I am alone I don't have a problem*' , E20). The lack of understanding on the part of their peers could seriously undermine their self-confidence and might push them towards giving up. Interviewees' quotes that '*At school I'm more stressed because I had read it the day before but at school I can't read it because I'm embarrassed*' (E36). Moreover, they were afraid of being compared to others as they were students with different language learning profiles and abilities. Related to that, there were quotes like '*They may tell me you didn't read as well as I did*' (G23) and '*the others may hear me and say that I didn't read as well as them*' (G23). Also, they expressed being shy, which is related to public appearance and performance ('*I feel shy to read*' , G18) and is highly affected by the social environment.

Moreover, the role of the teacher is crucial in the school achievement as he/she is the person who they look up to and seek for his/her approval ('*If I get anxious and I read in front of my teacher I get more anxious and I may make errors*' , G14). Especially in the case where the teacher displayed a negative attitude, it became even more difficult and an anxiety-provoking experience for these students who had different language learning profiles and abilities. Furthermore, they were highly concerned by the evaluation of the teacher and what mark he/she would assign to them. '*I get anxious of the mark I will get after the reading*' (G14). Due to their dyslexia, many participants had negative experiences in the language learning group: '*If I get anxious and I do not*

know it very well and I read in front of the teacher and the time is 9 and 10 times, and 20 and I don't say it in front of the teacher I get anxious, and if I read in front of the teacher I will make errors.' (G14)

Moreover, parents highly influenced the emotions of children with dyslexia (*'when I read in front of my father, I get shy and I can't read'*; G24). Children were particularly concerned with the opinion that their parents had for them as they sought for their approval and applause. However, there were comments like *'my mum asks me what my other classmates did and I say I did well'*, G14). The mother of this student is interested to know how the other students did. In this way, the mother set the student in a mindset of comparing himself with other students, which is not a healthy action. These comments indicate that parents showed lack of understanding and intolerance.

However, different emotions and situations were expressed when participants were reading on their own and there was no other person around to observe them. In particular, opposite experiences were described. On the one hand, when they were alone, participants said that they felt confident and read well; on the other hand, when they were around other people, they became anxious and insecure. Participant G30 and E10 said that *'When I read alone, and no one is around to hear me I don't feel anxious, and I read well'* and *'I am always anxious when others hear me'* respectively. Also, *'Out loud I haven't get used to it because when I read it alone, I read very well and when I read out loud, I do not read so well'* (G14). These utterances confirm that students' performance and the number of errors were highly affected by the pressure of the social surrounding rather than the performance as it was. Nevertheless, they preferred reading on their own since in this way, they would not make errors feeling

more confident and assured. In conclusion, participants were highly affected by the opinion of others to the extent that they changed their motions and emotions. Positive influence of others was observed in the quotes of the participants such as *'Sometimes if I hear by the other classamtes that I was confident and I read well, I do better'* (G20) and *'If I could know what they say I would be confident and happy and sure for myself'* (G31) as well as negative *'I am afraid of what they say inside them.'* (G30), and *'Although when I read out loud, I am anxious 10/10, if I read on my own I am 0/10.'* (G5).

Self-regulation

Throughout the interviews, students with dyslexia expressed that they managed to regulate themselves and focused on their performance. For example, participant G14 said that *'I will make some errors, but I will try to correct them'*. In general, all children in this study were willing to try and that was expressed verbally too (*'I don't feel very confident, but I will try'*, G28). Although they felt uncertainty about their abilities, they performed without thinking of a possible negative outcome (*'I will make errors, but I will get better'*, G14).

Moreover, students commented that they had adopted or thought of strategies so as not to let anxiety affect them. Specifically, students explained that *'I read them [i.e., the texts] 5 times until I know it by heart'*(G14) and *'I read it silently and then to my mum'* (G14). These comments suggest that one method that many students followed was reading the text again and again until they were not making any error. Another student confessed that he had a secret way which was assisting him through reading but when I asked him to tell me more, he did not want to tell me this secret (*I have something odd that helps me'*, E13). Another student said that although he might make some errors,

he would correct them or the teacher would help him (*'I will make 1-2 errors at the beginning but I will correct them'* (G14), *'I just want to read it on my own, or if I don't know a word, I will go to the teacher to ask her to explain the meaning to me'* (E10)). In general, students were trying their best and knew that they had to be careful and concentrated on their reading, because it would help them not to make errors (*'I am careful not to make errors'*, E12).

Effect of Positive and Negative Emotions

Furthermore, they were asked about the influence that emotions had on their performance. In the interview, contradictory comments were made. It would have been expected that negative emotions would lead to negative results and positive emotions to positive results. However, this relationship was not always necessarily unidirectional and straightforward. Indeed, participants argued that positive emotions sometimes led to negative outcomes and negative emotions to a positive outcome. However, as seen in Table 20, anxiety leading to negative results gathered the majority of answers or mentions.

Relation	Mentions
Negative Emotions – Negative Results	40
Negative Emotions – Positive Results	27
Positive Emotions – Negative Results	24
Positive Emotions – Positive Results	39

Table 19. Mentions *N* of emotions and their outcomes.

Anxiety leads to Negative Results

In this category, students explained that *'when I am anxious, I perform horribly'* (G20). Moreover, G24 and G21 specified that *'when I am anxious, I make more errors'*. As such, students admitted that there is a negatively effect of anxiety on their performance. They start making errors and reading is an experience which they start to avoid (*'I don't want to read, I get anxious'*, G50).

Anxiety leads to Positive Results

On the contrary, students said that anxiety does not always affect them negatively and they perform well by making fewer errors (*'I don't have a problem, If I get anxious I will read better'*). Anxiety is an emotional state, but each individual manages their emotions differently. The data included comments such as *'I don't think that anxiety can affect me'* (G22). Certain students were able to control their anxiety and reverse it to productive anxiety thus being given a boost to become more productive and effective (*'I am more anxious so as not to make errors in reading'*, G23).

Confidence leads to Positive Results

On the other hand, as far as positive emotions were concerned, the majority of participants admitted that if they were confident, they expected to perform better (*'when I feel confident, I read well and when I am not confident, I make errors'*, G27). Confidence was beneficial for the interviewees as it helped them reduce their errors. They believed in themselves and felt certain, and at the end they managed to perform better (*'If I am confident, I think I will do better'*, G22, G9) and *'I will become more careful so as not to make errors'*, E14).

Nevertheless, positive emotions affected not only their reading performance but their motivation too. Participants were certain about their success and for this reason, they

were constantly motivated to do their best (*'I want to learn more, and I will continue to be very good at it'*, G12).

Confidence leads to Negative Results

On the other hand, opposite statements were heard during the interviews as well. Specifically, participants argued that confidence and other positive emotions would not necessarily lead them to positive results: *'If I am confident I will not read so well'* (G13) and *'When I said that I was sure about myself, I got confused because the letters were small, and I didn't notice them and I got confused and I said summer instead of good heart'* (G20). These comments highlighted the opposite outcome that an emotion might have led to suggesting that by the time students felt confident, they started being too sure of themselves and were lax, thus making more errors than normal. They admitted that being confident was a trap and led them to opposite results of what they would have expected (*'When I am confident, I make errors because I may read by heart'*, G50).

Neutral Attitudes

Apart from positive or negative emotions and outcomes, the view that students were feeling both positive and negative emotions simultaneously also surfaced in the interview data. This was also supported by the results of the emojis, where students chose both positive and negative emojis. Other students reported that emotions did not affect their academic performance. Specifically, they argued that they were not affected by their emotional state but performed as well as they could (*'I don't believe that it can influence me'*). Moreover, participants knew that everyone could say something wrong or make an error even without necessarily being dyslexic (*'Both when I am anxious and confident, I will make errors, it doesn't change anything'*, E5). These thoughts were helpful towards summoning courage and not being affected by the comments and

evaluations of others. In the same vein, another student (G22) recognized that we are all human, and everyone makes errors (*I will become more careful, but I make some errors, we all make errors.*)

Feedback on the procedure

One of the interview questions asked participants to provide feedback and comments on the training procedure and the collection of the qualitative data. They did not provide negative feedback such as in the form of a dislike or disapproval. Some comments were '*It was ok*', '*It was fine*', '*I really like it*', '*It was perfect*'. After the analysis of the interview, an emerging model was identified. Specifically, it was noticed that students who are more inhibited and restrained in their feedback were indeed anxious when they read the text and reported that in the instruments too (*'I don't like reading'*, G13). On the other hand, those participants who responded that they enjoyed the task were those students who were feeling more confident while reading the texts and had trust in their abilities.

4.6. Observations

Unlike interviews, a significant strength of research observations is that they allow 'researchers to see directly what people do without having to rely on what they say they do' (Dorniey, 2007, p.185). In this project, observations were chosen as a means of providing further support to the evidence that were collected by the questionnaire and the interview. In the text that follows, the focus is placed on students' bodily expressions and manifestations of emotions, and how these emotional experiences varied in the different phases of participants' performance. After the analysis of the gathered data, two themes emerged: 1) behaviours and reactions while experiencing

positive emotions and 2) behaviours and reactions while experiencing negative emotions.

Some students' reactions could be attributed to anxiety or participants being nervous. For example, G07 was fidgeting, and students such as G22, G31 were rubbing their hands and/ or legs while G28 had palmar sweat. According to Steptoe and Voegelé (1992), sweaty hands are an indicator of anxiety and are characterized as one of the most known nonverbal symptoms of anxiety. Moreover, other students were impatient asking repeatedly the same questions and answering quickly without taking time to process their thoughts. Other students were shy and hesitant. Participants G05, G09, G22 hesitated to give an answer to questions I asked or take initiatives during the training process. In addition, the tone of the voice of some participants was low and particularly G07 was very often using 'eee' in his speech or had a trembling voice.

Other participants presented contrasting behaviours and reactions, which indicate that they were feeling different emotions than the above-mentioned participants. For example, students like 8AG and 21EL seemed calm and confident; their posture was relaxed, laying back in the seat and not making abrupt movements. They were also patiently waiting to hear the instructions and were taking time to think or process their answer. This indicates that they were feeling confident and sure about themselves and their performance. They did not ask too many questions and the tone of their voice was strong and certain. 11EL also seemed happy because she was smiling, laughing and was not afraid of asking the researcher questions.

Taking this analysis into consideration, some participants' behaviours seemed to be in accordance with the answers that they gave in the questionnaire and interviews.

Therefore, this evidence validates and confirms the results of the other instruments that were used.

4.7. Conclusion

In this chapter, findings were presented in five main sections: 4.2. section addresses research question (1) which is related to stress pattern assignment of dyslexic individuals in L1, 4.3. section addresses research questions (2) and (3) providing evidence regarding the stress pattern assignment of dyslexic individuals in L2. Research questions (4), (5) are analysed in the sections 4.4. -4.6.

Summarising the data derived from the emotions' instrument tools, students experienced various and often conflicting or contradictory emotions. The most widely mentioned emotion throughout the data was anxiety about their reading performance and their overall academic achievement. Nevertheless, other positive and negative emotions were found to play a significant role in students' overall emotional state. Emotions like joy, confusion and fear were found to highly influence students with dyslexia. It was also evidenced that, after reading, participants experienced a change of emotions – from positive to negative. Further discussion of the findings is unfolded in the next chapter.

Chapter 5. DISCUSSION

5.1. Introduction

The purpose of this chapter is to present the findings of this study in relation to the existing literature review. Moreover, by integrating the quantitative and qualitative results presented in the previous chapter, it offers a more holistic interpretation of the data that neither inferential statistics nor thematic analysis would have achieved individually. In this way, data have been linked into meta-inferences according to the principle of sequential mixed method analysis (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2009).

The first part of the chapter is dedicated to explicating the relation between dyslexia and stress pattern as well as the existence of visual deficits (research question 1). In the second part, the influence of visual deficits on second language learning as well as a comparison between Greek and English are discussed (research question 2 and 3). Lastly, the significant role of emotions and their impact on the reading performance of students with dyslexia is explored, focusing specifically on the themes that were found to be particularly important (research questions 4 and 5). Unexpected findings will also be discussed extensively in this section.

5.2. First Language Acquisition

5.2.1. Developmental Dyslexia and stress pattern

Developmental Dyslexia is the most common language disorder in school-aged children with adequate level of intelligence (Fisher & Defries, 2002; Vellutino et al., 2004). This could be one of the reasons why high attention was paid to dyslexia and researchers felt the need to better understand its nature and causes. Thus, the objective

of the current study was to provide further evidence about the origins of this difficulty, by investigating the impact of possible impaired sensory abilities on stress pattern assignment. Specifically, speakers of Greek language were tested on whether there is an improvement on their reading performance levels after visual or auditory training.

Studies have reported increased numbers of phonological errors and other literacy difficulties among dyslexic readers (Curtin, Manis & Seidenberg, 2001; Wimmer et al., 2000). Specifically, results in other reading tasks indicate that, in comparison to typically developing children, children with developmental dyslexia present deficits in both suprasegmental and segmental phonology (Protopapas et al., 2013, Wimmer, 1993). The results of the reading task in the present study indicate that students with dyslexia made reading errors that are also listed among the indicative criteria of identifying Greek students with dyslexia (Propodas, 1997). Moreover, similar pattern of errors and categorization was observed in the study of Paizi et al. (2011) in which they tested stress assignment in sixth-grade readers and found that students with dyslexia present difficulties in applying stress patterns. Moreover, as in this thesis study, they classified errors based on segmental and supra-segmental level. A closer look at the results helped to see whether the dyslexic children were exhibiting similar characteristics previously reported for Greek-speaking children with literacy difficulties. Regarding the Greek language, a study which has classified the errors of students with dyslexia is the paper of Protopapas et al. (2013). The authors tried to classify spelling errors of normally developing children and children with dyslexia who speak Greek as their native language. In comparison with our results, the equivalent category to that of pronunciation errors is the phonological category in their study and their subcategorization shares many similarities with those of the present study such as letter and words omission and addition. A similar pattern of errors has been observed

in other studies on Greek language such as the study of Niolaki et al. (2015), in which the researchers used text, single words and non-word reading and found that students with dyslexia were less accurate and slower than typically developed students.

In particular, scores of the project (Table 3) indicated that indeed, dyslexic children omitted or added words and letters as well as made errors in punctuation and stress pattern. As a matter of fact, during the interviews, participants reported that they were highly concerned of their performance as they were often afraid of making errors. For example, participants G50 and G60 indeed reported themselves some of the errors that were detected in the reading task as well. For example, G50 said that '*I may read the word play (paizo) and say kid (paidi)*' and G50 explained that '*I may confuse words*'. These quotes can also be considered as validation proofs for the reading test because the errors which were found in the tasks were those reported by the students too. These results fulfilled the expectations of Douklias et al. (2009, p.708) according to whom: 'A mild impairment in real word reading accuracy might be expected in dyslexic children.'

