Ca' Foscari University of Venice

Master's Degree programme

in Language Sciences

Second Cycle (D.M. 270/2004)

Final Thesis

SuperReading™: Where Does the Improvement Come From?

The Effects of *Eye-Hopping* on Reading Speed

Supervisor

Prof. Giulia Bencini

Assistant supervisor

Prof. Francesca Santulli

Graduand

Martina Pucci

Matriculation Number 989044

Academic Year

2017 / 2018

Abstract

SuperReading™ is aimed at increasing readers' speed during silent reading and improving text comprehension. Prior research has shown reduced time spent on reading a text and improved comprehension both in normal readers and in readers with dyslexia. The exact source of the improvements is yet unknown – whether they come from the training course as a whole, or whether individual parts of the training contribute to enhancement of the reading process. The aim of this thesis is to begin to address this question by examining the effects of one component of the training program - *Eye-Hop™* exercises, which consist in jumping with the finger between groups of words in a text with a special layout while reading - on measures of reading speed and effectiveness. A five-week training program focusing on *eye-hopping* was designed to examine whether there would be an improvement in silent reading speed in a group of 18 adult students.

Result showed improved (shorter) reading times for all participants (including the participant with dyslexia), and improved *Reading Effectiveness* for normal readers.

Keywords: SuperReading™, silent reading, reading speed, dyslexia, text comprehension.

List of Abbreviations

BA: Brodmann Area

BDA 16-30: Batteria per la diagnosi della dislessia, disortografia, disturbo di comprensione in adolescenza e in età adulta

BDI-II: Beck Depression Inventory

CISS: The coping inventory for stressful situations

CFSEI: The culture-free self-esteem inventory

DTI: Diffusion Tensor Imaging

EEG: Electroencephalography

fMRI: Functional Magnetic Resonance Imaging

IULM: International University of Languages and Media

LASSI: Learning and Study Strategies Inventory

LLU+: London South Bank University

MSLQ: Motivated Strategies for Learning Questionnaire

OVP: Optimal Viewing Position

PVL: Preferred Viewing Location

RC: Regulatory Checklist

RE: Reading Effectiveness

SEM: Strategy Evaluation Matrices

SLD: Specific Learning Disabilities

SLI: Specific Language Disorder

SRLIS: Self-Regulated Learning Interview Scale

SVR: Simple View of Reading

TOWRE Sight Words and Nonwords: Test of Word Recognition Efficiency

WPM: Words Per Minute

WRAT4 Reading and Comprehension: Wide Range Achievement Test 4

List of Figures

Table of Contents

Introduction

Specific Learning Disabilities (SLD) are a wide-known problem in schools of all countries of the world. Every year, teachers encounter many students (kids, adolescents and adults) with reading, writing and calculus deficits, each of them with special needs to overcome their difficulties both in formal education and in everyday life. Institutions and researchers have been cooperating for long time to develop protocols to help these disadvantaged students and guarantee them equal access to education as for their neurotypical peers.

Dyslexia has a life-long impact on the correct functioning of reading process. Among other factors, dyslexia can manifest itself with characteristics that vary on the basis of the type of orthography of the native languages of the students: for example, Italian-speaking children with dyslexia show a slow and effortful reading with preserved accuracy. Their main deficit concerns reading speed, while if we consider English-speaking children, we will see that they are less accurate in their reading, but speed is generally alike to the one of their neurotypical peers. The difference in the characteristics of dyslexia can be linked to the type of orthography – which is not the same between Italian and English – affecting also speech therapy.

Among school protocols and diversified speech therapies, we can find an innovative course which aim at reinforcing the some of the most important components of the reading process in both neurotypical and dyslexic readers, SuperReading™. This course – designed by Ron Cole in the US during the 1990s – is innovative on many aspects, also for what concerns the promotion of inclusion. In fact, neurotypical and dyslexic readers work together and achieve the greatest improvements by enhancing the basilar components of the reading process, such as speed and text comprehension. They can enrich their repertoire of metacognitive strategies for text comprehension, improve self-esteem through the promotion of positive affirmations and strengthen the reading process. To do so, during the course are taught strategies and exercises designed to enhance these components: the most peculiar exercise is called Eye-Hop™. It is designed to teach readers to absorb more information from a text with a single fixation of the eyes, in this way increasing reading speed and diminishing the time an individual spends reading a text. The mechanisms behind the functioning of this exercise are in contrast with the linear method of decoding strings of letters and words which are taught in formal education, and it is still unclear how the *eye-hopping* practice influences individuals' reading process and eye movement patterns.

The efficacy of the course has already been proved not only by Cole, but also by scholars who carried on researches in England and Italy. What is clear is that both populations previously cited have benefitted from training of the course, with a special mention to the dyslexic population, which has displayed the greatest improvements. However, it is still not clear which of these components of SuperReading™ is the main source of advancement in the readers of both populations. For this reason, this dissertation has as its principal aim of isolating one of the main components of the course – the Eye-Hop™ – to observe its effects on a group on neurotypical and dyslexic readers after a five-week training.

This dissertation is divided into three parts. Chapter One will introduce three topics. The first part will deal with an accurate description of the reading process, from the first steps a child needs to take to learn this ability, to text comprehension, which is the main goal of reading. The second part will describe in general terms the Specific Learning Disabilities, especially focusing on dyslexia. In this part of Chapter One will be given an account of the characteristics of dyslexia, on how developmental dyslexia manifests itself differently in languages with shallow or opaque orthographies, to how dyslexia affects text comprehension. The last part of this chapter will focus on eye movement control in reading, illustrating the main model and the differences in patterns between neurotypical and dyslexic readers.

Chapter Two will provide a description of the SuperReading™ course and its structure by analyzing its single constituents – metacognition and the emotional sphere – which are fundamental for the reading process to be effective in both populations. It will be also discussed theoretically the mechanisms behind the most peculiar exercise that can be find within the course, that is, the Eye-Hop™. This chapter will also include a small literature review of the studies conducted on SuperReading™ both in England and Italy.

Chapter Three will describe the study conducted on a group of adult neurotypical and dyslexic readers to observe the effects of *eye-hopping* practice in a five-week training. The results will be illustrated and discussed considering the previous researches, and follow-up points of research will be look over.

CHAPTER ONE: A Step-by-Step Guide to Reading

1.0 Introduction

Differently from spoken language, reading – "the visual comprehension of language" (Sereno & Rayner, 2003; page 489) is not innate, but it is an acquired, cultural ability. This means that individuals need to work hard and exercise to master that ability, it cannot be acquired naturally without apparent effort. While the origin of spoken language can be set approximately 100˙000 years ago, written language began its development later, around 3500 BC, when the Mesopotamic and Egyptian civilization were technologically progressing. The main purpose for the birth and elaboration of a written code was to fix and preserve meaningful information (principally – the law), which was intended to be comprehended and observed by the population (Grigorenko, 2001). But for a long time, literacy and formal education was reserved only to the less numerous and wealthy class of a population: in fact, literacy for the largest portion of the population was not granted until the second half of the nineteenth century (Sereno & Rayner, 2003). This poses the ground for the affirmation that reading is not an innate ability, implying that systems assigned to general cognitive procedures adapt themselves for this complex process (Wilding, 1989[1] in Castles & Coltheart, 1993); unlikely speech production, there are no single areas of the brain devoted to the reading process.

[1] Wilding, J. (1989). "Developmental dyslexics do not fit in boxes: Evidence from the case studies", *European Journal of Cognitive Psychology*, volume 1, n° 2, pp. 105-127.

Nowadays, researchers are convinced that it is more likely that behind the reading process there are complex networks made up of cortical and subcortical regions across the left hemisphere of the brain (Elliott & Grigorenko, 2014; Reichle *et al.*, 2003). The reading process is made up of many cognitive subprocesses (such as visual recognition of graphic symbols, various grammatical processes and vocabulary) that need to be strengthened and automatized through exercise in order to work together and achieve comprehension (Grigorenko, 2001). An effective description of skilled reader's characteristics is given by Horton Bowden in the following quote:

> *"The adult gives no more thought to his reading than he gives to his walking. The process has become automatic; when he sees the printed symbols, he reads in spite of himself. He can no more tell how he reads than he can tell how he walks; he simply reads. He has so far forgotten the time and energy he spent mastering the process that he is not even aware of its complexity. (...) He may think that his eyes do not move across the page with each line but that he takes in two or more lines at once; he may believe that the movement is a continuous one and that he experiences no difficulty in gauging the length of the line or in fixating any given point in the line. When the psychologist tells him that he reads but a line at a time, that the movement across the page is a succession of short movements and brief pauses, and that even after the movements have become automatic, the eyes sometimes fail to fixate the correct point, he realizes that learning to read is a difficult task for the eyes, and he understands why the beginner's finger follows the line word by word as he reads"* (Horton Bowden, 1991; page 21).

Achieving comprehension of a sentence or a text is the main purpose of reading. Readers can succeed in understanding the information contained in a text applying their own strategies and methods. However, most of the individual differences can be linked not only by the personal knowledge of a reader for what concerns – for example – vocabulary or memory, but also by the degree of automatization of processes such as accuracy in word recognition and reading speed (Grigorenko, 2001). Another factor that affect comprehension could be the presence of dyslexia or the lack of knowledge of metacognitive strategies, which guarantee efficient methods to collect the most relevant information from a text.

This chapter will tackle three major topics that have already been cited in this small introduction. In the first part will be given an account of the reading process and its mechanisms – from word recognition to text comprehension – in neurotypical individuals. The second part will deal with the description dyslexia and its characteristics between different orthographies, focusing also on text comprehension and the knowledge of metacognitive strategies in dyslexic readers. The third and final topic will concern eye movements processing both in neurotypical and dyslexic readers, including a description of the most important model and the differences in eye movement patterns observed in the two populations.

1.1 The Reading Process

1.1.1 General Steps in the Acquisition of Reading

Learning the steps of the reading process is not an easy task, since it requires a lot of effort and exercise from students to reach a level of automatization which guarantees a certain rate of speed and fluency in decoding. When we talk about reading we do not talk only about the action of decoding: in fact, reading can be accounted as the understanding of a linguistic message conveyed by decoding graphic symbols impressed on a material support by associating the graphic symbols to certain sounds (Boulware-Gooden *et al.*, 2007; Ziegler & Goswami, 2005; Goodman, 1967). Since childhood, students start developing this ability by going through a series of general steps. The most important steps of the reading process are to acquire knowledge of printed symbols (which is a code different from culture to culture; Ziegler & Goswami, 2005) developing phonological awareness and decoding along with visual skills to process the orthography of their native language. The fact that children learn to talk way before reading leads to the step in which they make connections between the graphic forms of words and the abstract meaning (Warren, 2013). These steps then lead to more complex steps, that will bring children – for example - to read whole words through a quicker route, perfecting the mere decoding task to understand the message sentences possess, ultimately also developing strategies to maximize text comprehension (Bellocchi *et al*., 2013; Boulware-Gooden *et al*., 2007).

The first step that children need to take towards the learning of the reading process is the one to acquire the rules which govern the correspondences between symbols and sounds (Ziegler & Goswami, 2005). These rules are different from cultures to cultures: each language has its own orthography, that can be divided into non-alphabetical (or ideographic) and alphabetical orthographies (variation of spelling-to-sound consistency). In cultures speaking languages characterized by non-alphabetical orthographies, such as Chinese, children need to learn to associate complex characters to a group of sounds, which may correspond to whole words (Warren, 2013; Ziegler &

Goswami, 2005). On the other hand, children speaking languages characterized by alphabetical orthographies first learn how to associate a single grapheme to its correspondent phoneme at the beginning of their formal education, then they start to blend vowels and consonants to practice first with syllables and later with words (Wimmer, 1993).

Taking in consideration this last variety of languages, Frith (1985[2], in Fanari *et al*., 2013; Castles & Coltheart, 1993) hypothesized that children native speakers of English undergo three stages in the linear development of reading. First, children start developing the reading process by building a small lexicon made up of words with salient visual characteristics (*logographic stage*). Second, the following stage comes up when children start schooling: in fact, the *alphabetical stage* begins when children start acquiring the principles that lie behind the codes of their language. This means that teachers start illustrating to children how to recognize the single graphemes and to assign their phonemic value (Horton Bowden, 1991). In other words, children – who are at the same time learning how to write and how to read graphemes - start to see words differently, as linguistic symbols by all means, and start to develop their phoneme and phonological awareness (which "comprises the ability to recognize, identify or manipulate any phonological unit within a word, be it phoneme, rime or syllable", Ziegler & Goswami, 2005; page 4). This is the stage in which children slowly start decoding both familiar and unfamiliar words, using a route devoted to grapheme-phoneme conversion. By identifying grapheme after grapheme, they assign their correspondent phoneme to assembly and generate aloud the pronunciation of the word (Grabe, 2004). An important process that children acquire in this stage is the one called *phonological recoding*. This process consists in applying the alphabetical codes and the principles of the orthographical system of their native language and it is extremely important in the very first stages of learning the reading process, because it is at the base of the grapheme-phoneme conversion of the native language. Moreover, thanks to this process, children can recode all the words they know by sound to write them down (this process is also called *double conversion*) (Fanari *et al*., 2013; Ziegler & Goswami, 2005), connecting the written form with their meaning (Warren, 2013). The third and last phase is the one called the *orthographic stage*, in which children learn how to read words without segmenting them through the conversion route but recognizing them

[2] Frith, U. (1985). "Beneath the surface of developmental dyslexia", in Patterson, K. E., Marshall, J. C. & Coltheart, M. (ed.), *Surface dyslexia*. Hillsdale, NJ: Erlbaum.

rapidly as belonging to their personal stored lexicon, developing in this case another route, much faster in comparison to the conversion route (Fanari *et al*., 2013; Castles & Coltheart, 1993).