Moreover, as indicated in the introduction chapter, one of the characteristics of developmental dyslexia is stress sensitivity. The paper of Wood and Terrell (1998) was one of the first discussing sensitivity of young poor readers to prosodic segments of rhythm and stress. It can therefore be understood that not only phonetic but also prosodic structure plays a crucial role in language acquisition. This characteristic of dyslexia is further supported by the findings of this project as dyslexic children (poor readers) did show deficit in stress sensitivity in the reading tasks. In general, stress diacritics were largely omitted by children with dyslexia. In support of these findings, Protopapas et al. (2013) argue that stress errors concern a specific deficit in dyslexia and further research is needed. However, the study of suprasegmental phonology in

dyslexia has received much less attention than segmental phonology, but lately there has been growing interest in this subject. In the study of Protopapas and Gerakaki (2009), participants were children in Grades 2–4 and tested in a battery of experiments and found that they placed more weight on the identification of words segments than on the diacritics of stress assignment. Moreover, they concluded that stress markers are underutilized in reading. Children only highly proficient adult readers rely strongly on the diacritic (Protopapas, Gerakaki, & Alexandri, 2007). This is consistent with the hypothesis that processing of the diacritic is not only challenging but also largely unnecessary, insofar as the occasions requiring decoding of the diacritic for lexical disambiguation have been estimated at less than 1 % for isolated words (Protopapas, 2006).

The present study confirms that stress sensitivity is impaired in individuals with dyslexia (research question 1). Specifically, the fact that the mean number of errors was high offers further proof that dyslexic children face difficulties assessing the correct stress pattern. Moreover, other researchers have focused on the stress pattern, which they approached from different aspects. For example, Goswami, Mead, Fosler, Huss, Barnes & Leong (2013) tested whether dyslexic individuals present impairment in perceiving stress pattern using the Deedee task. This task analyses how dyslexic individuals perceive stress pattern and not their reading efficiency. Moreover, Gutierrez- Palma, Raya-Garcia & Palma – Reyes (2009), focused on whether individuals with dyslexia are able to detect changes in prosody and Holliman, Wood & Sheehy, 2010 focused on speech rhythm. These studies showed a significant influence of stress sensitivity on reading fluency. As such, the study reported in this thesis provides evidence for the existing belief of poor sensitivity to stress perception, which

will be discussed later in this chapter by approaching it from a unique angle and one that has not been researched before, that of reading performance.

Furthermore, during the training it was noticed that in some categories such as stress errors and pronunciation errors, some errors show a repetitive pattern. Specific words were mispronounced repeatedly by the majority of participants. For example, βάρδαρης [ˈvarðaris] instead of βαρδάρης [vaˈrðaris] and πράγματα [ˈpraŋmata] instead of πράματα ([ˈpramata] = things). This phenomenon could be attributed to the difference between low- and high-frequency words. Sotiropoulos and Hanley (2017) found that in irregular word reading accuracy, participants performed worse than in regular word reading accuracy. This could possibly be attributed to the fact that dyslexic children are more prone to errors than skilled readers especially when it comes to low-frequency words. However, further research is needed, which would examine these results taking into account the parameter of word frequency.

5.2.2. Comparison of Visual and Auditory task/ training

Speech is a phenomenon which is related to various senses as both auditory and visual information is activated (Benoit et al., 1996). New proposals suggesting that visual and/or auditory dysfunction underlie dyslexia, are the focus of recent research (Goswami, 2015). Although there is a paucity of research into further understanding of word reading, the main issue investigated here concerned the possible effect of visual deficits on stress pattern.

Therefore, in an attempt to address this issue, the present study introduced a training programme constituting of visual and auditory modalities. As discussed in the previous section, participants performed poorly in reading tasks especially concerning stress

pattern assignment. The aim of this specially designed training programme was for dyslexic individuals to recognize differences between similar images and melodies through training and, thus, improve their stress sensitivity. To test this, in the design of the training programme, a task was included before and after the modalities to examine its impact on stress assignment. The task comprised of reading texts which were analysed for reading accuracy and reading speed. Participants were first trained in detecting details and differences and then they were tested on their efficiency in stress patterns and if they had improved in recognizing the diacritic marks of stress pattern in the Greek language.

Taking into consideration the overall picture regarding reading accuracy, there was an improvement in the majority of categories in the test after the visual training. More specifically, effect on performance was detected in all major categories (pronunciation, punctuation and stress errors) since the errors in the post-test were fewer than those in the pre-test. On the other hand, the results of the auditory training present a small rise in errors in the post-test phase concerning the categories of pronunciation errors and stress errors, which means that participants did not improve. In the punctuation errors category, frequencies in the post-test were found to be quite similar to the frequencies of the pre-test indicating no significant improvement. Similar findings were reported by Aylward et al. (2003), who tested 10 children with dyslexia and 11 average readers before and after intervention. They compared the two groups of students on reading tests as well as the level of activation during tasks of identifying letter sounds. They found that while the control children showed no differences between the two imagings, the students who received the treatment showed a significant increase in activation in the areas important for reading and language during the phonological task. Before the intervention, the children with reading disabilities showed significant underactivation

in these areas compared to the control children, and after the treatment their profiles were very similar.

Apart from general reading accuracy focusing on stress pattern, a significant improvement after the visual training was noticed, which constitutes preliminary evidence for a visual deficit in Greek dyslexic children. For the visual training, the mean number of errors for the pre-test was $M= 6.69$ and the post-test $M= 5.17$ while in the auditory training the mean number of errors for the pre-test is $M= 5.46$ and for the post-test is $M= 6.06$. Although in both tests only few of the words did not follow the indicative stress pattern, it was predicted that children who suffer from developmental dyslexia should show a significant difficulty in stress assignment due to a visual deficit. As such, the outcome of the research was that after the visual training, the scores of stress errors were ameliorated indicating improvement of dyslexic children in stress assignment answering research question (1). However, scores of the auditory task in the present study followed a different pattern which is going to be discussed followingly.

In general, while most of the studies regarding dyslexia have examined phonological processing, the examination of the relation between developmental dyslexia and visual processing should not be underestimated. The fact that reading includes the transformation of complex visual structures such as words and letters into meaning highlights the key role of visual process in literacy. In order for students to learn a language, they must learn the 'code' of each culture including its visual symbols (Ziegler & Goswami, 2005). This kind of relation was examined in the present research. However, visual deficits as discussed in the literature review could impair conversions such as grapheme-phoneme or in the lexical processing in the degree of visual word formation (Huestegge, Rohrßen, van Ermingen-Marbach, Pape-Neumann & Heim,

2014). Moreover, Ramus (2003, p. 216) has stated that ‘it remains possible that certain visual deficits, such as visual stress, may sometimes sufficiently disrupt reading ability so as to lead to a diagnosis of dyslexia’. This can affect not only segmental phonology but suprasegmental phonology such as stress pattern too.

Furthermore, the results of the present research are in accordance with recent studies implicating that visual processing deficits play a crucial role in developmental dyslexia. Since the evidence suggest that visual training improves the scores of stress assignment, the present study answers positively the research question (1) and provides further support to the arguments according to which there is a relation between visual deficits and dyslexia. Vidyasagar and Pammer (2010) argued that if a deficit in visual attention exists, it may mean that it affects the processing of sequences such as those of letters. The study of Huestegge et al. (2014) gives further support by examining the processing of visual input but from another perspective. The authors stated that visual deficits in long-term memory play a causal role in developmental dyslexia. These findings could be considered as supporting a particular deficit in performance with dyslexia as suggested by Protopapas (2012) and other studies have provided further evidence of this (e.g. Holliman, Wood, & Sheehy, 2010; Gutiérrez-Palma, Raya-García, & Palma-Reyes, 2009).

On the other hand, a growing body of research has demonstrated that temporal processing training, primarily in auditory modalities, may have positive effects not only on auditory temporal processing but on phonological awareness and reading as well (e.g., De Martino, Espesser, Rey, & Habib, 2001; Boets et al., 2011; Goswami, et al., 2011; White et al., 2006). Calet et al. (2019) examined non-linguistic prosodic skills in connection to linguistic tasks and found poorer performance in Spanish dyslexic participants than normally developed children. They also concluded that because of the

deficit in non-linguistic rhythm, it is possible for children with dyslexia to have diminished ability in the processing of linguistic rhythm. Another study (Goswami, Huss, Mead, Fosker, Verney, 2013) found that children performed significantly poorer than younger aged children concerning musical rhythm perception and amplitude rise time. In particular, Goswami et al. (2013) conducted a longitudinal study, in which they found that perception of beat distribution has the ability to link children's processing of both music and language. Nevertheless, auditory processing and reading processing should be examined longitudinally since developmental dyslexia needs a developmental focus (Goswami et al., 2003).

On the other hand, regarding auditory processing, it is theoretically possible that differences in auditory sensitivity cannot be related with difficulties in acquiring lexical stress patterns (Goswami & Leong, 2013). According to Ramus (2003), most studies on auditory processing found that it is impaired but only on short sounds or fast transitions, in other words on temporal auditory processing. Moreover, in another study only 39% of the total dyslexics had a significant auditory deficit (Heiervang, Stevenson & Hugdahl, 2002). The findings of this project have shown that participants' auditory deficit has a non-significant role to play especially in stress assignment. However, research on the level of visual or auditory perception in dyslexia is still not well developed (Vellutino et al., 2004) and, thus, further research needs to be conducted.

Furthermore, studies have found that dyslexic children are slower in reading than typically developed readers despite their accurate word reading. For example, Wimmer (1993) tested German students with dyslexia on all types of reading tasks and nonwords and found an impaired reading speed. He also found a significant difference between the group of dyslexics and the control group in rapid naming tasks. Regarding Greek, evidence on reading speed can be found in the studies of Niolaki, Gouladrakis &

Snowling (2003) and Niolaki, Terzopoulos & Masterson (2015). In the first study, the researchers conducted an experiment using reading texts and found slow reading speed. The second study showed that participants presented a rapid naming deficit using tasks such as reading words and nonwords and rapid naming. Based on this evidence and since reading speed is impaired in dyslexic individuals, the current research examined reading speed as well, with the aim to find whether after training, better results will be presented. The results indicated no significant improvement between pre-test and post-test for both visual and auditory training. In particular, participants performed worse in the post-test than in the pre-test. However, by performing descriptive statistics and comparing the mean number of minutes between the two trainings, better performance was indicated in the post-test after the visual task. Regarding the visual training, the difference of reading speed was 0.13 between pre-test and post-test while for the auditory training the same difference was 0.44. Although these findings are inconclusive, further research needs to be conducted in order to find whether there is a relationship between a visual deficit and reading times of an individual with dyslexia.

The results of the present study are well matched with previous studies arguing that visual processing deficits could play a significant role in developmental dyslexia. Our results showed that dyslexic children do improve after the non-linguistic task. In particular, the fact that there was improvement only in the visual task implies that there was a difficulty in the visual processing, although after the task there was improvement. However, it is crucial to note that based only on the present research, we cannot make universal conclusions and we cannot decide if the observed improvement in training is due to visual implications as there is need for a bigger sample. Additionally, it is understandable that with training, a non-linguistic task does have an effect on a linguistic task but future improvements in methodology and statistics can clarify the

relationships between possibly different types of auditory processing impairments and reading skills.

Hence, researchers' attention should be drawn to the need to examine the effects of interventions and trainings focusing on visual processing rather than theoretical examinations of its relation to the nature of dyslexia. By confirming the importance of visual processing in reading among children with dyslexia, a better understanding will be achieved on the questions that are floating around the nature of this reading difficulty. As Cassar, Treiman, Moats, Pollo, & Kessler (2005) have argued that because their spelling errors are quantifiable rather than qualitative, the hypothesis is that students with dyslexia could benefit from active educational methods and that their improvement would be significant.

5.2.3. The interrelation of findings with theories of dyslexia

The previous discussion regarding the auditory and visual tasks brings further support to the discussion of theoretical explanations regarding dyslexia. In the literature review, some of the most predominant theories were discussed. Based on the present findings, the present thesis indicates that indeed a phonological processing deficit exists, but it is apparent that there is a deficit in visual processing as well.

Dyslexia can be characterized by deficits in learning to read. The majority of researchers agree that poor phonological awareness is one of the main deficiencies for the difficulty to learn the relation between sound, spelling and reading (Bruck, 1992). In particular, the most well-known theory is the Phonological Deficit Hypothesis. This theory states that the impairment in representations provokes difficulty in recalling or maintaining phonological information. Ziegler and Goswami (2005) argued that

phonological awareness skills and especially phonemic skills could contribute to the representation of the words.

However, other theories have also tried to explain this learning difficulty having included various deficits as they state that deficit in phonological awareness is not the only one which has an impact on dyslexia. As Stein (2018, p.6) has stated, 'it is clear that we have to look more deeply at the psychological mechanisms that cause phonological difficulties. These throw up clear differences between dyslexic and typically developing readers, particularly with respect to their auditory and visual temporal processing and sequencing'. In particular, the magnocellular theory states that except a phonological deficit, there is difficulty in visual processing. According to Stein and Walsh (1997), there is a deficit in magnocellular pathway which is possible to lead to visual and phonological deficits.

As the present study demonstrates, it is possible for a dyslexic individual to face various literacy difficulties. The results of the present study indicate that after training, participants present improvement in assigning stress pattern and consequently improvement in visual attention. Moores, Cassim, and Talcott (2011) found that since text is a crowded stimulus, reading of dyslexic children is more difficult - having in mind how close words and letters are to each other - compared with skilled readers. Thus, it is noticeable that a theory including not only a phonological deficit but difficulty in the process of visual information is necessary for a better explanation of this learning difficulty. Other theories that are based on a visual deficit and our findings can support is about visual stress. In addition, visual stress appears to be independent of phonological deficit and hence a probable independent cause of reading difficulties. However, the underlying biological origin of these visual abnormalities and their

influence on reading remain unknown and the magnocellular origin concept does not appear to be well supported.

On the other hand, it is possible that variety in auditory sensitivity cannot be related with difficulties in the acquisition of stress patterns (Goswami & Leong, 2013). Goswami and Leong (2013) state that auditory sensitivity can derive from poor representation of dyslexic individuals. Moreover, these kinds of deficits are neither sufficient nor necessary to be the causal factor of a phonological deficit or a literacy problem. In studies like Ramus et al. (2003), the researchers concluded that participants with reading difficulties do not show auditory processing deficit. In this way, having examined the assignment of stress pattern in Greek dyslexic children with both visual and auditory task, the previous studies offer further support for the visual explanation and not the auditory. Nevertheless, it could be argued that developmental dyslexia is likely to be a more complex learning difficulty to be justified by only one causal factor. Moreover, Van Wassenhove et al. (2005) found that visual speech information speeds up the processing of auditory speech information. This indicates that if there is difficulty in processing visual information, this may lead to delay of the auditory information and gives further support to the significance of visual information.

In conclusion, it is still interesting to examine in which level visual training can have an impact on the performance of stress pattern. The results of the present study present congruence with the overall literature, which on the one hand presents various inconsistent findings but on the other hand is dominated by an unquestionable link between reading, visual and auditory skills. Gavin, Reid, and Fawcett (2004) argue that despite the fact that this subject is still controversial, the idea of a deficit including auditory and visual processing is being researched more and more.

5.3. Second Language Learning

5.3.1. Dyslexia and Second Language Learning

While most of the research into dyslexia has centered on first language acquisition, learning a second language is an important concern for students. Second language learning is widespread nowadays as more and more individuals start to acquire an L2 and especially English. However, its acquisition has been found to be particularly difficult for dyslexic students or students with other learning difficulties, and this field of research has been neglected until recently. In the study of Kormos et al. (2019), less than half of the learners with dyslexia belonged to the group of poor L2 readers. Moreover, another study of Kormos (2017) revealed that students with dyslexia may fall behind their other classmates in English language skills such as grammar, vocabulary or listening.

Based on these findings, in the first place, one of the objectives of the present study was to investigate the reading performance of Greek students with dyslexia in L2 English, especially with respect to stress pattern. In the study of Kaperoni (2016), the researcher used a questionnaire that was administered to a group of individuals with dyslexia and a group without dyslexia to test the skills of reading, writing, listening and speaking. She found that there is large variation in the rates showing a greater degree of difficulty among the Greek dyslexic students. Regarding reading skills, the findings of the present study are in agreement with Kaperoni (2016). In the present study, reading tasks were administered and reading difficulties were spotted. The test also revealed errors that are considered characteristic of dyslexic learners. Specifically, errors were classified in the same categories as in the Greek assessment, that is phonological, stress, and punctuation errors categories.

In addition, another category was added to the classification scheme, that is the Identification Errors category. This category was introduced because through the analysis of data, students were observed making errors on phonemes because they did not recognize the letters of the English alphabet. Specifically, they made errors such as in the words ‘classmates’ they would pronounce it as [kla:s.'mateç] / instead of [ˈklæs.meɪts] and ‘arrived’ would pronounce it [ə'.ɪvɛd] instead of [ə'raɪvd]. These examples suggest that participants did not identify the English letters as they articulated Greek phonemes. In this category, errors were attributed not because of a possible impairment in phonological awareness which is one of the main theories of dyslexia according to which there is an impairment in the correspondence between grapheme and phoneme. These errors were classified in the category of punctuation as they followed the principles of identification of dyslexia. On the contrary, in the category of identification errors, students seemed to not recognize or have knowledge of the letter that they saw. Especially, as the examples above demonstrate, students corresponded English graphemes to similar or familiar Greek phonemes. Having in mind that at this stage they are learning a new language and a new alphabet, it is understandable that it takes them time to fully acquire the new alphabet. In addition, dyslexic students have been found to lag behind their peers roughly one to two years in terms of knowledge. This is supported by studies such as Calet et al. (2019), Douklias et al. (2009) and Goswami, Gerson & Astruc (2010). As participants were in the third year of learning L2 English, this categorization can be justified. Interestingly, this category presents the highest rate of errors that students made, twice than the control group.

Moreover, regarding L2, a control group was introduced in the present study. Since age is known to have an influence on reading abilities, groups were carefully matched. The control group was chosen in order to compare the results of students with dyslexia to

normally developed students for similarities and differences. As there is very little research in SLA and dyslexia in the Greek context, the goal of this project was to provide further insights. According to the t-test results, participants with dyslexia indeed made significantly more errors than the control group in reading accuracy as the phonological errors they made were significantly more than the errors that the control group did. Specifically, dyslexic students performed significantly worse in all phonological categories than the control group. Participants were tested on reading speed as well. In the analysis of reading speed, students without dyslexia performed significantly better than students with dyslexia. Normally developed students read faster than the control group. Also, a statistical significance was found for both reading accuracy and reading speed. This is proof that the students with dyslexia face literacy difficulties especially in reading. Several studies have concluded that students with dyslexia compared to non-dyslexic peers make more phonological errors, as has been shown in Bourassa and Treiman (2003), for instance.

However, the main focus of this project was to better understand the stress pattern assignment in students with dyslexia. Although suprasegmental phonology, in dyslexia, has received much less attention than segmental phonology, lately there has been growing interest in this subject. The results show that Greek dyslexic children performed significantly poorer than the control group at reading typically English stressed words. These findings are in accordance with other studies on English language as L1 albeit not in English as L2. Previous study on English learning showed that students with dyslexia are also poor in stress pattern (Helland & Kaasa, 2005). According to the study, they found that students with dyslexia are more prone to make errors in reading accuracy than normally developed children. Specifically, the present study presents significant difference between stress pattern assignment between

dyslexic group and control group. In other words, this means that students with dyslexia made more stress errors patterns than control group in second language learning.

As shown through the findings of the interview, the role of the teacher is crucial. Praskidou (2016) examined teaching practices that are considered effective for the learning of a foreign language by dyslexic students by evaluating the books of four classes. Overall, a lack of effective practices for the learning of the English language by dyslexic students was identified in the English textbooks, which makes the position of these students quite difficult. Antoniou (2017) investigated the awareness among English language teachers of the nature of dyslexia, their level of education and their ability to apply teaching methods that improve the wellbeing of students with dyslexia in primary education. The research findings showed that teachers' knowledge about dyslexia is insufficient as well as their training. In the present study too, especially inferring from the interview, the crucial role of the teacher was highlighted. Under no circumstances should the teacher believe that dyslexics cannot learn a foreign language. They can certainly learn, but they need special treatment and encouragement; it's just that the road to learning for dyslexic students is always thorny and rocky. For this they need a good companion, time convenience, patience, persistence and goal consistency (Ziegler & Goswami, 2005; Ganschow & Sparks, 1986).

5.3.2. Comparing Visual and Auditory Task

Theories about visual and auditory deficits are universal and concern all alphabets and language systems. As Helland and Kaasa (2005) have stated, in second language learning, the deficits associated with dyslexia in L1 should be accounted for. For this reason, another aim of this study was to investigate whether the visual/auditory deficit can be detected on reading performance in L2 (research question 3). In addition,

researcher has also underlined the need for extensive studies across languages to investigate auditory and visual processes.

In general, while most studies regarding dyslexia have examined phonological processing, the examination of the relation between developmental dyslexia and visual processing has received much less attention. ‘Sensory and/or motor disorders do occur more often in the dyslexic than in the non-dyslexic population’ (Ramus, 2003, p.214). However, these deficits have not yet been adapted to the linguistic domain. It is highly likely that in a language with transparent orthography and especially with the presence of a diacritic mark, the assignment of stress can be improved by completing visual exercises. This is indeed applicable to the Greek language, and in this project, an influence of a visual deficit on stress performance was found. Nevertheless, how are participants performing in a foreign language and especially in English?

Dyslexic groups showed evidence of impairment in the reading processing in second language learning as they were slower and less accurate than the control group. However, regarding research question 3 and concerning the training on visual and auditory modalities, no substantial differences between training groups were observed. In the visual training, the mean number of errors was $M= 0.9$ for the pre-test and $M= 1.1$ for the post-test, while in the auditory training the mean number of errors was $M= 1.1$ for the pre-test and $M= 0.95$ for the post-test. This means that neither visual nor auditory training had a significant influence on the reading performance of students with dyslexia with regard to stress pattern. Moreover, regarding reading speed, no substantial difference between the training groups was found either. Although there was a small improvement after the auditory training, this difference was not significant based on the inferential statistics that were conducted during the analysis. In addition, the texts were examined for reading speed as well. As in L1, there was no statistical

significance between the two test phases. The descriptive statistics demonstrated that in the visual training, participants performed worse in the post-test while for the auditory training there was a small decrease in the mean minutes.

However, although stress errors did not present improvement after the visual training, the Punctuation errors and Identification errors categories presented improvement in the descriptive statistics. The fact that punctuation pattern presented improvement after the visual training can be explained by the research hypothesis. As is the case with stress pattern in Greek, which is identified by a marker, punctuation pattern is also visible by markers such as the full stop, commas and others. These markers can be found in abundance in a text, nevertheless, students faced difficulties with processing and recognizing them. Thus, similarity between the stress and punctuation pattern categories was observed, and their errors could be explained by a visual deficit. Similar to the Greek texts, students in English texts were facing difficulties with identifying these small and indistinguishable markers of punctuation. These findings are of particular interest since participants themselves confessed that they may forget to stop when they see a full stop (e.g., G29 in the open-ended question).

Furthermore, comparing the performance between visual and auditory training, the results support the evidence of a visual deficit since in English considering the fact that stress patterns are not marked. It was therefore expected that students would not perform better after the training since there was no marker that they could have been trained on and then be able to distinguish it.

5.3.3. Comparing Greek and English

Although dyslexia has been studied for many years, it is still challenging to specifically identify this reading difficulty, explain its causes and suggest effective interventions (Nicolson & Fawcett, 2008; Vellutino et al., 2004). Researchers should also take into consideration that dyslexia manifests in different languages, whether alphabetic or non-alphabetic and transparent or non-transparent. The differentiation between transparent and non-transparent languages has been examined in this study and is discussed in the current chapter. The study aimed by research question (3) to examine the visual deficit phenomenon on dyslexia in a non-transparent language such as in Greek and whether a visual training will have similar influence on stress assignment in a non-transparent language like English.

First of all, as discussed in the literature review, the Greek language is consistent to a large extent at the grapheme-phoneme relation in reading, as most graphemes are corresponding unambiguously to a particular phoneme. Thus, due to its orthographic properties, phonological errors are unlikely especially for normally developed children, since there is a small number of cross-phoneme inconsistencies. However, for individuals with dyslexia, it is common to make several phonological errors by attributing phonemes to wrong graphemes which may be similar, familiar, or just random, as it was also observed in the analysis of data and the studies that were discussed in the literature review. On the contrary, in less transparent languages such as English, one grapheme may map to more than one phoneme and vice versa. According to Cossu et al. (1995), this has a negative effect on the acquisition of reading skills among English-speaking children. The factor of phoneticity leads students with dyslexia to be more aware of their spelling performance. Having observed these differences between the two languages, the present study centred on the extent to which

transparency affects the relation between stress pattern and visual identification. Landerl and Wimmer (2000) have argued that researchers should be concerned that English-based research might have overestimated the importance of phonological awareness in reading development. Moreover, as Douklias et al (2009) has stated, a phonological deficit is not one of the main causes of dyslexia in transparent languages. This raises the question of the commonality of dyslexic characteristics across languages and how it interacts with the complexities of diverse language typologies. Therefore, further research could shed light on this relation, especially across different languages.

In particular, Greek is one of the few languages that includes a stress diacritic. Stress is always marked, and its absence means spelling errors. In Spanish, stress diacritics can be presented to indicate irregular stress position while in Italian, stress assignment needs lexical knowledge because it cannot be predicted and is not marked based on orthography. In contrast, English do not include a mark to signify the stress pattern. However, the fact that stress pattern is marked to such an extent in the writing of Greek but students with dyslexia nevertheless still make errors, may imply that these dyslexic children may face another type of difficulty than the dyslexics of other languages. In particular, the argument of impaired stress awareness has been put forward in other studies regarding different language systems, both transparent and non-transparent. Wimmer (1996) argues that dyslexic individuals of transparent languages may experience fewer decoding problems than non-transparent languages like English due to grapheme and phoneme correspondence.

To explain this further, it would be worth juxtaposing the results of the present study with structurally similar and different languages. The article of Jimenez- Fernandez, Gutiérrez-Palma and Defior (2015) investigates the performance of Spanish dyslexic children in stress awareness. According to the authors, reaction times played an

important role as they argued that participants were using different kinds of procedures or strategies to succeed in the tasks. They argued that the deficit of dyslexic children can be linked with the access to representations which are intact, but they face difficulty in accessing them. On the contrary, the present study did not include reaction times of the participants. This may imply that further research is needed in order to investigate whether reaction times offer further information on this matter. Another article about stress pattern in developmental dyslexia is that of Paizi et al. (2011). This study focuses on Italian and the researchers found that readers rely particularly on lexical information for the stress pattern. On the other hand, in languages such as Greek, skilled readers with typical development are used to applying a default metrical pattern in one of the last three syllables of a nonword, which means that they were not based necessarily on lexical information (Protopapas et al., 2006).

On the contrary, for English, Holliman, Wood and Sheehy (2012) investigated the relation of suprasegmental phonology and phonological awareness and found connection between prosodic sensitivity and phoneme awareness. This connection enhanced the belief that both segmental and suprasegmental phonology matter in order to improve the phonological processing skills. By the same token, the present study found that errors in pronunciation could affect stress pattern. As a consequence, it may implicate that since dyslexic children present poor phonological awareness, this may affect prosodic sensitivity since they could be interdependent. Nevertheless, in the above study, phonological awareness impact was studied in English-speaking participants. These consistencies between categories of languages may affect the impact of an impairment in phonological awareness for reading outcomes. Further research in this topic should be conducted. It could, thus, be concluded that after all, language systems vary in the consistency in which phonological level is represented in

orthography. However, each language bears its own characteristics especially if they are transparent or non-transparent. As Georgiou et al. (2008) explained, differences may arise between linguistic systems regarding the special relation between auditory skills and reading skills or the dependability of auditory skills as indicative factor of dyslexia or in general reading difficulties. Developmental dyslexia continues to attract interest in connection with phonological awareness, which is the most dominant cause of phonological and reading deficits.

Overall, both similarities and differences of the two languages were spotted. First of all, the scheme of the classification was the same. The only exception was the addition of the identification errors category in the English-based phase of the study, which was explained thoroughly in the methodology chapter. This could be explained by the fact that first language skills are significant base for L2 (Kormos et al., 2009). Moreover, students were willing to read and participate in the experiment whether the text was English or Greek, showing no presence in a particular language. However, a difference in standard deviations was observed as in English reading, students performed better. This difference in the word reading between the two languages seems to indicate that dyslexics were not influenced by the lack of transparency of the English language. Moreover, as the above studies presented a particular pattern of stress pattern sensitivity, the present study is not out of the rule. Based on the results, a sensitivity was identified in the stress pattern of both Greek and English participants. However, the proportions of stress errors were substantially different. Stress pattern was omitted disproportionately more frequently in the Greek language than in the English language as participants in the L1 text made 5 times more errors than in the L2 English text. This outcome contradicts the above studies as based on transparency, it would be expected that participants would present more errors in L2 than in L1. Although there is a large

number of studies exploring transparency in relation to characteristics of languages, studies can broaden their scope to research the direct comparison between orthographically different languages.

For instance, in the study of Barry, Harbodt, Cantiani, Sabisch and Zobay (2012), the authors stated a different view by examining the phenomenon in German language. They argued that dyslexic children showed poor performance in stress pattern as was the case with the Greek language. However, they attributed this deficit not to lack of perception but of various abilities. In particular, they stated that dyslexic individuals may have the knowledge of stress usage but do not have the cognitive resources to attain metalinguistic awareness. On the other hand, 'causal relationships between word identification problems and deficiencies in such phonological skills are more prominent in dyslexics learning to read in opaque orthographies such as written English than in dyslexics learning to read in more transparent orthographies' (Vellutino et al., 2004, p.30).

The present research approaches dyslexia and stress pattern in a different way than phonological awareness studies. It examines whether visual sensitivity can affect the stress assignment. Having examined the characteristics of dyslexia in different languages, it is highlighted that in Greek, it is possible that visual or auditory factors play a crucial role on representation, too. The fact that stress is not used to such an extent in other languages gives the opportunity to examine the relation of dyslexia and stress pattern from another perspective. This was why in this project the English language was used. The reason was dual: on the one hand, to explore the difference between first language acquisition and second language learning in children with dyslexia, and on the other hand, to examine this visual deficit in a language other than Greek with different orthography and alphabetical system. According to the findings of

this research, in the Greek task an improvement was noticed after the visual training especially for the stress pattern, while for the English task, there was no significant improvement neither after the visual nor after the auditory training. Specifically, for L2, after the training students did not present an improvement in the stress pattern but in the punctuation pattern. The findings of this project are in accordance with the research hypothesis. In particular, it was expected that children who suffer from developmental dyslexia would perform better in processing stress markers after the visual training because of the stress diacritic assignment. On the other hand, a non-improvement after the visual training in the English language was expected (research question 3).