In recent years, Frith's model has been criticized, especially for what concerns the existence of the logographic stage. As an alternative to this first stage, Share (1995[3] in Fanari *et al*., 2013) proposed what is called the *self-teaching hypothesis*, which justified the expansion of the lexicon to a series of necessary factors, including phonological recoding, the degree of exposition to certain strings, experience with reading, visual abilities and writing (Fanari *et al*., 2013). Another criticism moved to Frith concerned the fact that she developed her model considering only English, and not considering languages with orthographies with different characteristics.

1.1.1.1 Differences between orthographies: consequences

Even if many languages can be considered alphabetical for their characteristics, not all of them have the same orthography. In alphabetical languages there can be a variation in the consistency of spelling-to-sound variation: even if children acquire phonological awareness with more or less the same patterns, there are cross-languages differences in the codes concerning the relations between graphemes and phonemes, the organization and complexity of syllables and the various degrees of transparency (Ziegler & Goswami, 2005). This fact led scholars to discriminate between two types of orthographies, languages with opaque (or deep) orthography, such as English and French, and languages with shallow orthography, such as Italian, Spanish and German (Barca *et al*., 2006; Ziegler & Goswami, 2005; Grigorenko, 2001; Zoccolotti *et al*., 1999). In phonologically opaque orthographies there is not a one-to-one correspondence between grapheme and phoneme, but certain graphemes can be associated (pronounced) to more than one phoneme, and vice versa (Fanari *et al*., 2013). A clear example from English could be the following pair words: the sequence of graphemes '*ea*' can be read in multiple ways, like /ɛ/ in *head* (pronounced /hɛd/), /ʌ/ in *heart* (pronounced /hʌrt/) or

[3] Share, D. L. (May 1995). "Phonological recoding and self-teaching: *sine qua non* of reading acquisition", *Cognition*, volume 55, n° 2, pp. 151-218.

/eɪ/ in *steak* (pronounced /steɪk/) (examples taken from Luzzatti & Serino, 2012; page 256). On the other hand, phonologically shallow orthographies are defined by a high correspondence between grapheme and phoneme. In fact, Italian has very few examples of orthographical ambiguity, one example could be the pronunciation of words with the sequence of graphemes '*gli*'. This group of graphemes can be read as /tʃ/ in *glicine* (pronounced /ˈglitʃine/) and /ʎ/ in *orgoglio* (pronounced /orˈgoʎʎo/) (examples taken from Luzzatti & Serino, 2012; page 256). At least three factors seem crucial for explaining cross-language differences in phonological awareness, that is consistency of spelling-to-sound relations, granularity of orthographic and phonological representations and teaching methods. This dissimilarity in types of orthography for example explains the difference in the rate of learning a language: in fact, it has been observed that children speaking languages with opaque orthographies show a slower average rate in the learning process of reading due to their low consistency between graphemes and phonemes (Ziegler & Goswami, 2005). Moreover, Seymour, Aro and Erskine (2003[4], in Fanari *et al*., 2013) underlined the fact that English-speaking children take more than four times to reach the accuracy level in reading in comparison to children speaking languages with shallow orthographies. Researchers ascribed this difficulty not only to the low consistency between graphemes and phonemes (and vice versa), but also to the fact that this inconsistency generates confusion in beginners, complicating the learning of phonological decoding.

1.1.2 Word Recognition

Many methods of teaching the reading process exist, with main differences that can be linked to the variability of languages, especially referring to orthographies (Grabe, 2004). Focusing on Italian, when teachers begin instructing children to read words, they begin illustrating how to recognize and write the single graphemes and which sound (phoneme) corresponds to a grapheme. For this reason, before starting to read, children need to learn which sound is linked to a specific symbol. They progress

---

[4] Seymour, P. H., Aro, M. & Erskine, J. M. (2010). "Foundation literacy acquisition in European orthographies", *British Journal of Psychology*, volume 94, n° 2, pp. 143-174.

by learning how to write certain groups of letters, which sounds are linked to that groups of letters, at the same time beginning to associate the concepts linked to the words (Horton Bowden, 1991). After having learnt letters and sounds correspondences, children start putting together the single elements to read whole words. Many models have been developed trying to explain which processes lie behind the reading of single words (Warren, 2013). The *Logogen Model* (Morton, 1969[5] in Warren, 2013; Luzzatti & Serino, 2012) was one of the first models which theorized the functions behind single word reading. It is a serial model in which *logogens* are a sort of containers in which the attributes of a (visual or auditory) stimulus are analyzed, leading to the activation of the correspondent response (Warren, 2013, see figure below).

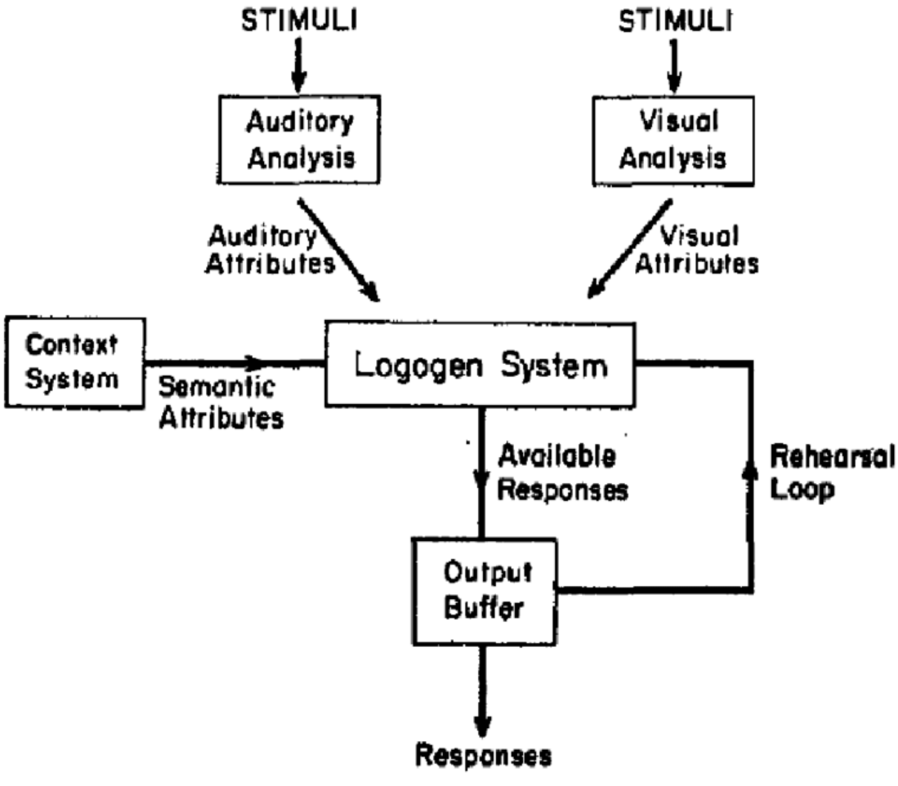


Figure 1. The *Logogen Model* developed by Morton in 1969.

[5] Morton, J. (1969). "Interaction of information in word-recognition", *Psychological Review*, volume 76, pp. 165-178.

The *Search Model* (Forster, 1976[6]; Murray & Forster, 2004[7] in Warren, 2013) is another serial model. The search for the association of input and candidate words is made by scrolling a list of possible words one by one, until there is a match between the input and the candidate (candidates are arranged on the basis of their initial letter/s).

Another model is the one which involves *Interactive Activation,* shown in the figure below (McCLelland & Rumelhart, 1981[8]; Rumelhart & McClelland, 1982[9]; Seidenberg & McClelland, 1989[10] all in Warren, 2013). This model starts from another concept, different from the ones described in the other models.

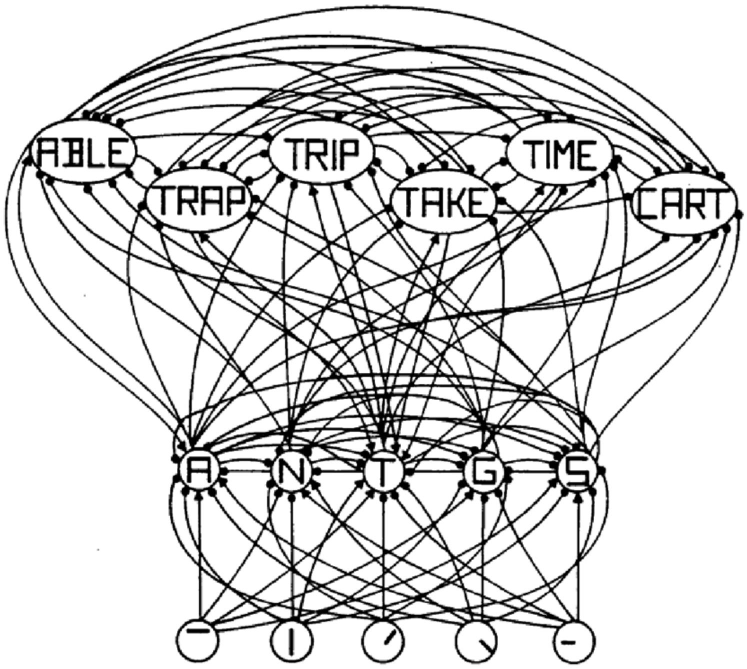


Figure 2. The *Interactive Activation Model* (McClelland, J. L. & Rumelhart, D. E., 1981; Rumelhart, D. E. & McClelland, J. L., 1982).

[6] Forster, K. I. (1976). "Accessing the mental lexicon", in Wales, R. J. & Walker, E. (ed.), *New Approaches to Language Mechanisms* (pp. 257-287). Amsterdam: North Holland.

[7] Murray, W. S. & Forster, K. I. (2004). "Serial mechanisms in lexical access: The rank hypothesis", *Psychological Review*, volume 111, 721-756.

[8] McClelland, J. L. & Rumelhart, D. E. (1981). "An interactive activation model of context effects in letter perception: Part 1. An account of basic findings", *Psychological Review*, volume 88, pp. 375-407.

[9] Rumelhart, D. E. & McClelland, J. L. (1982). "An interactive activation model of context effects in letter perception: Part 2. The contextual enhancement effect and some tests and extensions of the model", *Psychological Review*, volume 89, pp. 60-94.

[10] Seidenberg, M. S. & McClelland, J. L. (1989). "A distributed, developmental model of word recognition and naming", *Psychological Review*, volume 96, pp. 523-568.

In this model there are no containers, no list of words: instead, this model has its roots in the concept that words are built up on the run, in the same moments a speaker/reader is engrossed in speech production/reading. This model is made up of three levels: letter features, letters and words. Some of the units of these three levels are connected to units at other levels via excitatory or inhibitory connections. If one unit is excited by activation, at the same time the other units will experience inhibition, that is, a reduction of activation. If activation excites at the one of the units localized at the letter features level, this jolt continues its trip along lines that connect the excited unit to units at higher levels which contains that features; at the same time, competing units that does not have the activated features will be inhibited due to their incompatibility with the input.

The model for visual recognition of single words upon which many researchers agree as the most accurate for what concerns the description of the process is the *dual-route model of single word reading* elaborated by Patterson, Marshall, Coltheart and later perfectionated by Coltheart, Rastle, Perry, Langdon & Ziegler (respectively 1985 and 2001) (Friedmann & Coltheart, 2018; Warren, 2013; Grigorenko, 2001). This model explains various phenomena such as regularity and frequency effects that can be observed in the reading process (Warren, 2013), it describes accurately the first steps children take when they start learning the reading process and then explains its later automatization. In general, the model is made of two main components, which are referred as sublexical (or indirect) route and lexical (direct) route. On one hand, the sublexical route is principally utilized to read unknown words and nonwords, that is to convert strings of graphemes into sequences of phonemes to be read. On the other hand, the lexical route is utilized for already known words: it is a faster way to activate a word present in the personal stored lexicon, and it is the route that more skilled readers use, optimizing and speeding up the reading process.

The model has a common starting component, which is the *orthographic-visual analysis* of the written input. This component is made of three subcomponents, namely *letter identification* – the process in which the sequence of graphemes is analyzed – *letter position encoding* – the moment when the position of letters inside a word are individuated and processed – and *letter-to-word-binding* – when all the single letters are taken and put together to form the whole word. At this point, the word enters into the *orthographic input buffer*, finding itself at a crossroads: if the word is yet unknown or it is a nonword, it will be moved to the sublexical route, in which the grapheme-phoneme conversion (a translation one-to-one of the single letters into the single phonemes) will take place and it will be made a hypothesis upon the correct pronunciation (Grigorenko, 2001). After the conversion, the word will be directed into the *phonemic output buffer* where the organs involved in language production will receive the input to get in position to pronounce aloud the word analyzed. This is the route that children use when they are learning to read, and it is time and energy consuming.