This is because, English and Greek language present some core differences morphologically. First of all, in English language, the stress mark is not present in words, which makes it difficult for the reader to receive information for the correct position of the stress pattern. In that way, students were not expected to have an improvement after a visual training. Nevertheless, surprisingly, there was an improvement in the punctuation errors. Punctuation is also signified by markers such as full stops and commas, similar to the Greek stress marker because in a text they are both small and discreet. Moreover, it is worth noticing that in the Greek analysis as well, an improvement in punctuation errors was presented after the visual training. Hence, it could be assumed that punctuation assignment was improved after the visual tasks because it includes diacritic visual information

This result, supported by the statistical analysis, provided validation of the training scheme and provide further evidence of the existence of a visual deficit. Furthermore, it was observed that neither in the auditory training, participants seemed to perform better, thus confirming the existence of a visual deficit in students with dyslexia

regardless of the language or orthographies. In response to lack of support and guidance for teaching students with dyslexia, a practical dyslexia guide based on the principles of a multisensory approach should be designed as well as distributed to teachers as Kormos, Csizer & Sarkadi (2009) suggesting.

5.4. Emotions

5.4.1. Dyslexia, Emotions and Performance

‘Emotions are an integral part of education activity setting’ (Schutz, Lanehart, 2002, p.67), having a decisive role in the learning and reading process of every student. Students with learning difficulties may be more vulnerable to emotional consequences of their learning difficulties. Even though they present different learning profiles and abilities, students with learning difficulties are experiencing the same emotions that normally developed students experience, although their degree of appearance and frequency may differ. Moreover, this is also supported by the field of neuroscience and neurodiversity which argues that individuals differ in their cognitive, emotional, and social abilities, and this variation must be acknowledged (D’Mello & Gabrieli, 2018).

Specifically, in the research of Novita (2016), it was found that students with and without dyslexia present the same emotional profiles. The researcher conducted a quantitative study in which they administered questionnaires in order to examine the general levels of anxiety and self-esteem. Similar results have been found in other studies too (e.g., Burden, 2008; Carroll et al., 2005). However, a larger number of studies have showed that students with dyslexia are experiencing higher levels of emotions such as anxiety. For example, in the study of Conrwell and Bowden (1992) and Lavis et al. (2019), the results showed that students with learning difficulties present an elevated risk of anxiety, often four times more than students without

dyslexia. In the present research, strong evidence was found that similar emotions were reported by the participants, such as anxiety, low self-esteem and confidence. In particular, students commented on the influential role of these emotions on their life and especially their school performance.

Regarding the school context, the influence of emotions can be noticed in various stages of the learning process. This project has turned its focus on reading activity and performance. Specifically, its goal was to add to the understanding of emotions in the educational context by linking them with dyslexia and reading performance. Although research on reading and emotions is scarce, this relation should be taken into account since by reading in front of the class, a student might see this as a form of assessment, and when students are performing well in their reading this could be considered an achievement. As Pekrun, Muis, Frenzel, and Goetz (2018) highlighted, achievement emotions are related to the activity and the outcome of achievement activities and are judged based on ‘competence-based standards of quality’. Indeed, the data illustrate the desire, hope and anxiety of students to perform according to the expected standards of the teacher and classmates. Moreover, as Pekrun, Goetz et al. (2002a) has stated, there is a reciprocal relation between emotions, performance and reading as a student’s emotions may influence achievement but the feedback on achievement may, in turn, affect their emotions. This was also observed in the data of the present study. In particular, students stated that their emotions and especially anxiety would make them read with more errors than usual, while it was also stated by students that their realisation of errors would make them feel anxious and discouraged. This reciprocal relation was also represented in Figure 11 of the results chapter (research question 4).

Specifically, a strong relation between emotions and known literacy difficulties of students with dyslexia was found in the data. First of all, participants were worried of

the phonological errors they may make and were concerned throughout the data collection process. They reported errors that they indeed made while they were reading the linguistic task. This indicates that students were aware of their difficulties but were trying to perform well. At the same time, they were happy and willing to read the texts. They did recognize their fear of reading accuracy but at the same time presented strong motivation to perform well and achieve their best. However, due to dyslexia, many participants had negative experiences in the past and this was another reason why they were concerned. They identified their difficulties and weaknesses, being concerned of the view of others.

Moreover, the use and effectiveness of the instruments of this project were proven to be crucial in the investigation of these multifaceted emotions. Research tools worked as an integral piece complementing one another as proven by the findings. The qualitative data broadened the scope of investigation, and the quantitative data confirmed the qualitative data through numbers in a circular way (Dornyei, 2007). In the case of anxiety, an instrument like the interview, provided further insight into what was derived from the questionnaire since it provided further details about the conditions and circumstances of the experiences of students with dyslexia. The fact that data on the emotions that participants felt were corroborated across in all research tools proves the validity and reliability of these results.

As such, these research tools helped to shed light to the role of social interactions as emotions are infused in classroom life. Recently, a number of studies have illustrated the relation between the school environment and the emotions of students. The present study confirms that the case for students with dyslexia may be more difficult as the pressure from the entourage and the current educational model is stronger having in mind their difficulties. As such, Kormos (2017, p.31) argues that ‘the educational

consequence of such models is that the main focus is on meeting children's individual needs and little attention is paid to how the children's environment itself creates barriers to a successful learning'. This argument is also supported by the findings of this research as participants were highly affected by their social environment and the opinion of the members of class. Specifically, the dynamic nature of emotions in combination with the pressure by the social environment proved to have a decisive role in their reading performance. Participants referred to circumstances which affected their reading and to social acceptance. In particular, students seemed to be very concerned of the evaluation of people that would be present and hear them reading.

The majority of responses related to social acceptance of students with dyslexia was concentrated around the class and peers. As Pekrun (2014, p. 6) has argued, "the classroom is an emotional place", and one's emotions can be affected by multiple reasons such as friends and other classmates. In the interview data, participants frequently mentioned that they were getting anxious when they read in the class. This is because they wanted to avoid being classed as bad students and that they do not perform well. Emotions like shyness and embarrassment, which were reported in the results chapter, could be related to beliefs one has about oneself and the surrounding environment. Such an example is the fear of feeling embarrassed when speaking in class which may be due to a belief that a classmate will criticize or laugh at the student's performance. The object of fear and embarrassment in this case, the teacher or a classmate, may occur with the belief that the other person is considered "superior" and this leads the student to feel and think as "inferior" (Kormos et al., 2007). Miccoli (2003) had documented that students avoid speaking in class because of fear of criticism by other classmates along with conceiving the class as a judgmental environment. Similar observations were noticed in the current study too. However, this has leading

consequences to students' learning process, motivation, performance, identity development, and even health (Schutz & Pekrun, 2007). Moreover, students might have the sense of lagging behind others, and a constant sense of failure in a group might finally result in giving up learning languages altogether. Barcelos (2009) suggests that these feelings are caused by beliefs such as "other people know more than I do". This emotional burden affects students both emotionally and mentally and has been also identified in other studies such as Gkonou (2017). In the present study too, regarding second language learning, participants found classroom evaluation as a significant source of anxiety. However, they were not feeling anxious of their performance per se but rather the classroom evaluation. For example, in the analysis of the data, it was noticed that participants reported that they were feeling shy when they were reading in front of the class and especially in front of their friends. This fact, in addition to the lack of understanding on the part of their peers, might seriously undermine their self-confidence and finally lead to giving up (Kormos, 2002).

Furthermore, another person with high influence on the development of students is the teacher. According to Griffiths (1984), the emotional states of the teacher and student are relevant and interdependent. In the face of the teacher, students see the person they look up to and consider the one that they have to please with their achievements. As highlighted in the research of Gkonou and Miller (2019), the relationship between teacher and student is vital for their flourishing, both mentally and emotionally. In particular, in the study of Kormos et al., (2009), in cases where teachers were not supportive but were judgmental, student was affected. In the present study, students were also concerned of their teachers' opinion, and they were anxious when they were about to read in front of them. They reported that when the teacher was calling their name to read, they were very concerned about their performance as teacher evaluation

seemed to be quite important for students. Similar findings can be found in the studies of Pekrun, (1998, 2000), as evidence revealed that teacher's enthusiasm, positive feedback of an achievement and affiliation in the classroom reacted positively with students' joy of learning and desire for success.

Outside the borders of school, parents also have high influence on students. Although the role of the parents has been researched less than other factors, it is no less significant. Children look up to their parents and want them to be proud of them. Participants reported during the interview that they were getting anxious when the father or the mother were present while they were studying. Moreover, apart from the reading process, parents generally influence the development of children and there were cases where they were criticising the other students. This practice affects the psychology of children, and such idealized models are related with beliefs students form about themselves and their learning environment, as they are fixated on the need to impress and be praised.

These findings provide evidence to the theoretical framework of the poststructuralist approach, which states that emotions are not just cognitive characteristics but are highly relevant to the social context of an individual. According to this approach, emotions are 'contextual, cultural, overlapping, and related to power' (Benesch, 2017, p. 16), thus affecting individuals socially. Such like the social approach theory of emotions, the social rationality in this research encounters the social environment of the child, which is the school and family entourage. Particularly, the present research signifies the decisive role of students' social surroundings in the generation of certain emotions. However, different surroundings would lead to different emotions. This can be supported again by the comments of the participants who stated that in situations where they read alone, they were not afraid of errors they would make or would not be anxious.

As Schutz and Decuir (2002) stated, emotions should be considered as a fluctuating system.

As previously discussed, participants reported some literacy characteristics that students with dyslexia present. However, based on the data, these were connected to their emotions too. In this way, another parameter that affects students' emotions during performance is the text and its form. The most common comment was regarding the phonological errors that students were making. They reported that they were experiencing fear and concerns of how many errors they would make and whether the words would be 'easy' or not. Moreover, they admitted that the length of a text was another factor determining how they would feel. If the text was long, they would get anxious but if the text was short, they would feel more confident.

Furthermore, the analysis of the qualitative data revealed that students with dyslexia have developed strong self-regulation. 'Self-regulation implies planning, monitoring and evaluation of students' learning' (Pekrun, Goetz, Titzm, Perry, 2010, p.98). This implies that they have to develop their own strategies to cope with difficulties they may face. In the open-ended question participants included in their answers that *'I will take strong breaths'* (G06) *'I will have be very careful'*(G23), *'I will try to get better'*(G12). Self-regulated strategies include goal-directed actions in order to perform well and achieve in academic tasks. Thus, it can be observed that in order to manage that, they drew in personal, social and other resources so as to compensate their difficulties.

Another emotion that emerged repeatedly throughout this research is the state of confusion. Confusion is a state that is aroused by cognitive disequilibrium (Piaget, 1952) in which individuals 'encounter incongruence in the form of impasses, anomalies, contradictions, ...that cannot be comprehended, and interruptions of

organized sequences of actions' (D'Mello, Graesser, 2010, p. 153). However, apart from the cognitive aspect, confusion extends to the emotions of an individual as well, though its research has received considerably less attention.

Thus, a question arises to the nature of confusion to what extent is emotion or a cognitive dissonance. Nevertheless, it has been found to be beneficial on learning. Specifically, in the study of D'Mello, Lehman, Pekrun & Graesser (2012) conducted two experiments and found that confusion was largely insensitive to the manipulations. Indeed, Confusion is thought to occur when there is a mismatch of information, a violation of expectations, or other cognitive clashes during information processing. (D'Mello et al., 2018). Craig, Graesser, Sullins, and Gholson (2004) conducted an online observational study in which observers coded the affective states (frustration, boredom, engagement/flow, confusion, eureka) of 34 learners every five minutes during interactions with AutoTutor. When learning gains were regressed on the incidence of individual emotions, the only emotion that significantly predicted learning was confusion.

Similar findings were found at the data of the present study. A considerate proportion of responses commented that confusion in various occasions throughout all the qualitative research instruments. For example, G10 said '*I got confused*' or G22 '*I got confused of the text*'. Based on these quotes, students faced a confusion of their emotions as there were accompanied by anxiety and at the same, they were subject to a cognitive perplexity affecting their reading performance. Nevertheless, further research could be conducted to research to what extent the nature of dyslexia affects the state of confusion of these students compared to normally developed children.

Another emotion that was found to emerge in this research is fear, that is fear of the possibility of a negative outcome that was not related to actual facts. Fear causes individuals to avoid dangerous things or circumstances and thus is considered to be a negative emotion (Plutchik, 2001). Specifically, in educational context, this emotion is usually present as fear of failure or the possibility to happen a bad outcome that is not related to facts (Caraway, Tucker, Reinke & Hall, 2003). Thus, fear of failure has been often correlated to anxiety (Bryan Sonnefeld, & Grabowski, 1983; Caraway, Kirsten, et al, 2003). Moreover, Tops, Glatz, Premchand, Callens, & Brysbaert (2020) discussed and found that indeed students with dyslexia experience high levels of fear in the academic setting and were accompanied by test anxiety as well. Similar statements were found to be supported by many participants throughout the data derived for the qualitative analysis. In particular, they were afraid of not performing well and of a bad outcome that may happen. For example, G24 admitted that he is afraid of making errors and G34 that *'I am afraid that the teacher may hear me'*. These quotes suggest students with dyslexia unsecure and unconfident for their reading performances.

Thus, fear and confusion were found to be emotions that although they have not been discussed extensively in the literature were apparent in the emotional state of students with dyslexia and according to their interviews, they affected them to a large extent. However, individual needs of students with dyslexia should be taken into consideration (Kormos, 2007) because the emotional reactions that individuals experience during simulation can have a significant impact on what they attend to, what they remember from these events, their judgments and problem-solving approaches, as well as their motivation to engage in learning behaviors.

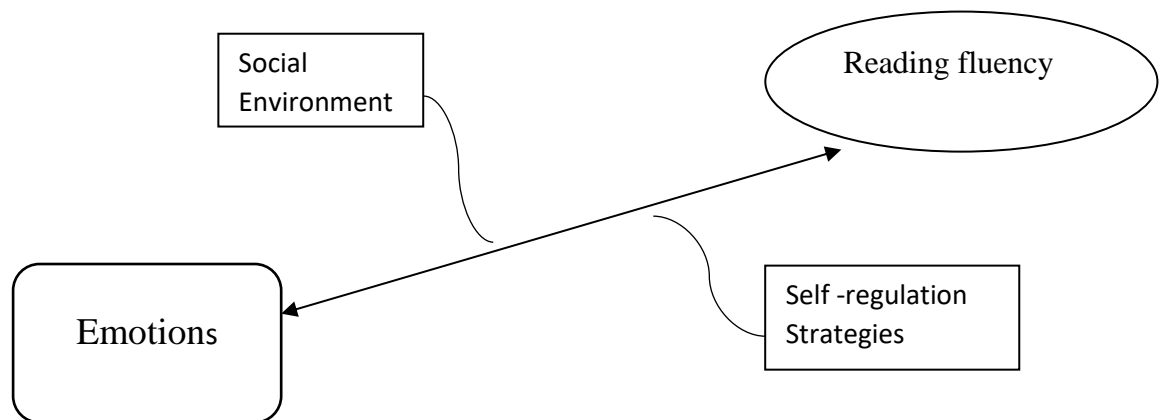


Figure 15. The reciprocal relation between emotions and reading fluency and factors which affect that.

5.4.2. Positive and Negative Emotions

Research has proved that students may experience a broad spectrum of emotions in educational settings including both positive and negative emotions. Attributions of success or failure are considered determinants of these emotions. Although negative emotions have been studied extensively in academic settings as well as in the field of dyslexia, more and more researchers are turning their attention to positive emotions as well. In particular, according to Pekrun, Goetz, Titz & Perry, 2002, p. 149), positive emotions are essential for human behaviours as they contribute to envision goals and open the mind to new thoughts and ideas.