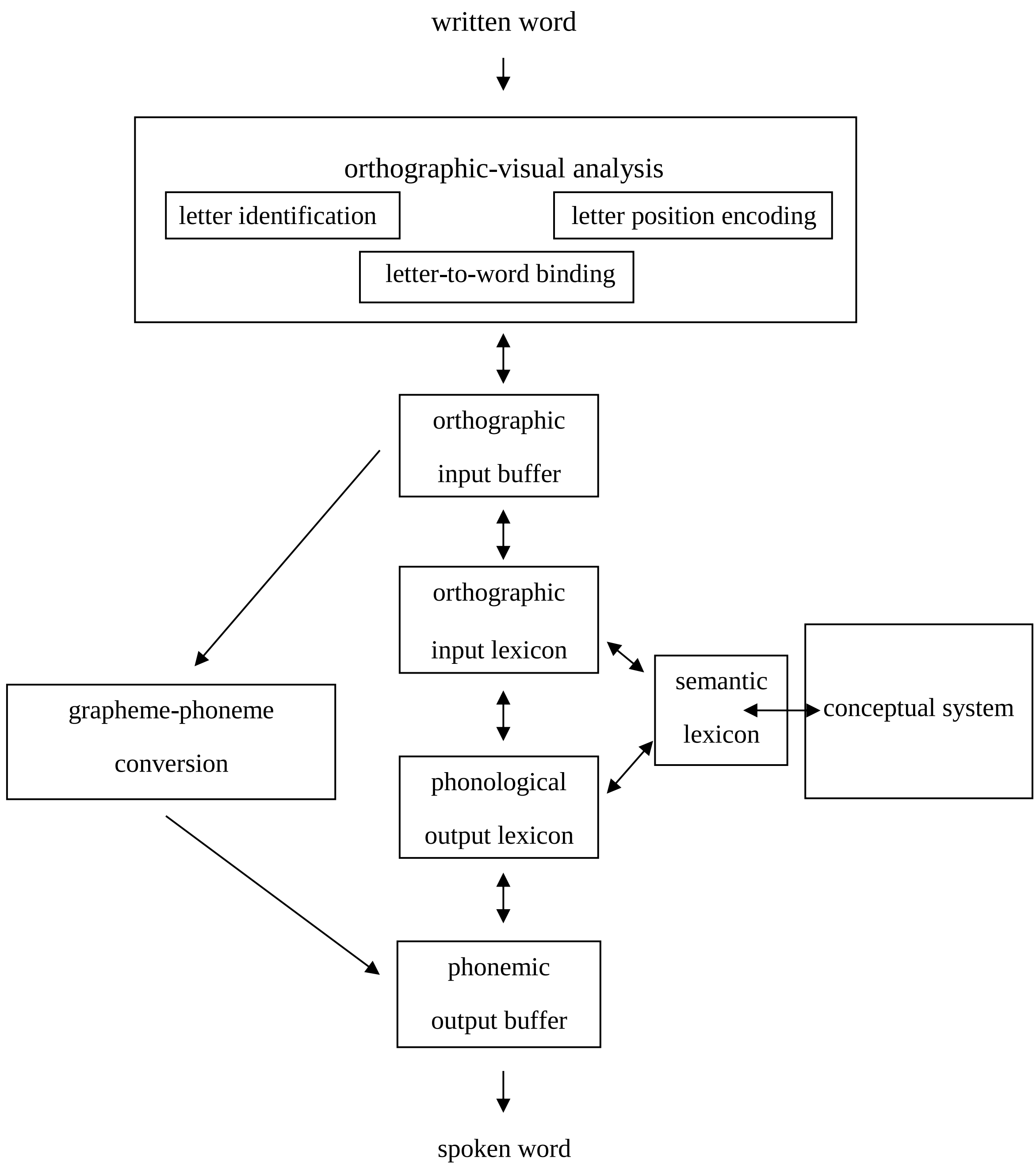


Figure 3. The *dual-route model for single word reading* (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001).

Instead, when an already known word enters the orthographic input buffer, it will be compared with orthographic characteristics already stored into the *orthographic input lexicon*. If the word is recognized, the correspondent abstract meaning will be retrieved from the *conceptual system* and moved to the *semantic lexicon.* As a result, this abstract form will activate the phonological characteristic of the word in the *phonological output lexicon*. The information concerning the motor programming will be then sent to specific areas of the brain designated to speech production, giving the input for the pronunciation of the word after it is moved in the phonemic output buffer. The conceptual system (or *mental lexicon*) contains only actual words, and for this reason the lexical route is activated only when the reader encounters a word s/he has previously analyzed (Friedmann & Coltheart, 2018; Castles & Coltheart, 1993).

The main evidences supporting the two-route model come from the observation of the error patterns not only in neurotypical participants - elicited with controlled tasks -, but also in participants with acquired dyslexia. In fact, these individuals show different types of errors when asked to read certain types of words (confirming a damage of a certain route) or showing preservation of a route instead of the other when asked to read other types of words (Castles & Coltheart, 1993).

1.1.2.1 Acquisition of the Reading Process in Italian Children

For what concerns Italian, scholars such as Orsolini and colleagues (2006[11], in Fanari *et al*., 2013) have observed the development of the acquisition of the reading process in Italian children. Orsolini and colleagues observed that children who had just begun to attend elementary school underwent three stages of development. The first one was observed three months after the beginning of the first year of elementary school: in this stage, it was observed that children employed mainly two strategies. The first strategy was based upon finding phonological clues searching randomly to recognize a word; the second coincided the beginning of reading via the lexical route, with a rare success of fusion between phonemes. In this first stage, very few children showed

[11] Orsolini, M., Fanari, R., Tosi, V., De Nigris, B. & Carrieri, R. (June 2006). "From phonological recoding to lexical reading: A longitudinal study on reading development in Italian", *Language and Cognitive Processes*, volume 21, n° 5, pp. 576-607.

phonological recoding. At the end of the first year (second stage), children reached a homogeneous level of development in the reading process. Children rarely used the grapheme-phoneme conversion route, generally analyzing a whole string of graphemes and associating it to a word. This step can be accounted as an advanced phonological reading before adopting the lexical route. The third and last stage was observed at the end of the second year of elementary school: in this stage, most children began reading with the support of the lexical route, and this could be observed especially by the fact there were no hesitation while reading a sentence or a text, along with the correct use of prosody (Fanari *et al.*, 2013).

For what concerns the development of the two routes involved in single word reading, at the very beginning of the learning path, children begin to develop the sublexical route, and this is evident by the fact that they recognize visually a letter at a time, they decode it, articulating its corresponding sound while reading aloud. With time and exercise, children then acquire new vocabulary enriching their mental lexicon, and they are no more obligated at using the sublexical route. At this stage, children develop a parallel route – the lexical route – with which words are recognized as a whole, with no serial process of analysis of all the letters inside a word. After the visual analysis, the already known word move from the orthographic buffer into the orthographic lexicon, where it starts the process of identification by matching the input with linguistic units already present into the semantic lexicon and the conceptual system, where the lexicon is stored. After the identification, the word is sent to the phonological lexicon, where the letters are linked to the correct pronunciation. The phonological information is sent to the areas of the brain designated for the control of the organs part of the linguistic production. The now complete word is sent to the phonemic output buffer to be produced aloud. As we can see, this route is faster in comparison to the sublexical route because there is no sequential identification: the features of the already known words facilitate the retrieval from the lexicon, accelerating the reading process (Grigorenko, 2001).

1.1.3 Oral Versus Silent Reading

At the very beginning of their learning process, children tend to vocalize grapheme after grapheme of the word they are reading, giving the opportunity to teachers to monitor their progress and eventually correct the errors (Santulli & Scagnelli, 2019). After months of practice, teachers gradually stop asking children to read aloud the written stimuli, transitioning from reading aloud to silent reading. This transition helps children in mastering the reading process, shifting from the only use of the sublexical route to the implementation of the lexical route. Children begin to stop focusing on each visual stimulus to recognize words, at the same time they begin to rely on few graphic cues to recognize words. Doing so, reading speed increases, and children naturally begin to use more silent reading, correcting themselves in case of reading errors (Santulli & Scagnelli, 2019). As Goodman (1967) notes, in this transition "silent reading can become a more efficient and rapid process than oral reading for two reasons: 1. the reader's attention is not divided between decoding and recoding or encoding as oral output, and 2. his speed is not restricted to the speed of speech production" (Goodman, 1967; pp. 6-7).

The fundamental difference between oral and silent reading concerns vocalization - the process of pronouncing out loud what we are reading - which is absent in silent reading. It is common to hear readers talking about an "interior voice" that vocalize what they read inside their heads (the "sub-vocalization" phenomenon) even when we are engaged in silent reading (Horton Bowden, 1991). The fact that the vocalization process is not completed in silent reading does not mean that the information concerning the programming of the movements for speech production are not sent to the brain areas. Even though there is no an explicit vocalization, the areas of the brain associated with movements linked to speech production are activated; this activation and sub-vocalization slow down the entire reading process, causing a diminution in reading speed[12], still maintaining a higher speed in comparison to oral reading.

Concerning comprehension, McCallum and colleagues (2004) in their study discussed the contrasted results of the previous literature upon the efficacy of text comprehension when using silent reading in comparison to text comprehension in oral

---

[12] Source: < https://www.sciencephoto.com/media/307176/view/colour-pet-brain-scan-when-reading-aloud-silently >.

reading (see also Santulli & Scagnelli, 2019). There is still no consensus upon which variety of reading is characterized by the most efficient comprehension, and even McCallum and colleagues concluded that there is no evident superiority of one type or the other, but that silent reading is more effective for what concerns text comprehension due to its higher speed, which is reflected upon better rates of reading effectiveness and efficiency (less time spent on reading a text) (McCallum *et al*., 2004). The relation between reading speed and higher rates in comprehension has been discussed also by Cooper (2012). He observed that in general, when readers want to better understand a text, they tend to slow down their reading speed, and that speed is influenced by a long list of factors, such as difficulty, prior knowledge and interest. On the other hand, Cooper also noted that makes a difference when talking about reading speed and text comprehension is the employment of certain strategies, such as the *preview* techniques. In that case, observing in advance what the text is going to talk about by quickly scanning it, it prepares the reader to approach the text by activating previous knowledge on its main topic: by doing so, the reading speed will increase, and comprehension will not be undermined by it, but rather it will have a boost (Cooper, 2012).

1.1.4 Text Comprehension

In educational settings and everyday life, reading isolated words is not as common as reading sentences and texts. For this reason, once readers have developed their decoding skills, they need to develop components of the reading process that facilitate text comprehension. For example, readers need to enrich as much as possible their vocabulary to increase comprehension rates – at the same time facilitating word recognition and accelerating the whole reading process – and to expand their knowledge of metacognitive strategies to optimize acquisition of new information (Boulware-Gooden *et al*., 2007 – see Chapter Two for a detailed account of metacognition and the relevance of metacognitive strategies). As Hoover & Gough (1990[13], in Furnes &

[13] Hoover, W. A. & Gough, P. B. (1990). "The simple view of reading", *Reading and Writing*, volume 2, n° 2, pp. 127-160.

Norman, 2015) said, "reading comprehension is the product of decoding skills and language comprehension" (page 274).

Children need to climb the steps of the reading process pyramid to reach the top, which is text comprehension: it is a hard task, since it supposes that at a certain level readers will have to master and use successfully many cognitive processes at the same time, such as knowledge of word meaning, syntactic processing and fluency in reading, to be considered proficient readers (Knoepe & Richter, 2018; Rayner *et al.*, 2006). At the base of this pyramid we can find all the small steps that lead to the development of the dual-route model for single word reading (Coltheart *et al.*, 2001) described in the previous paragraph. After some months of practice, teachers begin to ask children to read not only single words, but also longer strings of words. Teachers do this with a double aim: to strengthen both routes involved in the reading process and to help them expanding their knowledge of words part of the lexicon of their native language. In this way, they can read words they have never met, asking teachers to clarify their meaning; otherwise, when they encounter a word that is already part of the stored lexicon, they retrieve the meaning. The following step is the one that involves the integration of words from two points of view, which is the syntactic and the semantic level, to read and understand a sentence. This is fundamental since it is not enough to retrieve the meaning of the words contained in a sentence to understand it, but readers need to create a mental representation of a sentence blending together word meanings to the syntactic and semantic structure of the sentence. Children need to carry out an analogous work between sentences to create a consistent mental model which unifies coherently all the sentences of the text and ties all the information present in the text (Knoepe & Richter, 2018). Like for single sentences, this mental model (Johnson-Laird, 1981[14]; also called *situation model*, Van Dijk & Kintsch, 1983[15]; both in Knoepe & Richter, 2018; Warren, 2013) is generally based upon two levels, the syntactic and the semantic levels. Readers need to create this model by executing a series of cognitive activities: unifying the structure of the text on the basis of semantics and syntax by linking sentences and information of the text together in a coherent and cohesive way (e.g., Singer *et al.*,

[14] Johnson-Laird, P. N. (1981). "Comprehension as the construction of mental models", *Philosophical Transactions of the Royal Society, Series B*, volume 295, n° 107, pp. 353-374.

[15] Van Dijk, T. A. & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.