Specifically, in school settings, it has been argued that ‘positive emotions can be assumed to be central to attaining the educational goals’ (Pekrun, Goetz, Titz & Perry,

2002, p. 149). Thus, this kind of emotions are reinforcing the learning strategies of students and generally act as a helping tool. These observations were also highlighted in the present research. Students reported in the interview that confidence leads them to positive results. These results could range from performing well in the reading process and improving their reading accuracy to reinforcing their motivation. Specifically, regarding reading performance, students commented that positive emotions would help them in their reading accuracy by making fewer errors. However, apart from reading, positive emotions influenced students' motivation as well. For example, participants reported that feeling confident would make them feel that they could succeed. This is also supported by Pekrun and Goetz (2002a) who have stated that positive emotions such as joy and hope are the basic components of learning motivation. Joy and hope are emotions that were also discussed in the interviews, where participants stated that apart from making fewer errors, such emotions would help them to feel more motivated. Thus, emotions could influence students' internal motivation to learn (Pekrun, 2011).

On the other hand, negative emotions have been studied particularly with respect to anxiety. Nevertheless, there is a plethora of studies which showed the negative impact of negative emotions on academic achievement (Griffiths, 1984; Zembylas, 2007; Linnenbrink- Gracia & Pekrun, 2011; Pekrun, Goetz et al, 2002). The present study presented evidence both in the open-ended question and in the interview quotes of participants that negative emotions seemed to overwhelm the majority of them. The open-ended question in particular showed that participants feared that anxiety would them to make errors or feel shy, which could then lead to negative results.

After the above observations, the present research confirms the findings of other studies (Linnenbrink- Gracia & Pekrun, 2011; Pekrun, Goetz et al, 2002) that positive emotions

will lead to positive outcomes and negative emotions will lead to negative outcomes (research question 5). This bipolar pair has often been considered as emotionally opposite such as the pairs of good and bad, right and wrong (Solomon & Stone, 2002). Traditional theories have focused on the functions of positive emotions for cognition and behaviour and have addressed the negative effects of positive emotions apart from their benefits (Aspinwall, 1998). For example, fear could be perceived as a positive emotion if it is propelling us from danger (Solomon & Stone, 2002). For these reasons, in this project it was investigated whether emotions can lead to opposite results than the expected ones.

The thematic analysis evidenced that the opposite relation of emotions is not definite. Students in both open-ended questions and in the interviews reported that first of all, negative emotions could lead to positive results. Participants reported that they would become more conscious and focused on not making errors, if they experienced a small degree of anxiety. As such, negative emotions and especially anxiety could be considered as a motive to avoid failure (Atkinson, 1964). Furthermore, they reported that they had noticed in the past that by the time they felt confident, they would start making errors. In this way, the classification of these emotions was steeped with ambiguity.

Regarding the proportion of positive and negative emotions, the results indicated that the majority of emotions were negative. Especially, the emotion of anxiety was the most frequently mentioned emotion. These findings are in accordance to the study of Pekrun, Muis et al. (2018) in which they found that during classroom instruction and studying, more than 50% of the felt emotions were positive while during tests, negative emotions were more than positive. The same pattern was observed in the present data since after the training, students reported fewer positive emotions and more negative emotions.

These findings could mean that students were discouraged and started feeling negative emotions after their performance.

However, another evidence that contradicts the polarity of emotions is the presence of more than one emotion per participant. Participants proved that one may feel more than one emotion and, they expressed emotions that were classified as opposite such as feeling both joy and anxiety. In particular, in the task of emojis, students asked to choose up to four emotions. It was noticed that first, there were cases in which they chose more than one emotion, thus confirming that students were feeling various emotions, and secondly, they chose both happy and sad emojis, indicating that their feelings were not only positive or negative. The boundaries between these two categories of emotions are not stable, but they may change and are interconnected based on the conditions and experience of each individual. However, participants admitted that it did not matter which emotion they were feeling each time, either positive or negative, because the result was the same: they would make a few errors.

In the point where feedback was asked, it was interesting to observe the commonality of responses related to the emotional state of students. Those that reported being confident and that they liked the exercises provided supportive feedback admitting that they enjoyed the process and found the texts interesting. On the other hand, those that were conservative in their responses, were those that were more anxious and insecure. The fact that they were asked for their feedback on their emotions and how they could affect their performance provided detail on their self-reported self-concept of what they believed; their views were also double checked by the tasks, which confirmed or disconfirmed if what they said was indeed true or just an impression or idea.

5.4.3. Anxiety

As discussed in the literature review, the most widely mentioned emotion within educational research is anxiety and specifically test anxiety. Thus, the current project focused on anxiety in the context of dyslexia, confirming that anxiety is an emotion that is experienced by many students and exerts significant influence on their performance (research question 4). This has been proved by other studies too, such as Paget and Reynolds (1984) who showed that children with learning difficulties present more anxiety than the control group. In this way, anxiety has a detrimental effect on academic achievement and in the present study, anxiety was indeed often discussed during the interviews. Participants such as G09 argued that anxiety was the emotion that they felt most often.

The participating students had realized that anxiety affected them greatly, especially while reading a text. All the research tools of this project revealed a strong relationship between anxiety and reading errors. In particular, participants expressed being afraid of failure and this was highly combined with the number of errors they made. Moreover, in the qualitative data it was noticed that students were more concerned of being anxious than of making errors. It can therefore be concluded that anxiety could be characterized as a form of fear students have for a possible threat rather than the outcome of an action.

However, the present research has also provided evidence that errors may be the cause of anxiety traits for students with dyslexia. Indeed, a dual relationship between anxiety and errors was found. Specifically, not only might anxiety lead to errors but at the same time, errors can lead to anxiety, creating a reciprocal relationship. This observation is in accordance with the Attributional Theory of Weiner (1985). According to this theory,

anxiety can be attributed to the action of the mispronunciation of a word or letter. However, at the same time, this relation can be bidirectional as anxiety may have significant impact on the learning outcome as has been also argued by Goleman (1995). Moreover, it was noticeable that students felt anxiety more because of the possibility that they might make errors than actually making errors. Hence, they got anxious of a possible failure and especially because they would be judged by the rest of the class. Imai (2010, p. 288) states that emotions are ‘socially and discursively constructed acts of communication that mediate learning’. Thus, students were highly concerned of their social environment and especially how their reading performance would be judged. They got anxious because they wanted to succeed and perform well and not be criticised by their teacher or classmates.

Anxiety also emerged through the analysis of the interview data, and it was shown that participants might experience other emotions as well. In other words, one can feel more than one emotion and sometimes emotions that are considered opposite can be felt at the same time, such as fear and confusion. In particular, in the open-ended question of what anxiety would lead to, participants answered that anxiety could lead to other emotions. One would expect that the participating children wouldn’t like to read and that reading would be a process that they were doing by force. However, during the collection of data, students were very willing to read the texts and enjoyed the tasks although they made errors and were aware of the possibility that indeed they would make errors.

Nevertheless, it is worth keeping in mind that ‘test anxiety is not necessarily the most detrimental negative academic emotion.’ (Pekrun, Goetz et al., 2002a, p. 100) but there are other emotions that could lead to negative outcomes as well. The adoption of new research tools such as the emoji-based questionnaire. Using this battery of nonverbal

measurements of anxiety in future research and clinical settings would be a fruitful research trajectory. Moreover, students' levels of anxiety often led to equivalent levels of errors. In other words, if students were anxious, they made more errors, but if they were less or moderately anxious, they made fewer errors. Nevertheless, the present study confirms and supports the findings on dyslexia that anxiety may negatively affect student's performance, however, anxiety may positively influence students as the data from the interview indicated.

5.5. Conclusion

In this chapter, the findings of the present project are discussed in corroboration to other empirical studies. First, discussion regarding the findings of the training in L1 were summarized and similarities to other studies were found. Followingly, the findings of the training in L2 were presented as well as discussion comparing the two on focus languages. Last, emotions of students with dyslexia that emerged in the present study were presented.

Chapter 6: CONCLUSION

6.1. Introduction

The present thesis investigated evidence of visual deficits in students with dyslexia as well as the relationship between emotions and reading performance. Specifically, its aim was to gain insights into the difficulty that individuals with dyslexia face in the stress pattern assignment in both Greek as L1 and English as L2 and whether such difficulty is related to a visual impairment. Apart from the focus on anxiety, positive and negative emotions were also examined to investigate their influence on the reading performance of students with dyslexia.

This chapter draws conclusions based on quantitative and qualitative data that were discussed throughout chapters 4 and 5. The research questions are summarized and strengths and limitations are discussed next, followed by implications of the present study and suggestions for future research.

6.2. Aims achieved

The primary focus of this thesis was to provide further understanding to the visual nature and structure of developmental dyslexia. In particular, the rationale was to find whether a relation between visual deficits and the difficulty in stress pattern assignment exists. Moreover, emotions in the overall performance of these individuals were examined as well. In order to investigate that, mixed-method research was conducted. In particular, the methodology applied to test the performance of children with dyslexia was a training programme on stress pattern assignment in both Greek and English. Through its administration, the aim was to study the number of stress errors that dyslexics were making in L1 and L2, and whether their performance would improve

after the training. Moreover, in order to research the emotions of students with dyslexia, interview, questionnaire and observation were administered.

Overall, the debate on the nature of dyslexia is articulated around the question about the nature of this reading difficulty and this study has answered (research question1). The findings of the thesis offer a better understanding of the basic role of visual deficits in individuals with dyslexia. Apart from that, the performance of children with developmental dyslexia on stress pattern assignment was studied, and further viewpoints were reviewed, since suprasegmental phonology has not been studied to such an extent like segmental phonology. Indeed, it was found that students with dyslexia are making a considerable number of stress errors both in L1 and L2. According to Goswami (2013), nowadays there are a few studies regarding stress in both children and adults with developmental dyslexia and this study aimed to connect stress pattern with developmental dyslexia.

Moreover, apart from the cognitive aspect, dyslexia can pose a significant threat to the emotional state of individuals who face these difficulties. The present data revealed that participants feel various and even sometimes contradictory emotions. In particular, they presented an increased level of anxiety and generally negative emotions, however, positive emotions were also present in their comments. A complementary finding is that most participants enjoyed the reading process and the whole experience was found to be something that they would like to do again. However, based on the findings, it was evidenced that although before the training they were feeling mainly positive emotions, after the training negative emotions prevailed.

6.3. Revisiting research questions

6.3.1. Is there an improvement on stress assignment after the visual or auditory training in students with dyslexia?

This research question aimed to investigate the relation between visual/auditory deficits and the difficulty that students with dyslexia may face in stress pattern assignment. Regarding L1, data revealed that Greek children with developmental dyslexia present improvement in stress pattern assignment after the visual training. A similar pattern was observed in other phonological categories such as in pronunciation errors and punctuation errors as well. On the other hand, after the auditory training, no improvement was presented in the stress assignment of Greek students with dyslexia. In the case of L2, neither visual nor auditory training was found to significantly affect stress pattern. These data provide evidence to theories that suggest a reconnection between visual processing and developmental dyslexia.

6.3.2. Do students with dyslexia make stress errors in L2 (English) as in L1 (Greek)?

The second research question focused on the performance of Greek students with dyslexia in English as a second language. First language has a significant role in the learning process of learning subsequent languages (Taylor, 1974). First of all, stress errors in L2 were fewer than in L1. Moreover, it was found that students with dyslexia make significantly more stress errors than normally developed students. However, as discussed in the literature review, there are differences between transparent and non-transparent languages taking into account the fact that English does not include a stress marker such as Greek. Nevertheless, further research needs to be done to investigate this in more depth.

6.3.3. Do stress errors in L2 improve after the visual or auditory training?

Regarding students' performance in L2, it was found that students did not present improvement neither after the visual nor the auditory training. These findings are in accordance with our hypothesis that in English, students would not improve in stress pattern because there is no marker to signify it. However, the punctuation errors category presented improvement which could provide further evidence to the support of visual deficits since punctuation is represented in written speech through markers/indicators.

6.3.4. How does anxiety affect students with dyslexia?

The emotion that has been thoroughly investigated in the educational context is anxiety. Specifically, 'children with dyslexia may be highly vulnerable to emotional consequences such as anxiety' (Carroll, Iles, 2006, p.653). Thus, the aim was to investigate how students with dyslexia are experiencing anxiety and how anxiety relates to reading performance. Both qualitative and quantitative data were considered. The thematic analysis of data revealed that students were indeed feeling high levels of anxiety. Apart from that, they were highly concerned by the negative consequences that anxiety may present to their performance.

6.3.5. How do negative/ positive emotions affect students with dyslexia?

However, apart from anxiety there are other negative emotions which affect students' wellbeing. Using a variety of research tools, students were found to experience other negative emotions such as fear and confusion. Positive emotions were also present in the responses of students. In particular, a significant number of positive emotions were selected in the emoji task as well as in the quotes of the thematic analysis.

Nevertheless, the notion of positive and negative emotions should be abandoned. The data revealed that positive and negative emotions do not necessarily lead to positive and negative outcomes respectively as students revealed in the interviews and the emojis that they experience simultaneously a variety of emotions which are considered to be opposite. Thus, the research field should view emotions more broadly and holistically, and overcome the assumption that anxiety is always a negative emotion.

6.4. Strengths and Limitations

The present study presents both strengths and limitations. The overall goal of studying children's learning abilities was to create evidence-informed methods for fostering and training the neurocognitive mechanisms that are responsible for the development of reading skills (Peters & Ansari, 2019). For this reason, this study was constrained to deficits of children who score at the lower rate of the distribution and this thesis provided a step forward to investigate that.

The research explored dyslexia from different and various perspectives such as from cognitive and first language performance to academic emotions and dyslexia's social context. Therefore, the present thesis investigates the bigger picture of this learning difficulty compared to most of the research in the field. Thus, via this research project, the complexity of dyslexia regarding both its characteristics and its impact on reading was delineated.

Furthermore, this project is a first attempt to approach a training focused on stress patterns especially in Greek students with dyslexia as there is a paucity of research related to this topic. Thus, in order to achieve statistical power of the data, another important strength of this thesis was the big sample that was used for the collection of

data. Gathering data from participants with learning difficulties is a challenging process as it entails some particularities regarding accessibility to this sample. The need for greater sample sizes has been highlighted many times in the research field, and thus the call for larger samples is addressed in this study.

Moreover, the present research provides further evidence to the existence of a visual deficit. As discussed in the literature review, there are several theories that explain the causes and characteristics of dyslexia. Thus, this research project offers further support to the existence of impairments in visual processing. Nevertheless, it cannot be argued that this project agrees or not with a particular theory but provides findings for a general observation of the visual processing.

Moreover, the research instrumented a range of methods from qualitative to quantitative, using a variety of methodological and statistical techniques. This selection contributed towards providing significant and reliable results to all of the research questions that were posed. By approaching the issue from different perspectives, it gave the opportunity to offer a more multidimensional view of the representation of the phenomena discussed. Analysing these two approaches, it represents different channels of thinking and conceptualising dyslexia (Nunan, 1992).

In educational research, the majority of studies has focused on emotions such as anxiety, low self-esteem and behavioural problems (Zeidner, 2014; Livingston, Siegel, Ribary, 2018; Novita, 2016). However, the impact of emotions on reading difficulties has not been thoroughly studied. In the present study, a plethora of emotions was explored, and it was found that positive emotions play a significant role on students with dyslexia as well as negative emotions. That means that anxiety is not the most adverse negative emotion.

Despite the strengths of this study, the project is subject to some limitations. Although the total number of participants is large compared to other studies in the dyslexia field, since smaller participants groups were created, the subgroup could include a larger number of participants since statistical power depends on it. For example, some findings in the results chapter could show stronger significant differences, although a between- groups difference was noticeable.