1992[16] in Knoepe & Richter, 2018; Warren, 2013) and using their general previous knowledge to comprehend the text (e.g., Knoepe & Richter, 2018; Bransford, Barclay & Franks, 1972[17] in Warren, 2013). Along with these processes, there are other cognitive activities that are necessary to come into play to achieve comprehension, such as (Graesser *et al*., 1994[18] in Knoepe & Richter, 2018), previewing other parts of the text (Van Berkum *et al*., 2005[19] in Knoepe & Richter, 2018), monitoring the plausibility of the information inside the text (Isberner & Richter, 2013[20] in Knoepe & Richter, 2018), and monitoring the whole text comprehension process (Nation, 2005[21] in Knoepe & Richter, 2018). The positive outcome of text comprehension can also be affected by subjective factors, such as motivation, level of tiredness and prior knowledge of the reader (Cooper, 2009).

The most important model used to describe how text comprehension works is the *situation model* elaborated by Zwaan and Radvansky in 1998 (in Santulli & Scagnelli, 2019). This dynamic model – that is built while the reading process is underway, and it is constantly modified by the reader - is composed of three different levels, namely the linguistic, the semantic and the situation model level. While the first level supervises the decoding of graphic symbols, the semantic level is appointed to create the connections between words and the information contained in the text, posing the foundations for the *textbase*. Ultimately, the *situation model* level is the step in which the mental image of the situation described in the text is built from the information given by the text and the personal knowledge of the reader, along with the purpose of reading (Santulli & Scagnelli, 2019; page 27). In the *situation model* many cognitive processes and abilities are included, from the decoding of written symbols to the application of specific strategies to achieve comprehension. Moreover, many factors

---

[16] Singer, M., Halldorson, M., Lear, J. C. & Andrusiak, P. (1992). "Validation of causal bridging inferences", *Journal of Memory and Language*, volume 31, n°4, pp. 507-524.

[17] Bransford, J. D., Barclay, J. R. & Franks, J. J. (1972). "Sentence memory: a constructive versus interpretive approach", *Cognitive Psychology*, volume 3, pp. 193-209.

[18] Graesser, A. C., Singer, M. & Trabasso, T. (1994). "Constructing inferences during narrative text comprehension", *Psychological Review*, volume 101, n° 3, pp. 371-395.

[19] Van Berkum, J. J. A., Brown, C. M., Zwitserlood, P., Kooijman, V. & Hagoort, P. (2005). "Anticipating upcoming words in discourse: Evidence from ERPs and reading times", *Journal of Experimental Psychology: Learning, Memory & Cognition*, volume 31, n° 3, pp. 443-467.

[20] Isberner, M.-B. & Richter, T. (January 2013). "Can readers ignore implausibility? Evidence for nonstrategic monitoring of event-based plausibility in language comprehension", *Acta Psychologica*, volume 142, n° 1, pp. 15-22.

[21] Nation, K. (2005). "Children's reading comprehension difficulties", in Snowling, M. J. & Hulme, C. (ed.), *The Science of Reading: A Handbook*, pp. 248-265. Oxford, UK: Blackwell.

come into play for what concerns the success of text comprehension, from the reader's characteristics to the features of the text (Santulli & Scagnelli, 2019).

1.1.4.1 Text Comprehension Strategies: What Makes a Reader Skilled?

Reading written texts is an action that literate individuals carry out on daily basis: they have automatized the reading process during the years at school, at the same time developing some strategies to improve text comprehension. Thinking about an example, a teacher asks students to learn about a topic for a test scheduled a few days later. The teacher indicates written texts, books and websites – in other words, from written sources - to collect relevant information. For this reason, before starting to study, students will have to *read* and *understand* the material that will allow them to obtain all the knowledge required, eventually using a repertoire of strategies to absorb as much information as possible in preparation of the test.

Reading and understanding what we are graphically decoding is not an easy task. In scholastic and academic environment, adolescents and adults engage in this process very often when they want to acquire new information, and while doing so, these students apply a sort of *tactics* – namely, metacognitive strategies - to optimize comprehension while reading a written text. While many readers develop strategies and monitoring skills (the metacognitive ability to monitor the comprehension process and to detect comprehension problems as well as inconsistencies with the text or with prior knowledge - Baker, 1989[22] in Knoepe & Richter, 2018), many others do not develop the right amount of strategies in their personal repertoire or possess the necessary amount of knowledge to comprehend a text and optimize the learning process. In this case, researchers have discovered that - compared to others - these readers are *less skilled*, they are lacking in what concerns awareness and monitoring of metacognitive knowledge and regulation in reading comprehension: for these reasons, these processes are the main aspects of what is called *skilled reading* (Mokhtari & Reichard, 2002).

[22] Baker, L. (1989). "Metacognition, comprehension monitoring and the adult reader", *Educational Psychology Review*, volume 1, n° 1, pp. 3-38.

As it will be illustrated later in Chapter Two, it is fundamental for readers of being aware of the existence of *metacognition*, the human ability to regulate and monitor cognitive processes, and ultimately, learning (e.g., Schraw, 1998). Among other components, metacognitive strategies "are used to ensure that a particular goal (e.g., understanding a text) has been reached (e.g., quizzing oneself to evaluate one's understanding of that text)" (from Livingston, 2003; page 3). It comes easy to think that every student should be aware of the existence of reading strategies, and that teachers should explicitly help students discover them with the help of their personal knowledge and of tools which bring students to explicitly think about the way they approach reading and learning, reflect upon their own knowledge of metacognition. Students should be given the opportunity to apply this repertoire of strategies, to explicitly think about their approach to written texts and new information, aiming at automatizing the whole process that goes under the umbrella term of metacognition (Garner, 1994[23]). For all the reasons above, a student becomes a *skilled reader* when s/he has automatized all these processes, and s/he applies them without explicitly thinking about while reading.

On the other hand, if either component involved in text comprehension is inadequate, it can be impeded, and a reader can be considered *unskilled*. For example, lack of vocabulary can bring the reader to a dead end for what concern comprehension of a text. And if there is no comprehension, readers are obligated to make steps back in the text, trying to make sense to what they are reading or to search for the unknown word in the dictionary, losing time and losing the track of comprehension. Another problem that teachers should be aware of – that has already been mentioned – is the awareness and knowledge of metacognitive skills. Paris and Jacobs gave a description of skilled and unskilled readers in 1984 (in Mokhtari & Reichard, 2002; page 249):

> *Skilled readers often engage in deliberate activities that require planful thinking, flexible strategies, and periodic self-monitoring. They think about the topic, look forward and backward in the passage, and check their own understanding as they read. Beginning readers or poor readers do not recruit and use these skills. Indeed, novice*

[23] Garner, R. (1994). "Metacognition and executive control", in R. B. Ruddell, M. R. Ruddell & H. Singer (Eds.), *Theoretical models and processes of reading* (pp. 715-732). Newark, DE, US: International Reading Association.

readers often seem oblivious to these strategies and the need to use them.

In the words of Paris and Jacobs (1984) we can find what has been illustrated until this very page, highlighting the fact that unskilled readers seem that they do not possess the same amount of awareness in metacognition that skilled readers instead have acquired in a certain amount of time. Many studies that focused on this topic have already proved that skilled readers possess more metacognitive knowledge and have more success in tasks such as reading comprehension compared to unskilled readers. However, there is no 'black and white' division when it comes to be a skilled or an unskilled reader, but it is a continuous line in which can be found many shades corresponding to various degrees of awareness of metacognition and its components (Boulware-Gooden *et al*., 2007). Students' level of awareness is certainly linked to their previous scholastic and personal experiences, and the personal repertoire of strategies used to enhance text comprehension has been built through years of practice: in this sense, time has helped students to identify and develop which strategies are the best suited to aid comprehension for them. If skilled readers have the tendency of being more aware of metacognition and its components, less skilled readers possess fewer strategies and they are weaker on their knowledge and awareness of metacognition. They possess fewer strategies and they are even less aware of the existence of these strategies; moreover, the few strategies these less skilled readers possess are less effective compared to ones applied by more skilled readers in their reading tasks. For what concerns monitoring, unskilled readers display less effective monitoring of their cognitive processes, underlying the fact that their knowledge of metacognition and its processes is overall poor (Cubukcu, 2008). The fact that metacognition is somehow lacking in unskilled readers influences negatively the learning process, blocking readers for what concerns monitoring applying strategies. As we will discuss in Chapter Two, these situations can be reversed by with the help of the right tools and teachers.

Taking in considerations the strategies, more skilled readers possess a way more strategic approach to reading, which not only allows them to maximize the absorption of information by choosing the best approach based on which type of text they are about to read, but also by employing the most effective strategies to memorize most relevant information (Scagnelli *et al*., 2018). Skilled readers then approach a text with general tendencies at the beginning, later shifting these general tendencies to more specific actions based upon their goals and the nature of the text itself (Pressley & Afflerbach, 1995). Research has confirmed that enhancing comprehension by teaching strategies leads to a positive improvement that reflects upon the whole learning process. Take as an example the study conducted by Cubukcu in 2008: to enhance learning of new vocabulary, teachers have helped students discover new strategies, and this training has confirmed the positive impact in developing vocabulary and improving reading comprehension skills. Enhancing learning using metacognitive strategies also influences the number of academic achievements, and a study made by Boulware-Gooden and colleagues in 2007 supports this claim. Among many other strategies, students were instructed to write a summary with a limited number of words, in this way compelling students to search for the most relevant information to be inserted in the summary.

Other than summarizing a text after having read it, examples of strategies used by more skilled readers can be found in a vast amount of literature. Taraban, Kerr and Rynearson (2004[24], in Cubukcu, 2008) divided the strategies used by the students in their study into three groups: text noting tactics, mental learning tactics and reading tactics. In 2004, Grabe suggested a series of abilities that students need to be stimulated to optimize and achieve effective text comprehension, such as – among the ones already cited – mnemonic practice, graphic organizers and summarization (Grabe, 2004).

Now it is also clear why it should be of teachers' interest to measure metacognition in the scholastic environment. Not only to help already skilled students to expand their repertoire, but also to bring awareness of metacognition and metacognitive skills to surface for less skilled readers, giving them the opportunity to enhance their learning process. In this sense, collecting readers' impressions and thoughts using tools give students the opportunity to think about the way they approach reading and learning, to explicitly show how they plan, monitor, evaluate, and use information available to them as they make sense of what they read (Schraw, 1998). Citing Grabe (2004), teachers need to give directions to students for what concerns which abilities they need to possess to achieve text comprehension. Also, teachers need to instruct students in ensuring general comprehension skills (e.g., learning vocabulary and metacognitive strategies), in teaching tools such as diagrams and maps to analyze text

[24] Taraban, R., Kerr, M. & Rynearson, K., (2004). "Analytic and pragmatic factors in college students' metacognitive reading strategies", *Reading Psychology,* volume 25, pp. 67–81.

structure and organization, and in developing motivation to read as many texts as possible and enrich their background knowledge (Grabe, 2004).

1.2 Specific Learning Disabilities and Dyslexia

1.2.1 SLD

Specific Learning Disabilities concern all those abilities that children acquire through formal education, such as writing, reading and making calculations (DSM-5, 2013[25]). Usually, this definition comes in opposition to the one called *Specific Language Impairments* (SLI for short), which is a deficit of all those abilities of speech production acquired spontaneously, such as phonology, lexicon and morphosyntax. Some scholars agree upon the fact that SLD could be in a direct relationship with SLI, that they are consequent with difficulties with language: moreover, scholars have observed cases in which there is a comorbidity of SLI and SLD (see, for example, Fitch *et al*., 1994[26] and Bishop & Adams, 1990[27] in Zoccolotti *et al*., 2005).

Specific Learning Disabilities are diagnosed excluding the presence of developmental neurological pathologies, sensorial deficits (such as blindness and deafness), motor limitations and cognitive deficits. For this reason, definitions such as the one of SLD are often referred as exclusion definitions: this means that to diagnose a SLD, doctors need to exclude the presence certain factors or deficits (Riddick, 1996). Moreover, to be diagnosed as such, these disorders need to significantly interfere with the scholastic path and everyday activities.

In Italy, dyslexia, dysorthography, dysgraphia and dyscalculia are recognized as *Specific Learning Disabilities*. In 2010, the Italian government issued a law to guarantee compensatory tools and adequate education to individuals with a diagnosis of SLD. This law – n° 170 – is the one which aims at assuring a high quality of scholastic education for students and their right to study, also taking care of specific teaching methods[28].

[25] American Psychiatric Association (2013). "Diagnostic and Statistical Manual of Mental Disorders, 5th Edition". American Psychiatric Publishing.

[26] Fitch, R. H., Tallal, P., Brown, C. P., Galaburda, A. M. & Rosen, G. D. (May 1994). "Induced Microgyria and Auditory Temporal processing in Rats: A Model for Language Impairment", *Cerebral Cortex*, volume 4, n° 3, pp. 260-270.

[27] Bishop, D. V. M. & Adams, C. (November 1990). "A Prospective Study of the Relationship between Specific Language Impairment, Phonological Disorders and Reading Retardation", *Journal of Child Psychology and Psychiatry*, volume 31, n° 7, pp. 1027-1050.

[28] Source: "La Legge 170/2010", < https://www.aiditalia.org/it/dislessia-a-scuola/legge-170-2010 >.

1.2.2 Dyslexia

1.2.2.1 History and Main Characteristics

Studies on dyslexia started during the 19th century and they were mainly conducted on a clinical basis. The term ‘dyslexia’ appeared for the first time in 1887 and was used by the ophthalmologist Rudolph Berlin and it was used to refer to an acquired difficulty with reading caused by a mild brain lesion affecting the decoding of written letters. ‘Dyslexia’ came in contrast with another term – ‘alexia’ – used by Berlin to refer to the complete inability to read, always caused by a brain lesion. But at the very beginning of the studies on dyslexia, doctors tended to refer to dyslexia as *word-blindness*, a term coined by Adolf Kussmaul in 1877 when he reported a case of a man afflicted by a severe reading deficit even if he was not diagnosed with any other problem concerning vision, language and intelligence (Kussmaul, 1877[29] in Elliott & Grigorenko, 2014). A later physician - W. Pringle-Morgan – reflected upon the fact that this word-blindness could be a developmental condition other than an acquired one. In his paper[30] published at the end of the 19th century, Pringle-Morgan described many cases of developmental dyslexia, including the case of an adolescent boy, linking the deficit to the “stor[ing of] visual impressions of words” (Elliott & Grigorenko, 2014; page 2). Other influential studies came from another doctor, the ophthalmologist James Hinshelwood, who in 1917 published a book (‘*Congenital Word-blindness’)* in which he described for the first time the characteristics associated with dyslexia. As in Pringle-Morgan’s case, also Hinshelwood though that the mechanisms behind dyslexia was purely to be referred to problems at the visual level. Twenty years later, another doctor, the American neurologist Samuel T. Orton published the book ‘*Reading, writing and speech problems in children*’, in which he confirmed that behind dyslexia there were problems regarding the visual level, adding an insight on the emotional sphere of the individuals with a diagnosis of dyslexia. As a neurologist, Orton thought that dyslexia could be related to “poor cerebral dominance” of the hemispheres (Elliott & Grigorenko, 2014; page 3), creating also the term “strephosymbolia” (literal meaning,

---

[29] Kussmaul, L. A. (1877). “Disturbances of Speech”, in von Ziemssen, H. (ed.), *Cyclopedia of the Practice of Medicine*, volume 14. New York: William Wood and Co.

[30] Pringle-Morgan, W. (1896). “A case of congenital word blindness”, *British Medical Journal*, volume 2, p. 178.

‘twisted symbols’[31]) to refer to what is today called dyslexia (Elliott & Grigorenko, 2014; Riddick, 1996). A wider number of researchers coming from different fields started a more detailed study of developmental dyslexia between the ‘60s and the ‘70s of the 20th century (Zoccolotti *et al*., 2005), years which were extremely important for what concerns the present knowledge of dyslexia. Nowadays, dyslexia is studied by two different lines of thinking: one, more clinical, is dedicated to the observation of the neuroanatomy, focusing on the anatomical basis of dyslexia. The other – which is the field on which we will focus from now on – is the one of psycholinguistics. As today, the knowledge of developmental dyslexia has been enriched, and the mechanisms behind it are not entirely clear. The most widely accepted definition is reported by the World Federation of Neurology (1968):

> *“Dyslexia is a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin”* (World Federation of Neurology, 1968 in Riddick, 1996; page 2).

The quote describes the case of developmental dyslexia, which is caused by the deficit or the failure of developing some components of the dual-route single word reading model previously described despite the normal development of other factors such the one indicated in the definition given by the World Federation of Neurology. It has been confirmed by research that it has a life-long impact on individuals and it has been associated with depression, anxiety, lower self-esteem, attention deficits and often, behavioral problems (Livingston *et al*., 2018). As we will see, this type of dyslexia comes in contrast with an acquired type of deficit in reading, which will not be taken in consideration in this dissertation.

[31] “Handbook of Australian School Psychology: Integrating International Research, Practice and Policy”, Thielking, M. & Terjesen, M. D. (ed.). *Springer,* 2017.

According to the most recent investigations[32], in the Italian scholastic system individuals with an attested diagnosis of SLD are around 255'000 on a totality of 8,6 million (2,9%) students. Out of this small percentage, the 43% are dyslexic readers. It has been observed that dyslexia can manifests itself in comorbidity with other SLD, Attention Deficit Hyperactivity Disorder and other deficits (Stella, Franceschini & Savelli, 2009[33]; Gagliano *et al*., 2007[34], both in Maroscia & Terribili, 2012[35]). There are evidences that lead researchers to think that a genetic base is behind the mechanisms of developmental dyslexia, even though they have not been completely clarified (Elliott & Grigorenko, 2014; Grigorenko, 2001). Starting from the fact that reading involves a large-scale neuronal network in the left hemisphere of the brain, researchers have hypothesized that developmental dyslexia could be the result of more than one deficit in the system (Elliott & Grigorenko, 2014). Moreover, it has been observed that the analysis of some components of the reading process (such as phonological decoding and naming) in parents can be a predictor for the presence of developmental dyslexia in their children, providing evidences for the involvement of genetic factors in dyslexia (Elliott & Grigorenko, 2014; Grigorenko, 2001). However, it needs to be underlined that these analyses are complex, and researchers are still working to clarify the genetic base of developmental dyslexia also by mapping human genomes (Elliott & Grigorenko, 2014).

1.2.2.2 Varieties of Dyslexia

To provide a description of the various types of dyslexia, we will keep in consideration the dual-route model of single word reading. This model, in fact, it is important not only to describe how the reading process takes place in an adult skilled

[32] De Carli, S. (2018). "Dislessia e DSA, in sei anni le diagnosi sono quadruplicate", < http://www.vita.it/it/article/2018/04/18/dislessia-e-dsa-in-sei-anni-le-diagnosi-sono-quadruplicate/146598/ >.

[33] Stella, G., Franceschini, S. & Savelli, E. (2009). "Disturbi associati nella dislessia evolutiva", *Dislessia*, volume 6, n° 1.

[34] Gagliano, A., Germanò, E., Calarese, T., Magazu, A., Grosso, R., Siracusano, R. M. & Cedro, C. (2007). "Le comorbidità nella dislessia: studio di un campione di soggetti in età evolutiva con Disturbo della Lettura", *Dislessia*, volume 4, pp. 27-45.

[35] Maroscia, E. & Terribili, M. (2012). "Comorbidità nel disturbo specifico di apprendimento". Scuola IaD, Roma.

reader, but also to localize the deficient subprocesses that give life to the different types of dyslexia (Friedmann & Coltheart, 2018).

The first division can be done considering that dyslexia can be consequent to a brain damage (acquired dyslexia) or can be affect the normal development of the cognitive process (developmental dyslexia). Acquired dyslexia results from brain injuries and affects an already acquired ability: the damage can be consequent from various reasons, such as strokes or head traumas from an accident. On the other hand, developmental dyslexia does not derive from a brain injury, and it affects an ability that has not been developed yet, usually affecting the normal development of the skills by a deficit in one (or more) subcomponents that individuals need to acquire to become skilled readers (Friedmann & Coltheart, 2018; Warren, 2013). Both types of dyslexia share the fact that if specific subcomponents of the model are impaired, they will result in the production of specific errors and difficulties in reading, leading to the differentiations of various types of dyslexia (Friedmann & Coltheart, 2018).

Concentrating our attention on the various types of developmental dyslexia, another subcategorization can be done by observing which subcomponent of the single word reading model is deficient and which is its position. Generally, the various types of dyslexia can be divided into peripheral and central dyslexia. These two terms refer to the position in which the deficient subcomponent is posited in the single word reading model. Peripheral dyslexia result from impairments of the very first stages of the model, namely the orthographic-visual analysis stage, instead, central dyslexia result from the impairment of one of the components of the lexical or the sublexical routes (Friedmann & Coltheart, 2018). In this paragraph we will focus especially on two types of central developmental dyslexia, which are phonological and surface dyslexia. For a complete list of varieties of dyslexias, see *Appendix A*.

Phonological dyslexia is caused by a failure in the route devoted to the grapheme-phoneme conversion. In this case, phonological dyslexics need to rely on the intact lexical route to read words, failing doing so with nonwords and new words - normally the type of words that rely on the sublexical route – but correctly reading the already known words. The most important characteristic of this variety of dyslexia is the fact that phonological dyslexics produce many errors during reading, but their speed is usually unaffected (Friedmann & Coltheart, 2018; Hawelka *et al*., 2010).

If phonological dyslexia derives from the impairment of the sublexical route, *surface dyslexia* comes up when the lexical route is deficient or not completely developed. To compensate this deficit, the reader continues reading words and texts using the sublexical route (Friedmann & Coltheart, 2018; Hawelka *et al.*, 2010). In relation to this, the most evident characteristic of this type of dyslexia is the slowness with which dyslexic individuals read. But reading only with the help of the sublexical route brings up other characteristics such as errors involving the regularization in the pronunciation of certain types of words, which graphemes and phonemes do not have a regular correspondence. While regular words are usually pronounced slowly but correctly through sequential analysis of the sublexical route, the phonological form of irregular words is stored in one of the components localized in the deficient lexical route, which is the orthographic input lexicon. Since the lexical route is inaccessible, surface dyslexics read a word using the most common pronunciation of single graphemes by relying on the sublexical route, consequently pronouncing it incorrectly.

1.2.2.3 Variability of Dyslexias Across Different Orthographies

Dyslexia results from deficits in various points of the reading network. Behavioral studies show that phonological and surface dyslexias manifest differently depending on the type of orthography of a language (Landerl *et al.*, 1997[36] in Ziegler *et al.*, 2003; Grigorenko, 2001). Phonological dyslexia is frequently diagnosed in languages with opaque orthography, such as English and French (Zoccolotti *et al.*, 2015). Because these languages have a relatively low one-to-one correspondence between graphemes and phonemes, dyslexic individuals commit more phonological errors when it comes to reading nonwords and irregular words (sometimes also low frequency words) even if their reading speed is normal. This happens because they rely on the intact lexical route (Ziegler & Goswami, 2005; Grigorenko, 2001). On the other hand, languages such as Italian and German – which are languages with relatively shallow orthographies – display more cases of surface dyslexia. In fact, it has been observed by scholars that dyslexic children who have as native languages Italian or German or other languages with shallow orthography show very low speed, but high

[36] Landerl, K., Wimmer, H. & Frith, U. (1997). "The impact of orthographic consistency on dyslexia: A German-English comparison", *Cognition*, volume 63, pp. 315-334.

accuracy compared to their English or French peers. Low speed is the result of a sequential analysis of the graphemes that compose the words using the sublexical route (Zoccolotti *et al*., 2015; Ziegler & Goswami, 2005; Grigorenko, 2001).

Focusing on Italian – a language with shallow orthography – the most evident deficit regards reading speed. Italian dyslexic children read slow and with extreme effort both words and nonwords, underlining a continuous linear decoding. On the other hand, errors are way less frequent in comparison to their English and French speaking peers (Barca *et al*., 2006; Zoccolotti *et al*., 1999). Tressoldi and colleagues (2001) highlighted both the difficulties in automatization of the reading process and the reading speed of dyslexic readers, who are slower (increase equal to .3 syllables per second per grade) in comparison to neurotypical readers (increase equal to .5 syllables per second per grade) (Tressoldi *et al*., 2001).

Scholars have made many hypotheses to explain the reading slowness of Italian dyslexic children. Many of them, including for example Zoccolotti and colleagues, think that the fact that Italian children can read without making errors both words and nonwords denotes that the sublexical route is intact. In their article published in 1999, the researchers analyzed four cases of developmental dyslexia observing vocal reaction times and eye movements. Results supported the hypothesis that participants relied on the use of the sublexical route, since vocal reaction times were slow and affected by word length effect, highlighting also the impossibility to access to the mental lexicon posited in the lexical route (Zoccolotti *et al*., 1999).

Other scholars, such as Barca and colleagues, think that Italian dyslexic children seem to rely on the sublexical route since the lexical route has not been developed entirely or is deficient; however, the deficit can be observed in upstream components of the dual-route reading model. In their study, researchers compared the efficiency of the two routes by administering word frequency and contextuality of the grapheme-to-phoneme conversion rules to Italian neurotypical and dyslexic readers. In their case, results showed how the lexical route was intact by the fact that both neurotypical and dyslexic readers showed similar data. For this reason, Barca and colleagues hypothesized that the deficient subcomponent could be found in the first step of the model – orthographic-visual analysis – which is also independent from the later activation of one of the two routes. A deficit in this first step of the model can explain the slow and sequential way of reading along the word frequency effect, which is derived from a slow acquisition of the graphemic information, while neurotypical and more skilled readers accomplish rapidly this first step (Barca *et al*., 2006).