In addition, no test to assess dyslexia and reading level was used, something which has been noticed in other studies too. Instead, participants were required to have a written diagnosis by a certified centre. Students with dyslexia have been long tested on this issue repeatedly. This has an emotional effect on students, and it is pointless – and even unethical – for students to be tested again since an official diagnosis has already been completed. Moreover, the time that the researcher could spend with every child was limited.

As in other studies (Kormos et al., 2009; Peters & Ansari, 2019;), the study did not control the treatments that participants with dyslexia were receiving. The variability of treatments can have an effect on the results of the study. Thus, it is suggested for future studies to take into account the different treatments of dyslexia, although the heterogeneity of characteristics in dyslexia should also be taken into consideration.

Regarding emotions, as Schutz and DeCuir (2002) have stated, emotions are quite fluid and can quickly occur and change. Especially in educational settings, from an ethical perspective, it is difficult to lend themselves to traditional research methods. For example, a parent or a principal is hesitant to agree to allow a researcher to make students become angry in order for researchers to study the emotion of anger in

education. For this reason, the study of emotions is faced with many research challenges. Apart from that, as Pekrun et al. (2017, p.26) argued, ‘emotions differ widely between individuals; and different students can experience different emotions even in the same situation’.

6.5. Implications

Dyslexia is a difficulty of reading ability that can be described as impairment in the development of language. Children with this learning difficulty often start a negative spiral of low educational participation and inauspicious prospects of employability and general adult wellbeing (Hulme & Snowling, 2016). Facing these challenges and taking into consideration that the debate about the existence of learning difficulties is still under discussion, further attention should be attached to supporting these individuals cognitively and emotionally. The terminology and the differences between the various theories are still quite complex and thus more stable ideas should be constructed about the identification of dyslexia and why it is different from other learning difficulties.

Taking these facts into consideration, it is crucial that new interventions are suggested in order to support these students. There is evidence that language interventions can contribute to the amelioration of language weaknesses if the latter can be detected during the early years. Thus, an as early as possible diagnosis should be recommended. The present study aimed to give further insight into the relation between dyslexia and visual deficits. Nevertheless, ‘the underlying biological cause of these visual disorders and their precise impact on reading still needs to be elucidated’ (Ramus, 2003, p.214).

Based on the findings, no firm conclusion can be drawn about the reasons of developmental dyslexia. The results of this study suggest that the approach may prove a useful tool for the investigation of individual differences in the perception of bodily

sensations. This research provided further evidence which supports the existence of visual deficits. For these reasons, there is need for further research to investigate and compare the multiple theories that already exist so that a catholic, more universal theory can be established. Further research will lead to the understanding of how the brain operates during language acquisition and dyslexia in general, and in L2 learning in dyslexia in particular.

Moreover, participants with developmental dyslexia speaking Greek exhibit improvement in stress assignment after visual non-linguistic training. However, in the English orthography, stress is not marked compared with other languages like Greek. However, English includes some implicit orthographic cues to stress (for example consonant doubling) (Kelly, Morris, & Verrekia, 1998), and its sensitivity to dyslexic individuals can be studied further in correlation with the findings of the present thesis. For this reason, further investigation is needed to verify a potential deficit in suprasegmental phonology among the Greek-speaking population and the population of different languages.

Lastly, research confirms that ‘emotions are frequent, manifold, and often intense in these settings’ (Pekrun et al., 2017, p. 5). However, it is assumed that students experience a rich variety of emotions in educational settings. Therefore, emotions should further be studied as they highly affect students’ performance, as shown in the present research as well. Moreover, the role of emotions in dyslexia and in specific occasions such as second language learning has not yet been clarified. Learning about the role of emotions in the association between dyslexia and negative living outcomes would offer a path of prevention. We still have a lot to learn about students' and teachers' emotional experiences in academic settings, as well as how to incorporate emotion into existing theories of motivation and learning. (Linnenbrink, 2006).

Research on emotions in education was and is currently needed. For this reason, the main focus of educational systems and teachers should be children's individual needs (Thomas & Loxley, 2007) and further attention should be paid to how the environment of students itself builds barriers against their learning.

6.6. Conclusion

In this concluding chapter, the findings of the present study were revisited in relation to the research questions of the present thesis. The study's objectives and limitations have also been evaluated, followed by recommendations for further research. Through the present thesis, new viewpoints were gained in an under-researched topic and new areas of interest were opened for further research.

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Appendices

APPENDIX A: Participant Information Sheet

Participant Information Sheet

My name is Ioanna Vasilopoulou and I am a PhD student in the department of Language and Linguistics at the University of Essex. Before you decide whether or not to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of this study?

It is an indisputable fact that students with dyslexia hold an important percentage in the classroom at schools in Greece. For that reason, I am interested to examine more about the difficulties that dyslexic individuals face and particularly as far as it concerns the stress pattern and how other factors affect it.

Why have I been invited to participate?

You have been invited to participate in this study because you are a student with developmental dyslexia in Greece. If your age is 7-17 then you are eligible to participate. Your knowledge and experiences are invaluable to me.

Do I have to take part?

Your participation in this study is strictly voluntary. If you do decide to take part, you will be asked to provide written consent. You are free to withdraw at any time, without giving a reason. Withdrawal will have no impact on your marks, assessments or future studies. If you choose to withdraw or if you have a question about the ethical nature of this study, please contact the researcher, Ioanna Vasilopoulou, Ioanna.vasilopoulou@essex.ac.uk.

What will happen to me if I take part?

This study requires participants to be involved in a series of tasks, lasting about 1 hour. The exact date of your participation will be discussed between the researcher and the participant. Participation will take place online and will be audio recorded, because you will be asked to read out a text. Your words in the questionnaire may be quoted or summarised in the findings of the study. You will not be identifiable as your real names and any personal data will not appear in this study.

What are the possible disadvantages and risks of taking part?

By participating in this study, the utmost care will be taken that no harm to your psychological wellbeing, physical health values or dignity will be affected. There is a risk of confidentiality. Taking part also means that participants must give up some of their free time.

What are the possible benefits of taking part?

The benefit of this study is that it will further our understanding of the difficulties that dyslexic students face and the reasons behind it. The majority of previous research focuses on English language rather than on Greek language which has a stress mark in every word. Currently, developmental dyslexia is under researched and more and more ways should be engaged in order to help those individuals deal with their difficulties.

Will my information be kept confidential?

Only the researcher and the researcher's supervisor (see name and contact details below) will have access to the data. Your privacy will be respected at all times and all information collected will be anonymous and remain completely confidential. Pseudonyms will be used to anonymise participants. Any personal data will be coded using a number, so no data can be linked to your identity. All data will be treated as personal under the 1998 Data Protection Act, and they will be secured electronically in my own laptop which contains a secure password.

What is the legal basis for using the data and who is the Data Controller?

Should you agree to take part in this study, you will be asked to sign a consent form before the study commences. The GDPR states that consent must be freely-given, specific, informed and unambiguous – given by a statement or a clear affirmative action.

The Data Controller will be the University of Essex and the contact will be Sara Stock, University Information Assurance Manager (dpo@essex.ac.uk).

Ethical approval

This project has been reviewed on behalf of the University of Essex Social Sciences Ethics Sub-Committee and has been given approval.

What will happen to the results of this study?

The results of this study will be published in my PhD Thesis. Please remember that the results are anonymised and therefore participants will not be identifiable. If you choose to participate, a copy of this study can be sent to you upon request.

What should I do if I want to take part?

If you wish to take part in this study, please send a signed copy of the consent form to Ioanna Vasilopoulou via email (ioanna.vasilopoulou@essex.ac.uk).

Concerns and complaints

If you have any concerns about any aspect of the study or you have a complaint, in the first instance please contact the researcher (see contact details below). If are still concerned or you think your complaint has not been addressed to your satisfaction, please contact the Departmental Ethics Officer (Dr Christina Gkonou, cgkono@essex.ac.uk). If you are still not satisfied, please contact the University's Research Governance and Planning Manager, Sarah Manning-Press (sarahm@essex.ac.uk).

Contact details

Researcher

Ioanna Vasilopoulou, Department of Language and Linguistics, iv18235@essex.ac.uk

Supervisor

Dr Christina Gkonou, Department of Language and Linguistics, cgkono@essex.ac.uk

APPENDIX B: Evaluator Information Sheet

My name is Ioanna Vasilopoulou and I am a PhD student at the University of Essex. Before you decide whether to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read the following information carefully.

What is the purpose of this study?

The purpose of this study is to examine the phenomenon of stress pattern in Greek dyslexic students. It has been noticed that students with dyslexia are making stress errors although Greek language includes a mark to indicate where the stress should be applied. This research will investigate that in relation to how psychology can affect, as well as the reading performance efficiency in English as second language.

Why have I been invited to participate?

You have been invited to participate in this study because there is need for people with good knowledge of Greek or English language to evaluate the performance of dyslexic participants in the assigned tasks.

Do I have to take part?

Your participation in this study is strictly voluntary. If you do decide to take part, you will be asked to provide written consent. You are free to withdraw at any time, without giving a reason. Withdrawal will have no impact. If you choose to withdraw, your data will be destroyed immediately. If you have a question about the ethical nature of this study, please contact the researcher, Ioanna Vasilopoulou (ioanna.vasilopoulou@essex.ac.uk)

What will happen to me if I take part?

This study requires participants to listen to students read some texts (Greek or English). These texts will be presented in a Word file on a computer. As you listen to the audio file of students, your task is to detect whether they make reading errors and highlight them with different colours into the word file of the text.

Letter omission: blue

Stress errors: yellow

Wrong letter: pink

Wrong word: purple

Letter addition: light blue

Word addition: green

Wrong punctuation: grey

Wrong order: dark green

Regarding the audio files of English texts, additional categories of reading errors are:

Wrong letter pronunciation (red),

Wrong word pronunciation (dark blue)

-You will not be identifiable as your real names and any personal data will not appear in this study.

What are the possible disadvantages and risks of taking part?

By participating in this study, the utmost care will be taken that no harm to your psychological wellbeing, physical health values or dignity will be affected. Taking part also means that participants must give up some of their free time. Please note that each audio file should last around 30 minutes.

What are the possible benefits of taking part?

The benefit of this study is that it will further our understanding of dyslexia and the kind of impairment originates it. Why are students making stress errors? Is there a visual or auditory impairment since there are still various theories regarding that? Furthermore, with its outcome, new approaches of teaching will be suggested as to how students should be approached and be taught.

Will my information be kept confidential?

Only the researcher and the researcher's supervisor (see name and contact details below) will have access to the data. Your privacy will be respected at all times and all information collected will be anonymous and remain completely confidential. Numbers will be used to anonymise participants. All data will be treated as personal under the 1998 Data Protection Act, and they will be secured electronically in my own laptop which contains a secure password.

What is the legal basis for using the data and who is the Data Controller?

Should you agree to take part in this study, you will be asked to sign a consent form before the study commences. The GDPR states that consent must be freely-given, specific, informed and unambiguous – given by a statement or a clear affirmative action.

The Data Controller will be the University of Essex and the contact will be Sara Stock, University Information Assurance Manager (dpo@essex.ac.uk).

Ethical approval

This project has been reviewed on behalf of the University of Essex Social Sciences Ethics Sub-Committee and has been given approval.

What will happen to the results of this study?

The results of this study will form part of the report for my PhD at the University of Essex. Please remember that the results are anonymised and therefore participants will not be identifiable. If you choose to participate, a copy of this study can be sent to you upon request.

What should I do if I want to take part?

If you wish to take part in this study, please let me know via email [Ioanna Vasilopoulou – Ioanna.vasilopoulou@essex.ac.uk].

Concerns and complaints

If you have any concerns about any aspect of the study or you have a complaint, in the first instance please contact the researcher (see contact details below). If you are still concerned or you think your complaint has not been addressed to your satisfaction, please contact the Departmental Ethics Officer (Dr Ella Jeffries, e.jeffries@essex.ac.uk). If you are still not satisfied, please contact the University's Research Governance and Planning Manager, Sarah Manning-Press (sarahm@essex.ac.uk).

Contact details

Researcher

Ioanna Vasilopoulou
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Supervisor

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Department of Language & Linguistics
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APPENDIX C: Consent form of Participants



Consent Form

Title: **Visual Deficits in Dyslexia: Examination of stress patterns and the impact of emotions on students' reading performance**

Researcher: Ioanna Vasilopoulou
(Department of Language & Linguistics, email: ioanna.vasilopoulou@essex.ac.uk)

Please initial box

1. I confirm that I have read and understand the Information Sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.

2. I understand that the participation of my child is voluntary and that he/she is free to withdraw from the project at any time without giving any reason and without penalty.

3. I understand that the data provided will be securely stored and accessible only to the members directly involved in the project, and that confidentiality will be maintained.

4. I understand that my fully anonymised data will be used for a study.

5. I understand that the data collected about me will be used to support other research in the future, and may be shared anonymously with other researchers.

6. I agree my child to take part in the above study.

Participant Name

Date

Participant Signature

Researcher Name

Date

Researcher Signature

APPENDIX D: Consent form of Evaluators Participants



CONSENT FORM

Title: **Visual Deficits in Dyslexia: Examination of stress patterns and the impact of emotions on students' reading performance**

Researcher: Ioanna Vasilopoulou
(Department of Language & Linguistics, email: ioanna.vasilopoulou@essex.ac.uk)

Please initial box

7. I confirm that I have read and understand the Information Sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.

8. I understand that my participation is voluntary and that I am free to withdraw from the project at any time without giving any reason and without penalty.

9. I understand that my fully anonymised data will be used for reports.

10. I understand that the data collected about me will be used to support other research in the future and may be shared anonymously with other researchers.

11. I give permission for the transcripts that I provide to be deposited in so that it can be used for future research and learning.

12. I agree to take part in the above study.

Participant Name

Date

Participant Signature

Researcher Name

Date

Researcher Signature

APPENDIX E: Greek Reading Texts

Κείμενο 1 **Το γαϊτανάκι**

Μια φορά, δεν πάει καιρός, ζούσε σ' ένα μικρό χωριό, κάπου εδώ κοντά, ένας άνθρωπος πολύ σοφός και πολύ γέρος. Η πλάτη του ήταν σκυφτή, τόσο σκυφτή, που η άσπρη του γενειάδα άγγιζε τη γη. Είχε διαβάσει τα βιβλία όλου του κόσμου και είχε μάθει τις γλώσσες όλων των ανθρώπων. Ζούσε απόμερα, σ' ένα μικρό σπιτάκι, ολομόναχος. Στον κήπο του φύτεωναν κι άνθιζαν όλων των λογιών τα λουλούδια: τριαντάφυλλα, τουλίπες, μαργαρίτες, κυκλάμινα, ζουμπούλια κι όμορφα κατακόκκινα γαρίφαλα. Οι συχωριανοί του πολύ τον αγαπούσαν κι όλοι τον φώναζαν: ο κυρ Νικόλας ο Γαρίφαλος. Όταν τέλειωσε το πότισμα, ο κυρ Νικόλας μπήκε στο σπίτι του και κάθισε στο γραφείο του. Μια στοίβα χοντρά βιβλία τον περίμενε. Έπρεπε να τα διαβάσει... Τι παράξενο όμως, εκείνο το βράδυ, όσο κι αν πάσχιζε να συγκεντρωθεί, δεν τα κατάφερνε. Ο λογισμός του έτρεχε αλλού: στα τρία κοριτσάκια, στο τραγούδι τους. Χρόνια τώρα ζούσε ευτυχισμένος με τα βιβλία του, τα λουλούδια του, ολομόναχος, και ξάφνου η μοναξιά τού φάνηκε αβάσταχτη. Κατάλαβε πως η ζωή του έφτανε στο τέρμα της, νοστάλησε τα νιάτα του. Ήταν πολύ λυπημένος εκείνο το βράδυ ο καλός κυρ Νικόλας. Κουνούσε το χιονισμένο του κεφάλι και μιλούσε δυνατά: «Είμαι μόνος, κανένας δεν μπορεί να με βοηθήσει, κανέναν δεν μπορώ να βοηθήσω με τις χίλιες γνώσεις μου. Είμαι άχρηστος. Ας ήμουν τουλάχιστο νέος, ας είχα τη δύναμη να ξανάρχιζα τη ζωή μου, θα μπορούσα...» Μονομιάς το πρόσωπο του κυρ Νικόλα φωτίστηκε. Σηκώθηκε από την πολυθρόνα κι άρχισε να χώνει βιαστικά κι ανάκατα μέσα σε μια βαλίτσα τα πράματά του.