1.2.2.4 Assessment and Speech Therapy in Dyslexia

Researchers agree on the importance of early identification and diagnosis of developmental dyslexia to help children cope with their difficulties with the right tools and support (Elliott & Grigorenko, 2014). The steps that lead to a diagnosis of SLD in Italy are regulated by the recommendations of the National Institute of Health. Children suspected with a SLD need to be examined by a team of experts (including a psychologist and a speech-language therapist) usually when they are attending the first years of formal education (precisely, starting from the end of the second year of elementary school) and they are beginning to learn to master the reading process[37]. However, in the last few years an Italian group of researchers have developed and standardized a battery of tests to diagnose developmental dyslexia in adult native speakers of Italian included in a range of age between 16 and 30 years old (BDA 16-30, *Batteria per la Diagnosi della Dislessia, Disortografia, Disturbo di comprensione in adolescenza e in età adulta* - Ciuffo *et al*., in print). This is extremely relevant because the more children grow up, the more difficult is to diagnose dyslexia in more adult individuals, because they could have developed compensative strategies to counterbalance their difficulties. For what concerns speech-language therapists and their role, they make their diagnosis by observing if there is a substantial difference between the performance of a child in the standardized tests and her/his general cognitive abilities, if these difficulties have a significant impact on their formal education, and if the presence of deficits such as deafness could entirely explain the existence of certain difficulties. Speech-language therapists evaluate the performance of children in reading aloud through a series of tasks from standardized tests. This means that the performance of a single child is compared to data collected from a wide sample of the neurotypical population. Usually these standardized tests include tasks of text comprehension or oral

[37] Source: "A proposito di false diagnosi nel DSA", < https://www.aiditalia.org/it/news-ed-eventi/news/diagnosi-dsa >.

reading of a list of certain types of words. In the first case, children need to read aloud a small text and answer some questions, while speech-language therapists evaluate their performance by doing a qualitative analysis of the errors, measuring the time employed to read the text (especially in languages with shallow orthographies) and checking if the answers are correct. Instead, for what concerns the reading aloud of lists of specific types of words, speech-language therapists can control and isolate single subprocesses in the reading process to observe which one of the two routes are compromised (Stella & Serino, 2011; Zoccolotti *et al*., 2005).

In addition to standardized tests, we can find experimental ways to evaluate the reading performance of children with suspected developmental dyslexia. For example, researchers can observe spoken reaction times in tasks such as single word reading or lexical decision with the help of a computer. Among the experimental testing methods, we can find the evaluation of the reading process in a text comprehension task through the observation of the ocular movements or using imaging techniques such as PET and fMRI (Zoccolotti *et al*., 2005).

It is worth noting that speech-language therapists and researchers have concentrated their attention on reading aloud since is easier to be observed in comparison to silent reading. However, Santulli and Scagnelli (2017) support the idea that silent reading analysis should be considered more in the evaluation of a diagnosis of dyslexia, especially in adult readers, because silent reading is the most common method of reading in this group of readers. It is therefore advisable for researchers and institutions to investigate more on this method of reading (Santulli & Scagnelli, 2017). In this sense, Ciuffo and colleagues (paper in press) made a step forward the integration of a method to investigate silent reading by including a task to evaluate its status in their battery for the diagnosis of developmental dyslexia in adults (BDA 16-30).

Concerning therapy, each project is differentiated on the basis of the characteristics of the single dyslexic individual and it consists of various interventions, from the clinical level to the scholastic level (Stella & Savelli, 2011). For what concerns the clinical level, among researchers there is no consensus yet on specific rehabilitation programs. This is due to the difficulties linked to the standardization of certain rehabilitation programs, their duration and the elevated costs of research (Stella & Savelli, 2011). However, the Consensus Conference in 2007 enumerated a series of principles to follow when it comes to the treatment of developmental dyslexia, which has a life-long impact on individuals. For example, in this list can be found a consideration upon the nature of the treatment, defined as “the whole set of actions aimed at increase the efficiency of an altered process” (translation made by the author – from Stella & Savelli, 2011; page 53).

1.2.2.5 Theories Behind the Mechanisms Underlining Dyslexia

Researchers are still at work to understand which are the mechanisms and the causes behind dyslexia. One of the points on which they agree is the hypothesis that developmental dyslexia could be originated by various factors, including genetics and environment (Stella & Savelli, 2011). Up until now, the most relevant hypotheses explaining the mechanisms of developmental dyslexia can be divided into four groups: phonological, visual, attentional and automatization hypotheses.

The *phonological* hypotheses are based upon the theory that dyslexic readers present impairments in the representation, storing or retrieving of the phonological information of words. These hypotheses have been developed by observing data collected in studies which utilized tasks involving verbal short-term memory and phonological awareness and recoding (Ziegler *et al*., 2003). The first that can be cited is the one called ‘*Core Phonological Hypothesis’* and it was developed principally by Snowling and colleagues in the 1990s. Following its principles, children with dyslexia have difficulties in tasks aimed at testing discrimination between phonetics and phonology, tasks which highlight the presence of a phonological disturbance at the center of the reading deficit (e.g., Snowling & Hulme, 1994[38]; Snowling, 2000[39] in Zoccolotti *et al*., 2005). Another hypothesis linked to the phonological disturbance is the one called ‘*Temporal Perception Hypothesis*’, in which there is an inefficiency of the phonological analysis in the discrimination of short stimuli or stimuli in rapid

[38] Snowling, M. J. & Hulme, C. (1994). “The development of phonological skills in children”, *Philosophical Transactions of the Royal Society B*, volume 346, pp. 157-170.
[39] Snowling, M. J. (2000). “Dyslexia”. Oxford: Blackwell.

succession (for example, a deficit in repetition of nonwords tasks) (e.g., Tallal, 1980[40]; Tallal *et al*., 1997[41] in Zoccolotti *et al*., 2005).

Among the *visual* hypotheses, we can find the one elaborated by Stein in 2001, called "disturbance of elaboration along the visual magnocellular pathway". The brain possesses two pathways localized in the posterior part: the parvocellular pathway (or what pathway, what are we seeing), which is utilized to identify objects, and the magnocellular pathway (or where pathway, where is the point we are seeing), which is utilized for spatial localization and the elaboration of transient stimuli. These two pathways are independent systems which analyze visual information before arriving to the cortex (*Figure 4*).

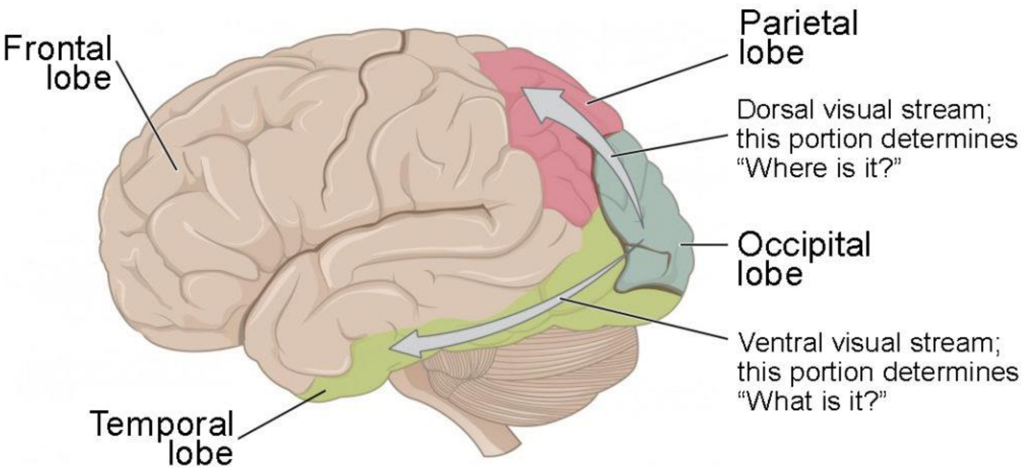


Figure 4. Description of the parvocellular (What?) and magnocellular (Where?) pathways from the visual cortex (source: < https://www.imagenesmy.com/imagenes/map-dorsal-stream-c5.html >).

[40] Tallal, P. (1980). "Auditory temporal perception, phonics, and reading disabilities in children", *Brain and Language*, volume 9, pp. 182-198.

[41] Tallal, P., Miller, S. L., Jenkins, W. M. & Merzenich, M. M. (1997). "The Role of Temporal Processing in Developmental Language-Based Learning Disorders: Research and Clinical Implications", in Blachman, B. (ed.), *Foundations of Reading Acquisition and Dyslexia*. *Implications for Early Intervention*. New York: Rutledge.

Stein's hypothesis is about an altered development of the magnocellular system, causing instability in the visual images during reading (Stein *et al.*, 2001). In dyslexic readers this instability of the visual images is probably causing confusion at the level of the order of the letters. At this instability follows a deficit in the visual shape of the words and an obstacle in the acquisition of orthographic abilities and lexicon. Another hypothesis related to visual deficits is the one named "crowding effect" (e.g., Bouma & Legein, 1977[42]; Pelli *et al.*, 2004[43]; Spinelli *et al.*, 2002[44] in Zoccolotti *et al.*, 2005). There is a physiological minimal distance that is necessary to detect correctly distinct stimuli especially in the periphery of the visual field (perceptual span). It is hypothesized that dyslexic readers possess a disproportionate enlargement of the minimal distance necessary to separately perceive nearby stimuli, incrementing the crowding effect. In this case, a deficit in the identification of the shape of words and an anomalous acquisition of the orthographic knowledge.

Facoetti (2000[45], 2003[46] in Zoccolotti *et al.*, 2005) is a researcher who hypothesizes that behind developmental dyslexia there is a deficit of the spatial attention. In his theory, he asserts that dyslexic readers suffer from a reduced ability in bringing in a voluntary or automatized way the attention towards visual spatial stimuli. In this case, the reading deficit can be re-educated through exercises finalized at compensating the deficit of attention.

Last, but not least, it is the *cerebellar theory* (or deficit of the automatization process). According to this theory, a deficit in the articulation of speech sounds could lead to an impoverished phonological representation (e.g., Nicolson & Fawcett, 1990[47]; Nicolson, Fawcett & Dean, 2001[48] in Zoccolotti *et al.*, 2005). Cerebellum has an important role in the motor control (the articulation of oral speech included) and in the

---

[42] Bouma, H. & Legein, C. P. (1977). "Foveal and parafoveal recognition of letters and words by dyslexics and by average readers", *Neuropsychologia*, volume 15, pp. 69-80.

[43] Pelli, D. G., Palomares, M. & Majaj, N. J. (2004). "Crowding is unlike ordinary masking: Distinguishing feature integration from detection", *Journal of Vision*, volume 4, n° 12.

[44] Spinelli, D., De Luca, M., Judica, A. & Zoccolotti, P. (2002). "Crowding effects on word identification in developmental dyslexia", *Cortex*, volume 38, pp. 179-200.

[45] Facoetti, A., Paganoni, P., Turatto, M., Marzola, V. & Mascetti, G. G. (2000). "Visual-Spatial Attention in Developmental Dyslexia", *Cortex*, volume 36, n° 1, pp. 109-123.

[46] Facoetti, A., Lorusso, M. L., Paganoni, P., Umiltà, C. & Mascetti, G. C. (2003). "The role of visuospatial attention in developmental dyslexia: Evidence from a rehabilitation study", *Cognitive Brain Research*, volume 15, pp. 154-164.

[47] Nicolson, R. I. & Fawcett, A. J. (1990). "Automaticity: A new framework for dyslexia research?", *Cognition*, volume 35, pp. 159-182.

[48] Nicolson, R. I., Fawcett, A. J. & Dean, P. (2001). "Developmental dyslexia: The cerebellar deficit hypothesis", *Trends in Neurosciences*, volume 24, pp. 515-516.

automatization of motor abilities in rapid sequence such as typing and reading. In this sense, the theory asserts that dyslexic readers possess certain difficulties with the automatization of the reading process due to an hypofunctioning of the cerebellum. This deficit leads to an impairment of the representation of the phonological grid of children, undermining the acquisition of the sublexical procedure (Zoccolotti *et al*., 2005).

1.2.2.6 Anatomical Correlates: A Clinical Perspective

In previous paragraphs, we have described in summary some of the studies on genetics aimed at identifying the neurobiological basis of dyslexia (Elliott & Grigorenko, 2014). There is another important body of research which focuses on finding where the reading network and its deficient components are posited, that is structural and functional analysis of the brain (Elliott & Grigorenko, 2014; Ziegler *et al*., 2003).

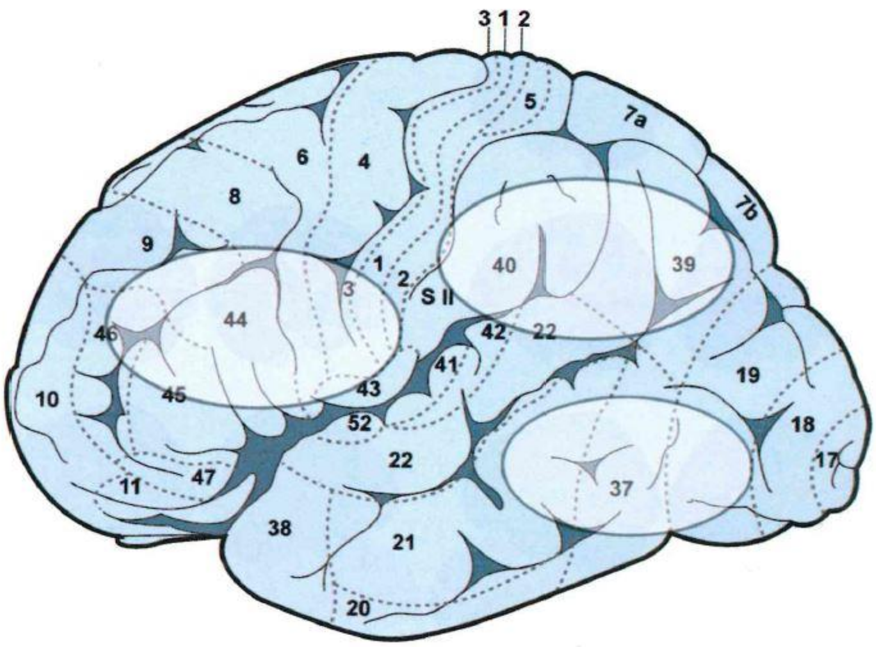


Figure 5. The neuronal network involved in the reading process. In the circles we can see the three main areas of the network (from Elliott & Grigorenko, 2014; figure 3.1 of the color plate).