*‘Το γαϊτανάκι’
Ζωρζ Σαρή*

Κείμενο 2

Μια γειτονιά, δύο εποχές.

Πρέπει να σου μιλήσω για τη γειτονιά μου. Έφυγα και φοβάμαι πως θα την ξεχάσω. Πρέπει να διαλέξω τις σωστές εικόνες για να μπορείς να κάνεις μια βόλτα με το νου στις μυρωδιές και στις εικόνες της γειτονιάς μου. Στη γειτονιά μου υπήρχαν, όπως σε όλες τις γειτονιές της πόλης, πολλοί φούρνοι, πέντε σε δύο τετράγωνα. Για να είμαστε δίκαιοι ως προς τους φουρνάρηδες, πηγαίναμε μια στον ένα, μια στον άλλο. Μετά ήταν το πάρκο απέναντι από το σταθμό. Παίζαμε, και τι δεν παίζαμε εκεί, όλα εκείνα τα παιχνίδια που τώρα δεν υπάρχουν πια. Κοντά στη γειτονιά μου είναι και το λιμάνι, και καμιά φορά ο βόρειος άνεμος, ο βαρδάρης – το όνομα του οποίου έχει και η γειτονιά – έφερνε μυρωδιές ωραίες, θαλασσινές, μια νότα αλατισμένου αέρα. Μετά ήταν η κυρά Μαρίκα και ο κυρ Νικόλας, που πέθανε πια εδώ και χρόνια, με το μπακάλικό τους. Έβρισκες και του πουλιού το γάλα, πραγματικά. Φαντάσου ένα γωνιακό μπακάλικο, με τρεις εισόδους, πέντε διαδρόμους, αποθήκες πολλές, γεμάτο με πράγματα. Τώρα, ο σοφός τους εγγονός, το έκανε κανονική επιχείρηση. Σημαντική εικόνα της γειτονιάς, στο νότιο άκρο της, είναι το δικαστικό μέγαρο. Μετακινήσεις συνεχείς στη γειτονιά, γιατί είναι εμπορική το πρωί, και έχει ησυχία το βράδυ. Η γειτονιά μου προσπαθεί, δηλαδή, να είναι ήσυχη, μα δεν την αφήνουν και τόσο. Είναι αυτό που λέμε «κέντρο-απόκεντρο». Ένα μελίτσι με δεκάδες διαφορετικούς ήχους και αλλαγή διάφορων ανθρώπων κατά τη διάρκεια του εικοσιτετράωρου. Η γειτονιά κλείνει για να ανοίξει ξανά σε λίγες ώρες, ενώ ένα κομμάτι της ψυχής μου κοιμάται και ξυπνά με όλα αυτά.

*‘Μια γειτονιά, δυο εποχές’
Άννα Κοκκινίδου*

APPENDIX F: English Reading Texts

Κείμενο 1

‘Hey Lisa! Can we talk to you for a moment?’ Lisa who was walking to her classroom turned to see two classmates Pauline and Ricky.

‘Sure!’ said Lisa. ‘What is it?’

‘It's about the maths test’ said Pauline. We need you to help us pass the test. Will you help us?’. Lisa smiled and said ‘No problem. I’ll teach you.’

‘Actually,’ said Ricky ‘We want you to help us during the test. You know- tell us the answers.’

Lisa was shocked! She said ‘You are asking me to help you cheat! That's not honest.’

‘So what?’ said Pauline.

‘Well, I'm really sorry, but I can't do that,’ Lisa answered.

‘Come on, Lisa! What kind of friend are you?’ Ricky shouted.

Lisa turned around and walked into the classroom.

At first Lisa wanted to say no because she was still upset. But Ricky was weak at maths and Lisa felt sorry for him. During the next week, Lisa and Ricky studied for the test every afternoon. The day of the test arrived. Everyone was very nervous. The teacher gave them the tests, they were all different and they couldn't copy.

Κείμενο 2

‘Oliver, my boy,’ said Fagin. ‘It's time you played our little game in town. Go with these two boys and don't come back with empty hands!’

In town, Oliver and the boys saw a rich, old gentleman standing outside the bookshop. To Oliver’s horror, the two boys walked up behind the gentleman, stole his wallet and ran away. He was among a gang of thieves! He began to run. The gentleman saw Oliver but he didn't see the other two boys. He shouted but he couldn’t catch him. ‘Stop thief!’. Oliver was soon caught by a policeman.

‘Please Sir,’ cried Oliver. ‘It wasn't me. It was two other boys. Why did you not see them? A bad man made them do it.’

‘You’re lying, are you?’ said the policeman as he took Oliver to the police station. ‘No! I’m telling the truth!’ said poor Oliver. The gentleman, whose name was Mr. Brownlow, followed behind.

At the police station, Mr. Brownlow said, ‘Let this boy go.’ The policeman couldn't believe his ears. ‘But Mr. Brownlow!’ he said. ‘This boy stole from you!’

‘No, I'm not sure it was him,’ replied Mr. Brownlow, and the angry policeman had to let Oliver go.

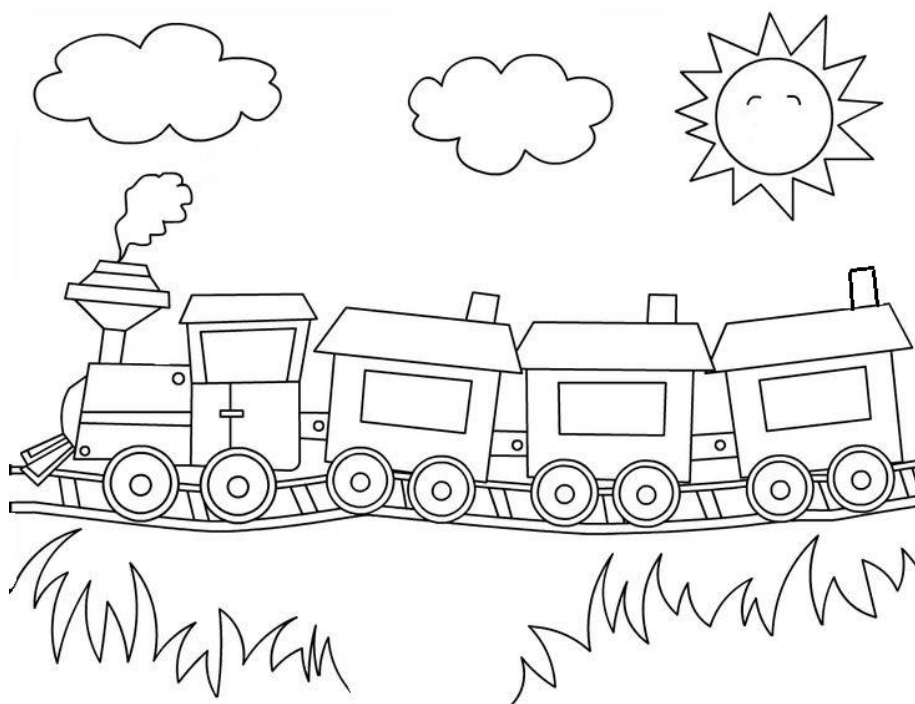
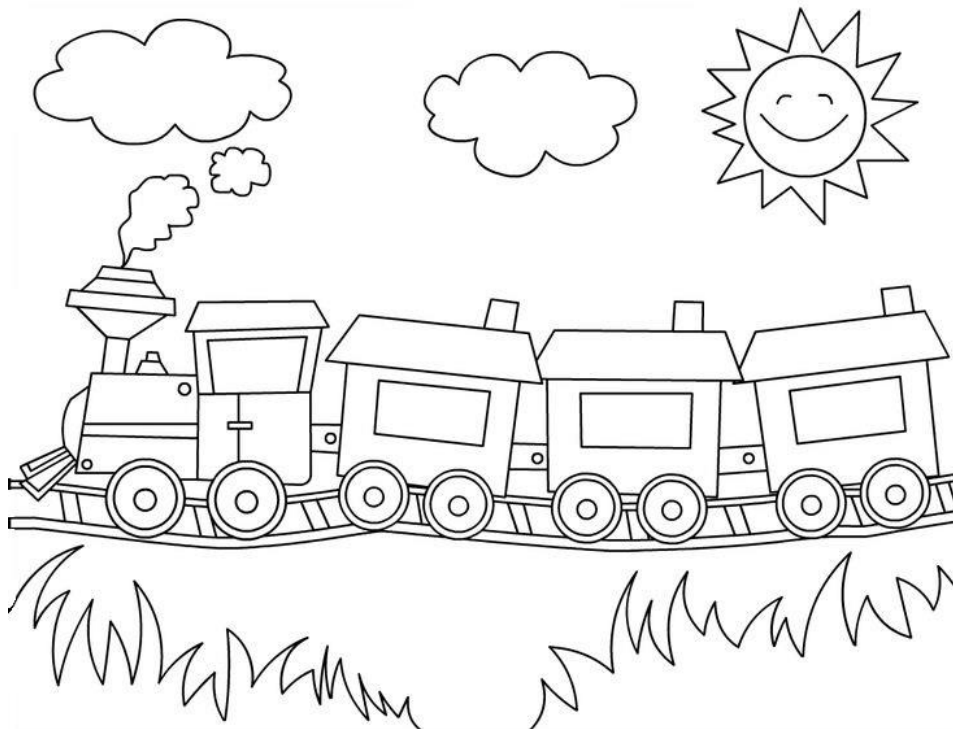
APPENDIX G: Visual Training**ΑΣΚΗΣΗ 1**

Βρες τις 2 διαφορές στις παρακάτω εικόνες:

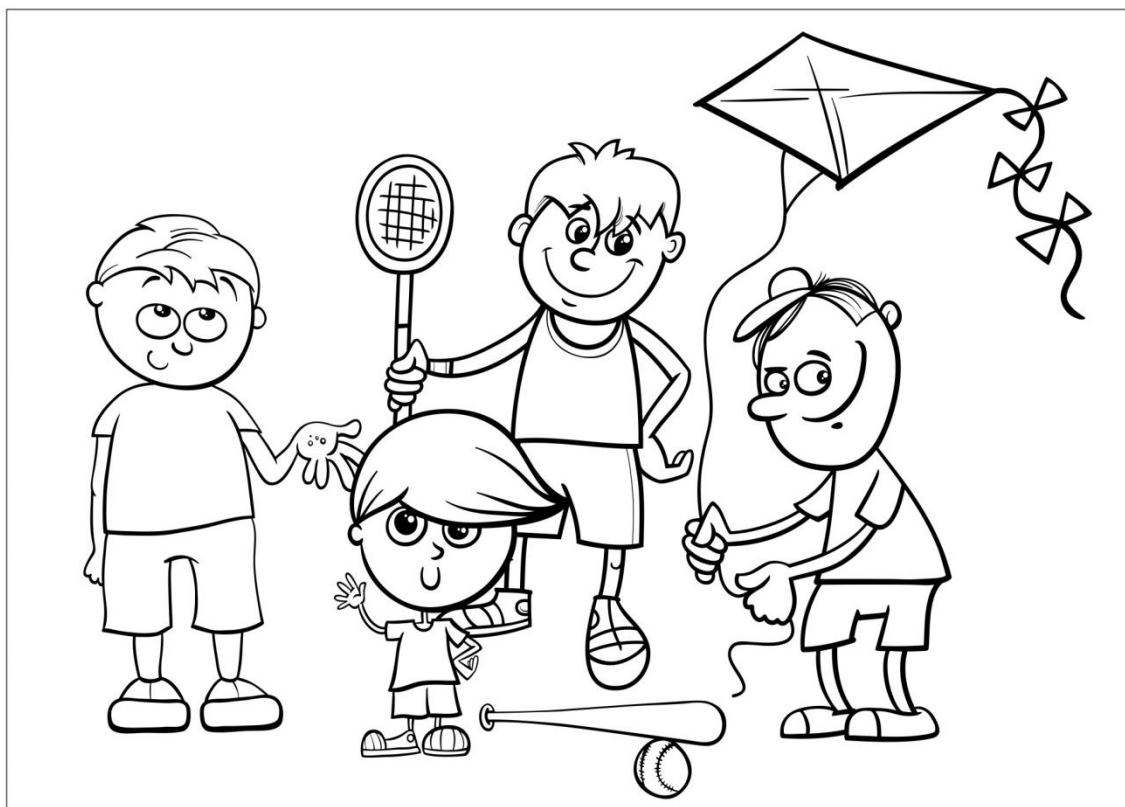
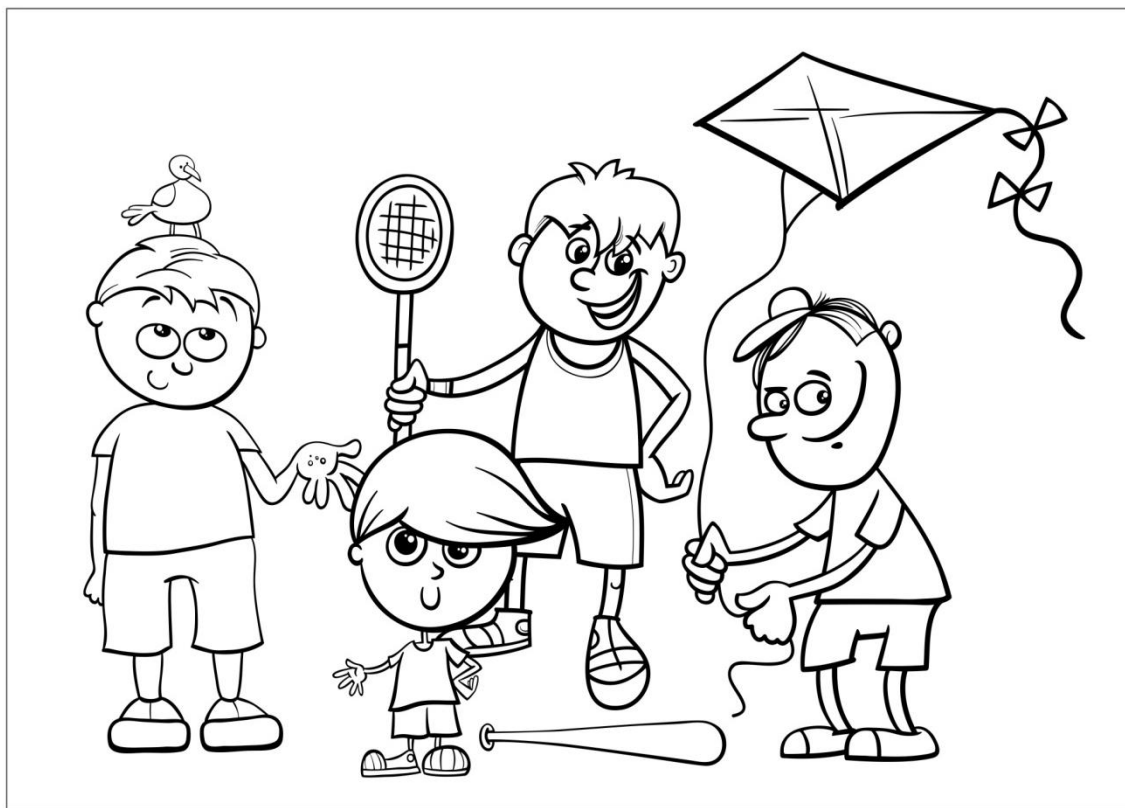


ΑΣΚΗΣΗ 2

Βρες τις 4 διαφορές στις παρακάτω εικόνες:

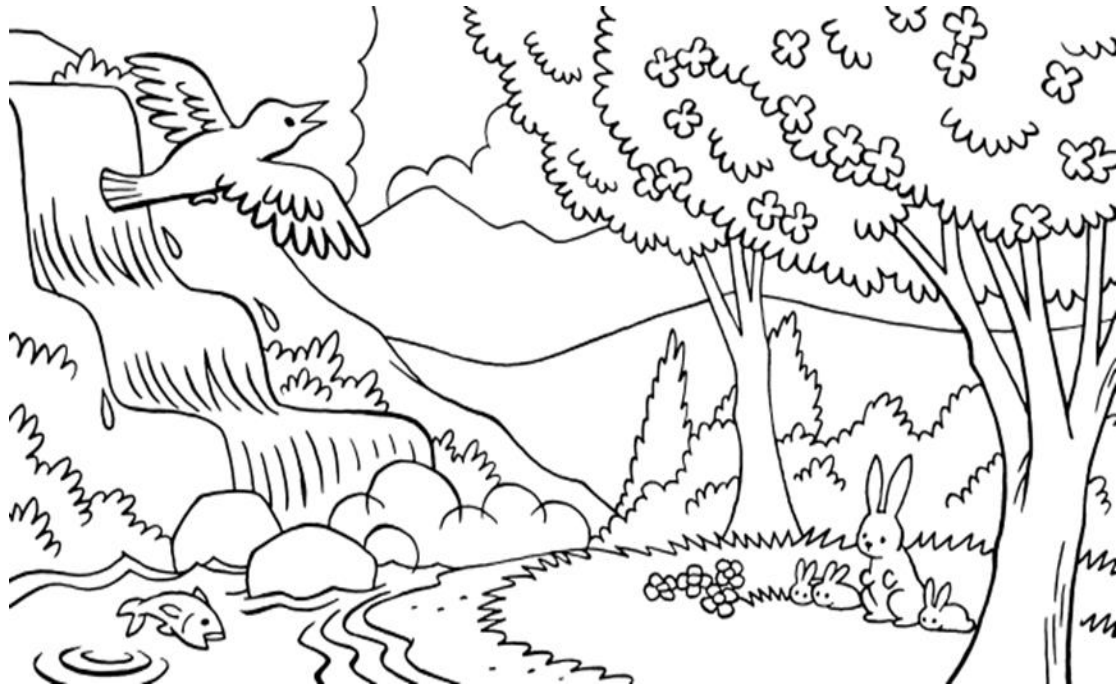


Βρες τις 5 διαφορές στις παρατω εικόνες:



ΑΣΚΗΣΗ 3

Βρες τις 7 διαφορές στις παρακάτω εικόνες:



Βρες τις 8 διαφορές στις παρακάτω εικόνες:












APPENDIX H: Questionnaire

Name:

Date of birth:

Sex:

School:

					
σίγουρος σίγουρη	χαρούμενος χαρούμενη	αποφασισμένος αποφασισμένη	νευρικός νευρική	αγχωμένος αγχωμένη	βαριεστημένος βαριεστημένη
					
ήρεμος ήρεμη	προσεκτικός προσεκτική	περίεργος περίεργη	ντροπαλός ντροπαλή	αβέβαιος αβέβαιη	κουρασμένος κουρασμένη
					
περήφανος περήφανη	αισιόδοξος αισιόδοξη	ενθουσιασμένος ενθουσιασμένη	λυπημένος λυπημένη	τρομαγμένος τρομαγμένη	ανήσυχος ανήσυχη
					
ικανοποιημένος ικανοποιημένη	έκπληκτος έκπληκτη	ευχαριστημένος ευχαριστημένη	θυμωμένος θυμωμένη	απογοητευμένος απογοητευμένη	δυσάρεστημένος δυσάρεστημένη

A) Circle what you feel when you read a text. (up to 4 emojis)

B) Which of the following options describe you better?

1. I like to read a text

Strongly disagree Disagree Agree Strongly agree

2. I feel self-confident when I read a text.

Strongly disagree Disagree Agree Strongly agree

3. I easily read a text.

Strongly disagree Disagree Agree Strongly agree

4. I am anxious when I read a text.

Strongly disagree Disagree Agree Strongly agree

5. I am anxious when I read a text out loud in the classroom.

Strongly disagree Disagree Agree Strongly agree

6. I am bored reading a text.

Strongly disagree Disagree Agree Strongly agree

7. I feel comfortable reading a text.

Strongly disagree Disagree Agree Strongly agree

8. Reading a text is a challenge that I enjoy.

Strongly disagree Disagree Agree Strongly agree

9. I make errors when I read a text.

Strongly disagree Disagree Agree Strongly agree

10. Can anxiety affect the reading of a text?

Strongly disagree Disagree Agree Strongly agree

11. If yes, how?

.....

.....

.....

APPENDIX I: Open-ended Coding Scheme

QUESTION: How can anxiety affect your reading?

1. Effect of Anxiety: Positive/Negative

Negative	<p>Students state negative effects on performance when they get anxious.</p> <p>e.g., <i>'I make errors', 'I am scared', 'I feel that I can't make it'</i></p> <p>Students state negative effects on the emotional state when they get anxious.</p> <p>e.g., <i>'I will make a lot of errors and I will be ashamed', 'I am scared', 'I feel that I can't make it'</i></p>
Positive	<p>Students state positive effects when they get anxious.</p> <p>e.g., <i>'I like it', 'I will do better, and I will be more conscious'</i></p>

1.1. Characteristics of Dyslexia (Negative)

SubCategory Label	Criteria
Errors	<p>Students state they make errors or get confused while reading.</p> <p>e.g., <i>'when I will do some errors', 'I will do more errors', 'I will do errors in reading', 'I may make some errors', 'I make errors', 'I may say something wrong', 'many errors', 'I will stuck in the words and I will not read well', 'I will read silly'</i></p> <ul style="list-style-type: none"> • <u>Individual Words</u> e.g., <i>'I will confuse words', 'confuse my sayings', 'I may say the words wrong', 'I may read a word wrong', 'I will say other words', 'I may read words that do not exist'</i> • <u>Letters</u> e.g., <i>'I confuse letters-words', 'I won't read some letters'</i> • <u>Lines of a text</u> e.g., <i>'I will lose my line'</i> • <u>Punctuation</u> e.g., <i>'I may forget to stop in full stops', 'I don't take breaths'</i> • <u>Syllabize</u> e.g., <i>'I will syllabize'</i> • <u>Stress Errors</u> e.g., <i>'I may stress a word wrong'</i>

Time	Students state that it takes more time for them to read. e.g., <i>'I read slower', 'I will stuck for some minutes', 'It may take me too much time', 'I will stop for 1 second and I will start again', 'I will pause', 'I will spell out'</i>
------	--

1.2. Emotional Conditions

SubCategory Label	Criteria
Shame	e.g., <i>'I will make errors and I will be ashamed',</i>
Afraid	e.g., <i>'I am afraid of doing mistakes during the lesson', maybe say something wrong'</i>
Thoughtful	e.g., <i>'I feel that I can't make it', 'I think that I will make an error'</i>
Shyness	e.g., <i>'I am starting to get shy', 'I feel shy sometimes.'</i>
Self-regulation	e.g., <i>'I will take strong breaths', 'I will have to be very careful', 'I will try to get better'</i>

1.3. Confusion

Emotional Condition	e.g., <i>'If I got confused, I will make errors', 'I may get confused'</i>
Performance	e.g., <i>'I may confuse the words', 'I get anxious, and I confuse the words or the letters'</i>
Stuttering	e.g., <i>'I get stuttered and I make mistakes'</i>

2. Circumstances

SubCategory Label	Criteria
In class	e.g., <i>'when I am in class', 'when I read a text out loud', 'I will be ashamed'</i>
New Text	e.g., <i>'when there is a new text'</i>

APPENDIX J: Example of Open-ended Question Transcript

<i>Answers</i>	<i>Category</i>	<i>Sub-category</i>
When the text is new and when I make too many errors	Circumstances	New text
When the text is new and when I make too many errors	Characteristics	Errors
I confuse words I read	Confusion	Performance
I will read slower	Characteristics	Time
I may forget to stop in full stops	Characteristics	Punctuation
I will get confused	Confusion	Emotional Condition
I may make some errors	Characteristics	Errors
I will have to be very careful	Characteristics	Self- regulation
I like it but I get shy	Emot. Cond.	Emotions - Shyness
I like it but I get shy	Outcome	Positive
when I read a text out loud	Circumstances	In class
I will make errors and I will be ashamed	Characteristics	Errors
I will make errors and I will be ashamed	Emot. Cond.	Shame

APPENDIX K: Interview Coding Scheme

Categories	Sub- Categories
1. Emotions	1.1 Anxiety
	1.1.1. Levels of anxiety
	1.2. Confidence
	1.3. Both anxiety and Confidence
	1.4. Confusion
	1.5. Fear
2. Phonological Errors	1.6. Disappointment
	2.1. Relation with Anxiety
	2.2. Categories
	2.2.1. Words + Letters
	2.2.2. Skipping Lines
	2.2.3. Text Length
	2.3. Other Reasons
	2.3.1. Presence of other people
2.3.2. Reading on their own	
3. Self-regulation	3.1. Strategies
4. Effect of Positive and Negative Emotions	4.1. Anxiety leads to Negative Results
	4.2. Anxiety leads to Positive Results
	4.3. Confidence leads to Negative Results
	4.4. Confidence leads to Positive Results
	4.5. Neutral Attitudes
5. Feedback on the procedure	5.1. Positive Feedback
	5.2. Negative Feedback

APPENDIX L: Interview Protocol

Questions:

- 1) What do you think about the procedure? Did you like it?
- 2) What do you feel when while reading? / Why did you choose these emojis?
- 3) Are you anxious or not about reading? Why?
- 4) If you are about to read a text and you get anxious, what do you think may happen?
- 5) If you are about to read a text and you get anxious, what do you think may happen?
- 6) Is there anything else that you would like to comment on?

APPENDIX M: Example of Interview Transcript

Transcript	Coding
<p>TRANSCRIPT #1</p> <p>-What do you think of the exercises we did together?</p> <p>-They were easy except for the sounds.</p> <p>- Have you done something similar before?</p> <p>-I think no.</p> <p>-In the emojis you chose that you were happy and calm. When you read a text, how do you feel?</p> <p>- Happy but I get confused.</p> <p>-Why?</p> <p>- Are you anxious or confident about reading?</p> <p>- I am more confident</p> <p>- If you are about to read a text and you get anxious, what do you think may happen?</p> <p>- I will not make errors.</p> <p>- If you are about to read a text and you get anxious, what do you think may happen?</p> <p>- I will make less errors</p>	<p>POSITIVE FEEDBACK</p> <p>CONFIDENCE</p> <p>ANXIETY LEADS TO NEGATIVE RESULTS</p> <p>CONFIDENCE LEADS TO POSTIVE RESULTS</p>
<p>TRANSCRIPT #2</p> <p>-What do you think of the exercises?</p> <p>- I enjoyed it.</p> <p>- Which part did you like the most?</p> <p>- I really liked the place where he would start his life.</p> <p>- When you read a text how confident do you feel?</p> <p>-I'm pretty I'll make it.</p> <p>-When are you most confident or anxious?</p> <p>-A little worried that I might make an error.</p> <p>-When you are stressed and you have to read a text out loud, have you noticed whether you will make errors or will you be more careful and make fewer mistakes?</p> <p>-When I read, I'm very anxious because I do not want to make any error but</p>	<p>POSITIVE FEEDBACK</p> <p>CONFIDENCE</p> <p>PHONOLOGICAL ERRORS</p> <p>BOTH ANXIETY AND CONFIDENCE</p>

<p>when I read a lot I don't make mistakes and I read relaxed.</p> <p>-So you don't make mistakes when you're anxious?</p> <p>-Yes</p> <p>-And when you are confident of yourself, will you read better or will you be careless and make a few errors?</p> <p>- I will read fine, but many of the words are difficult and that's why I get confused and I'm very careful.</p> <p>-So when are you sure? when do you make mistakes when you are confident anxious or confident?</p> <p>-When I'm anxious.</p> <p>-So when you're sure you do less?</p> <p>-Yes and when I read the text I'm doing better..</p>	<p>RELATION WITH ANXIETY</p> <p>CONFUSION</p> <p>ANXIETY LEADS TO NEGATIVE REUSLTS</p>
<p>TRANSCRIPT #3</p> <p>What did you think of the tasks we did together?</p> <p>-It was good</p> <p>-Which part did you like the most?</p> <p>-The second</p> <p>-The second text?</p> <p>-Yes</p> <p>- Fine. And when you read a text how confident do you feel from 1-10?</p> <p>-5</p> <p>-And stressed?</p> <p>-10</p> <p>-So most of the time are you confident or stressed?</p> <p>-Anxious.</p> <p>-What if you read a text and get a little anxious, what will happen?</p> <p>-I will do less, because I struggle with it and I don't want to stress and make mistakes.</p> <p>- Fine. And what about confidence? Will you make fewer errors?</p> <p>-A few errors because if it's easy and I can do it, I don't make mistakes.</p> <p>- Why did you say before when we were talking that you will do less because you will be more careful, does this apply when you read more difficult texts?</p>	<p>POSITIVE FEEDBACK</p> <p>ANXIETY</p> <p>SELF-REGULATION</p> <p>ANXIETY LEADS TO POSITVE RESULTS</p> <p>CONFIDENCE LEADS TO POSITIVE RESULTS</p>

<p>- In general, even if it's too easy, let's say if it's four paragraphs, I won't be very confident in order to not make may errors.</p>	<p>CONDITION -TEXT</p>
<p>TRANSCRIPT #4 -What did you think of the tasks? -Easy -How confident do you feel about yourself when you read a text? -10/10 sometimes. -And stressed? -Yes -How much? -10/10 -Most of the time are you anxious or confident? -Basically, all the times I am anxious and confident. -And when you read, and you are stressed what may happen? - Well, in the short text, I'm not stressed. Sometimes when I read a text alone, I basically don't make that many errors. - Will you make errors because you feel confident or anxious. -I feel confident about myself.</p>	<p>POSITIVE FEEDBACK</p> <p>BOTH ANXIOUS AND COFIDENCE</p> <p>CONDITION- TEXT</p> <p>READING ON THEIR OWN</p> <p>CONFIDENCE LEADS TO POSITIVE RESULTS</p>