In the last 30 years, with the help of the most advanced technology (fMRI, DTI and EEG to mention some) researchers have discovered that the network regulating the reading process involves mostly three areas the left hemisphere of the brain (*Figure 5*): left inferior frontal region (BA 44, 45 and 6), posterior dorsal region (including the angular and supramarginal gyri and the posterior superior temporal gyrus), and the posterior ventral region (including the fusiform and inferior temporal gyri) (see figure above - Elliott & Grigorenko, 2014; page 90). Supported also by studies on genetics, researchers have hypothesized that developmental dyslexia could be related to a defect in the organization and migrations of neurons which occur in a prenatal phase (Elliott & Grigorenko, 2014).

Other groups of researchers have focused their attention to the shape and size of other structures of the human brain that are involved in the reading process, namely the corpus callosum, the thalamus and the planum temporale. Concerning the planum temporale, it has been observed that most of the population (60-70%) is characterized by a left asymmetry. However, the remaining percentage of individuals can show a right asymmetry associated with language deficits. In fact, some researchers - such Duara and colleagues - think that symmetry (or right asymmetry) in the planum temporale could justify the presence of dyslexia in these individuals, being involved in the auditory processing (Stigler & McDougle, 2013[49]). Duara and colleagues observed that dyslexic individuals showed a higher incidence of symmetry between planum temporale of both cerebral hemispheres, while neurotypical readers were characterized by an asymmetry between the planum temporale of the two hemispheres (Duara *et al*., 1991[50] in Grigorenko, 2001), and that this difference could justify the reading difficulties of dyslexic individuals.

Other scholars, such as Lubs and colleagues (1998[51], in Grigorenko, 2001) observed neurotypical and dyslexic readers by comparing their glucose metabolism during a reading task. They concluded that parts of the brain involved in dyslexia could extend over the common parts of the brain traditionally involved in language and

[49] Stigler, K. A. & McDougle, C. J. (2013). "Structural and Functional MRI Studies of Autism Spectrum Disorders", in *The Neuroscience of Autism Spectrum Disorders*, Chapter 3.1, pp. 251-266.

[50] Duara, R., Kushch, A., Gross-Glenn, K., Barker, W. W., Jallad, B., Pascal, S., Loewenstein, D. A., Sheldon, J., Rabin, M. & Levin, B. (1991). "Neuroanatomic differences between dyslexic and normal readers on magnetic resonance imaging scans", *Archives of Neurology*, volume 48, pp. 410-416.

[51] Lubs, H. A., Smith, S., Kimberling, W., Pennington, B., Gross-Glenn, K. & Duara, R. (1998). "Dyslexia subtypes: Genetic, behavior, and brain imaging", in Plum, F. (ed.), *Language, communication and the brain*, pp. 39-58. New York: Raven Press.

auditory activity, such as the perisylvian region in the left hemisphere, observing reduced activity in areas usually involved with visual processing, more posterior areas of the cerebral cortex.

However, studies are still under way and results are not homogeneous: causes, mechanisms and anatomical correlations are still not entirely clear, and researchers need to keep working to understand what lies behind developmental dyslexia and give all the answers needed.

1.2.2.7 Text Comprehension in Dyslexia

Competent readers learn how to manage the various components of the reading process simultaneously and fluently, but if any of these components is inadequate, comprehension can be impeded (Knoepe & Richter, 2018; Friedmann & Coltheart, 2016). Researchers have analyzed text comprehension in dyslexic readers to answer questions regarding which component could be damaged and could affect the understanding of a complex written text.

In order to explain poor comprehension rates in dyslexic readers, many studies have focused on analyzing the stage in which words are decoded and meanings are retrieved. For example, Gough and colleagues hypothesized what is called the *Simple View of Reading* (SVR, Gough and Tunmer, 1986[52]; Hoover and Gough, 1990[53], both in Knoepe & Richter, 2018). This model assumes that visual word recognition has the principal role in the comprehension of written language, and if this process is in some ways deficient, it causes reading difficulties which also affect text comprehension. Another hypothesis concerning the sources for text comprehension difficulties in dyslexic readers is the one elaborated by Perfetti in 1985 (*Verbal efficiency hypothesis* - Perfetti, 1985[54] in Knoepe & Richter, 2018). Word recognition is also at the center of this hypothesis, which states that an efficient word recognition process saves time and

[52] Gough, P. B. & Tunmer, W. E. (1986). "Decoding, reading, and reading disability", *Remedial and Special Education*, volume 7, n° 1, pp. 6-10.
[53] Hoover, W. A. & Gough, P. B. (1990). "The simple view of reading", *Reading and Writing: An Interdisciplinary Journal*, volume 2, n° 2, pp. 127-160.
[54] Perfetti, C. A. (1985). "Reading ability". New York: Oxford University Press.

energies to be employed in more complex subprocesses, like at the sentence level. On the other hand, many other researchers (e.g., Stanovich & Siegel, 1994[55]; Snowling, 1980[56]; Griffiths & Snowling, 2001[57]; Ramus *et al*., 2013[58]; Dickie *et al*., 2013[59] all in Knoepe & Richter, 2018) hypothesized that a deficit in phonological recoding will affect the development of the reading process of all languages (independently from the types of orthography), from single words to – ultimately – text comprehension. Also linked to deficits at word level, some researchers observed how difficulties in word retrieval would affect rates in text comprehension (e.g., Richter *et al*., 2013; Perfetti and Hart, 2001[60], 2002[61] in Knoepe & Richter, 2018). It is widely known that knowledge of vocabulary is essential when it comes to text comprehension; the fact that certain individuals can have difficulties in accessing and retrieving the meaning of words leads to hypothesize negative effects in understanding texts (Knoepe & Richter, 2018).

Other researchers link text comprehension difficulties to deficits at working memory level. Simmons and Singleton (2000) used a long and complex text to observe which was the cause behind text comprehension failure in dyslexic readers. They asserted that information included in a short text could be easily remembered by all individuals after one reading session. On the other hand, longer passages of text would lead individuals to employ many more resources to manage the information contained in these passages. In front of longer texts, readers need to implement metacognitive strategies and to employ more cognitive resources (in terms of working memory) to supervise text comprehension. With their study, Simmons and Singleton concluded that dyslexic participants at their research did not display a direct relationship between deficits at single word decoding and text comprehension (since comprehension rates of

[55] Stanovich, K. E. & Siegel, L. S. (1994). "Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model", *Journal of Educational Psychology,* volume 86, n° 1, pp. 24-53.

[56] Snowling, M. J. (1980). "The development of grapheme-phoneme correspondence in normal and dyslexic readers", *Journal of Experimental Child Psychology,* volume 29, n° 2, pp. 294-305.

[57] Griffiths, Y. M. & Snowling, M. J. (2001). "Auditory word identification and phonological skills in dyslexic and average readers", *Applied Psycholinguistics,* volume 22, n° 3, pp. 419-439.

[58] Ramus, F., Marshall, C. R., Rosen, S. & van der Lely, H. K. J. (2013). "Phonological deficits in specific language impairment and developmental dyslexia: towards a multidimensional model", *Brain,* volume 136, n° 2, pp. 630-645.

[59] Dickie, C., Mitsuhiko, O. & Clark, A. (2013). Revisiting the phonological deficit in dyslexia: Are implicit nonorthographic representations impaired? *Applied Psycholinguistics,* volume 34, n° 4, pp. 649–672.

[60] Perfetti, C. A. & Hart, L. (2001). "The lexical bases of comprehension skill", in Gorfien, D. S. (ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity*, pp. 67-86. Washington, DC: American Psychological Association.

[61] Perfetti, C. A. & Hart, L. (2002). "The lexical quality hypothesis", in Vehoeven, L., Elbro, C. & Reitsma, P. (ed.), *Precursors of functional literacy*, pp. 189-213. Amsterdam: John Benjamins.

answers related to literal questions were high, implying that dyslexic readers could successfully decode words), but rather their difficulties were related to their problems in keeping in the working memory all the relevant information of the text to build inferences and maintaining comprehension (Simmons & Singleton, 2000).

1.3 Eye Movement Patterns in Reading

Reading *feels* like decoding a linear string of letters and words, but reality is far more complex than this. Instead, reading consists of rapid forward movements, jumps and pauses of the eyes, ultimately reconstructing the meaning of a text in a cohesive way, word after word, sentence after sentence (Rayner *et al*., 2006). All those movements have specific names and characteristics and are they essential when it comes to absorb new information from a text. Discoveries in this field of research are linked to the use of scientific tools such as the eye trackers: these instruments have revealed that eye movement patterns in reading are extremely complex, and many models have been designed to explain how the whole reading process works. Eye movement recording currently represents the best method to identify and explain the mechanisms behind word recognition and cognitive processes during reading (Sereno & Rayner, 2003; Rayner, 1998).

The following paragraphs aim at introducing very basic notions linked to eye movements in reading, describing the differences detected in neurotypical and dyslexic readers, and to establish an initial theoretical base for future research on the understanding of how *eye-hopping* modifies the ocular pattern of neurotypical and dyslexic readers.

1.3.1 Basic Characteristics of Eye Movements

1.3.1.1 The human eye and the structure of retina

The human eyes are complex organs that play a fundamental role when it comes to the elaboration of stimuli collected from the environments that surround us, and this includes also reading. The primary function of eyes in reading is to capture the visual input of the written material.

Taking in consideration *Figure 6*, the human eyeball can be divided into two parts. On the anterior part, the *pupil* is an aperture surrounded by the *iris* which regulates the entering of the light. These two organs are covered by the *cornea*, which acts up as an interface between the external environment and the more interior organs. Behind these three organs, the *crystalline lens* is a flexible organ that focuses more or less distant visual stimuli by changing in curvature. In a more posterior part of the eyeball, the vitreous and aqueous humor contribute in maintaining the right amount of pressure and dioptric apparatus (concerning the refraction of the light) the eyeball. All these organs are actively part of the creation a visual stimulus on the *retina*, a very sensible tissue in the interior part of the eyeball on which the captured image is formed in the inverted way (Irsch & Guyton, 2009).

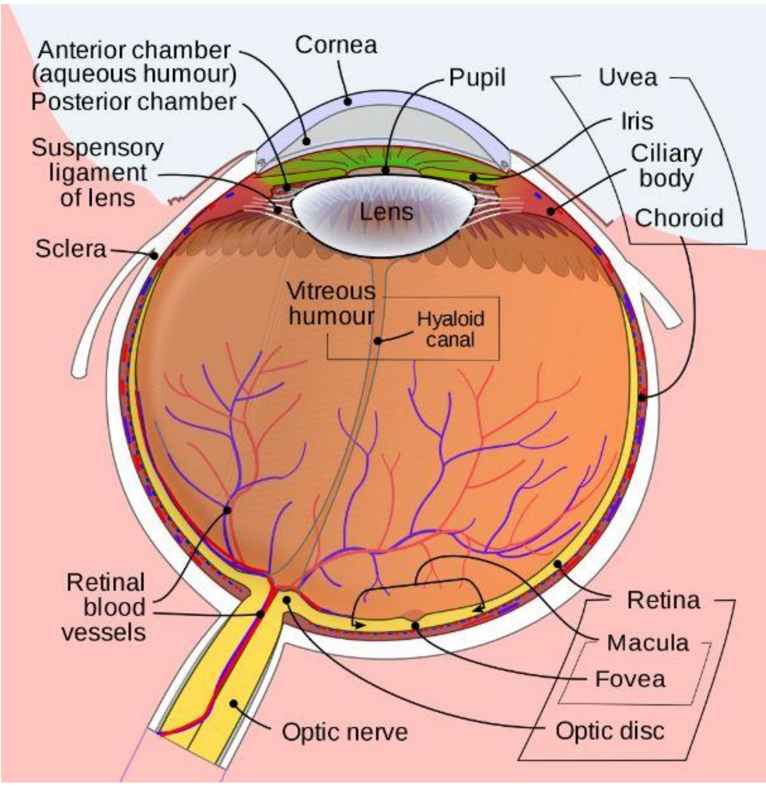


Figure 6. Horizontal section of the human eye and description of its components (source: Wikipedia, "Human Eye"; < https://en.wikipedia.org/wiki/Human_eye >).

The retina can be divided into two parts, the optic disc and the *fovea*. The optic disc is posited in a peripheral zone compared to the fovea, near the optic nerve, and it is the region of vision in which blind spots can be detected (Irsch & Guyton, 2009). The retina can be divided into three regions, which are characterized by different degrees of acuity and focus: Figure 3 shows the three main regions of retina in which visual inputs can be detected and analyzed. This division principally exists due to the conformation of the human eye: a small depressed area of the central region of the retina (the *macula*) near the optic nerve – the *fovea* - contains a high number of photoreceptor cells (the *cones*) that constitutes only 2 degrees of the human visual field. The fact that this is a very small area implicates that there are some limitations in visual acuity and focusing – in this case - on a specific word. In other words, an individual engaged in reading a string of words can read clearly what is posited in the portion of space of 2 degrees around the center of vision, that is the *foveal region*[62].

Outside this very small space there are other two regions called respectively *parafoveal* region – which expands from the center of vision in the fovea to 5 degrees on either side, with less acuity in respect to the fovea due to the minor density of photoreceptors – and the *peripheral* region – which is all the space beyond the parafoveal region, and it is characterized by a very poor acuity of vision (Rayner, 2009b, 1998; see *Figure 7*).

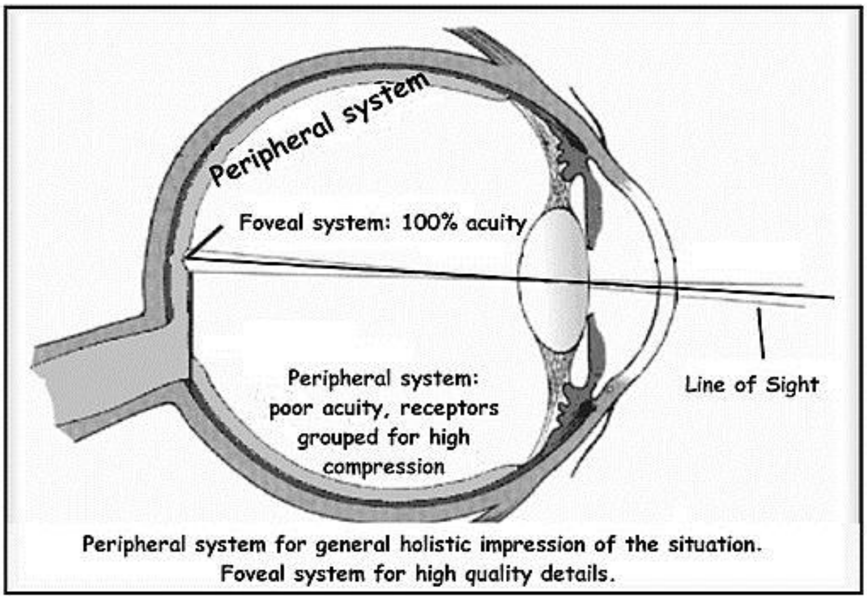


Figure 7. Description of the peripheral system and difference between foveal and peripheral system for what concerns quality of vision (by Hans-Werner34 at English Wikipedia, CC BY 3.0, < https://commons.wikimedia.org/w/index.php?curid=23332395 >).

[62] Source: <http://alumni.media.mit.edu/~faaborg/research/cornell/cg_fovealvision_site/site/background.htm >.

So, if individuals want to read any word, sentence or text, they need to move the eyes in a way in which its center of vision - the fovea - is always posited in that part of the stimulus they want to see clearly. What happens to more skilled readers (in this case referring to readers who have automatized the reading process) is that they do not notice that what is contained outside the foveal region is “blurred” (*Figure 8*). This happen because the muscles governing the eyes regulate the quick movements that shift foveal vision to the area that needs to be put on focus[63].

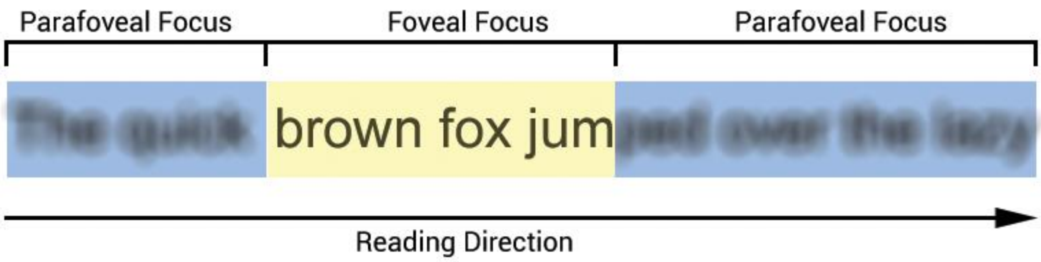


Figure 8. Difference between foveal and parafoveal focus for what concerns quality of vision (source: < https://www.spritz.com/why-spritz-works-its-all-about-the-alignment-of-words >).

1.3.1.2 Fixations

During reading, there is not a smooth and unified movement of the eyes. Sequences in which the eyes are fixed on a certain chunk of a word alternate to sequences in which the eyes move across the elements of a string. Since the ‘stops’ last an average of 250 msec while the ‘movements’ are very quick (between 10 and 20 msec), the eyes spend most of their time in the reading process almost motionless (Warren, 2013). Concerning this ‘motionless’ status, many studies on eye movements (e.g., Rayner *et al*, 1981[64]; Wolverton & Zola, 1983[65] in Rayner, 1998) have inspected

[63] Source: < http://alumni.media.mit.edu/~faaborg/research/cornell/cg_fovealvision_site/site/background.htm >.

[64] Rayner, K. Inhoff, A. W., Morrison, R., Slowiaczek, M. L. & Bertera, J. H. (1981). “Masking of foveal and parafoveal vision during eye fixations in reading”, *Journal of Experimental Psychology: Human Perception and Performance,* volume 7, pp. 167-179.

the role of *fixations*. Through the use of the masking technique (or "moving-window", which consists in obfuscating strings of words or sentences inside a text by using rows of *X*s or random letters; Rayner, 2009b), it was discovered that fixations are moments in which the eyes – specifically, the foveal region of retina - are pretty much still and focus on a small portion of the text (even if micro movements can be detected – Rayner, 2009b) for a very short period of time. Generally, fixations last 225-250 *ms*, but this time span can vary, from 50 *ms* to 500-600 *ms*, due to factors such as individual skills of readers, difficulty of the text and many linguistic variables including word length, word predictability and phonological properties of the fixated words, along with specific characteristics of the writing system in which the text was composed (Rayner, 2009b, 1998).

The role of fixations in eye movements is to acquire new information, specifically to collect visual inputs to be elaborated: this means that fixations on certain words start a process leading to their identification. However, this process does not begin with the fixation itself: while the reader is still processing a determined word in a sentence or text, s/he starts to process another word that is posited in the right portion of the point s/he is fixating. In other words, the real beginning of the process of word identification begins as a sort of preliminary processing when a word (or at least, some of its letters) appears in the parafoveal region, where it is processed as a whole at a low-level by the reader (e.g., Warren, 2013; Rayner, 1975[66] in Ashby *et al*., 2012; Sereno & Rayner, 2003; Rayner, 1998). This process influences the speed of the whole procedure, saving time for the later steps of the word processing and optimizing the whole reading process, contributing by making it more fluid due to the fact that it allows the reader to have a general idea of what is coming in the next stretch of text at the right of the fixation point and, based upon certain characteristics of a word, of where the next fixation will land (*preview effect* or *benefit effect*; Warren, 2013; Rayner, 2009, 2009b). This first step leads then to the process which involves the actual fixation. This second step consists in bringing the foveal region on a certain number of letters of a word, leading the brain to recognize it and to process its meaning. Fixation time can vary in relation to the characteristics of the words: for example, words that are short in length,

[65] Wolverton, G. S. & Zola, D. (1983). "The temporal characteristics of visual information extraction during reading", in Rayner, K. (Ed.), *Eye movements in reading: Perceptual and language processes* (pp. 41-52). New York: Academic Press.

[66] Rayner, K. (1975). "The perceptual span and peripheral cues in reading", *Cognitive Psychology*, volume 7, pp. 65-81.

regular in their spelling-sound pattern, frequent in their occurrence, or semantically or syntactically predictable from a previous context are fixated for less time than those that are not (Sereno & Rayner, 2003; Ashby *et al*., 2012). Moreover, thanks to the characteristics of the words (such as length or letters features), a reader can detect in the most efficient way which will be the next fixation in the reading process (Warren, 2013).

Since the foveal region is a very small portion of the retina and it possesses a restricted capacity (*Figure 9*), how much information can be absorbed, processed and used during a single fixation? Scholars have discovered the existence of the *perceptual span* (Bellocchi *et al*., 2013; Rayner, 1998, 2009b), that is the portion of a string of letters from which it can be acquired useful information, which quantity and what type of information the eyes can acquire when they are focusing on that particular point of a sentence.

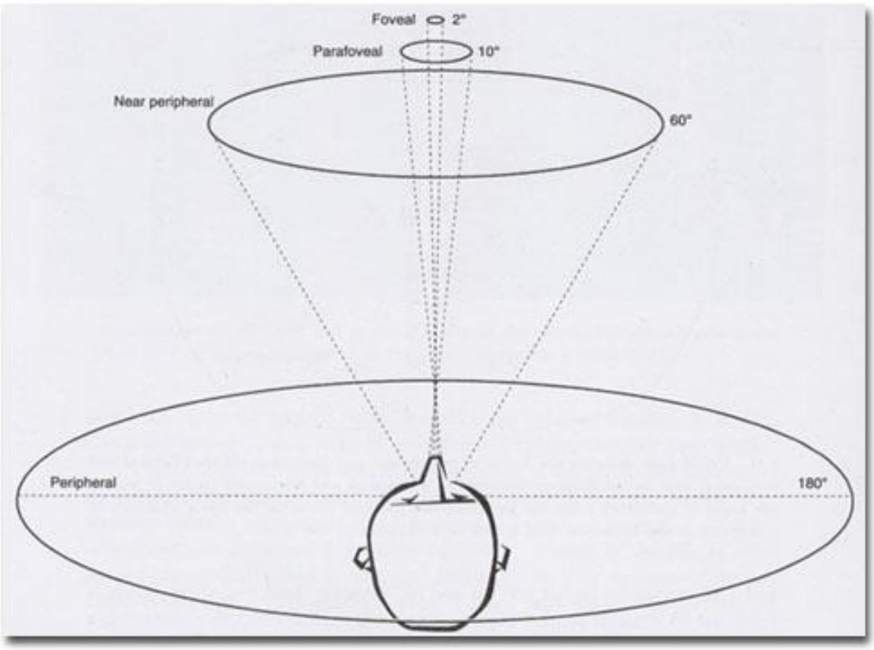


Figure 9. Scheme of foveal, parafoveal and peripheral regions of vision and corresponding degrees (source: <http://alumni.media.mit.edu/~faaborg/research/cornell/cg_fovealvision_site/site/background.htm>).

Using the experimental paradigm of the “moving-window”, it has been discovered the quantity of information a fixation can obtain: for example, “skilled readers of English obtain useful information from an asymmetric region extending roughly 3 or 4 character spaces to the left of fixation to about 14 or 15 character spaces to the right of fixation” (Rayner, 2009b; page 1462). This region can vary in size and asymmetry also on the basis of the readers’ skills (skilled readers present a larger perceptual span compared to their less skilled, beginning and dyslexic peers – with 12 character spaces to the right of the point of the fixation in opposition to 14 or 15 of skilled readers) and of the characteristics of the writing systems of the different languages (Rayner, 1998, 1986[67]). A widely shared characteristic of the perceptual span is the type of information that can be acquired. Readers first detect the visual stimuli posited in the fovea or immediately beside to it, but also, another type of information is acquired. This is a less accurate type of information, which concerns features of words posited in the parafoveal region such as length or shape (Bellocchi *et al*., 2013). Moreover, thanks to the discovery of the perceptual span, it has been hypothesized that attention – along with processing constraints - is a determinant factor when it comes to quantify the information that can be obtained through a single fixation (Rayner, 1986 in Rayner, 2009b), modulating the size of the perceptual span (Rayner, 1998).

1.3.1.3 Saccades

The movements of the eyes, which take place between fixations, are called *saccades*. These rapid movements – 500° per second – have the primary function to bring certain parts of the text an individual is reading into focus of the foveal region to analyze them in detail (e.g., Rayner & Bertera, 1979[68] in Rayner, 1998). It takes some time to plan this movements: it has been detected a latency period in which these movements are planned before being executed. In other words, time is required to compile the necessary steps that lead from a fixation to one another, encoding the

[67] Rayner, K. (1986). “Eye movements and the perceptual span in the beginning and skilled readers”, *Journal of Experimental Child Psychology*, volume 41, pp. 211-236.

[68] Rayner, K. & Bertera, J. H. (1979). “Reading without a fovea”, *Science*, volume 206, pp. 468-469.

following landing position of a fixation and the various movements. The period of latency corresponds approximately to 150-200 msec and it has been hypothesized that this programming happens at the same time of the comprehension processes during reading (Rayner, 1998). Like fixations, saccades possess various dimensions: length can vary on the basis of the characteristics of a language and of its writing system: for English – which is characterized by an alphabetic writing system – it has been calculated in 7-9 letter spaces. However, this length can be variable due to various reasons (e.g., text complexity), oscillating between 1 and 15-20 letter spaces (Rayner, 2009b; Warren, 2013). Due to high speed, it is impossible to obtain new information during saccades: vision is not stable and what a reader perceive is just a blur of the visual stimulus (Uttal & Smith, 1968[69] in Rayner, 1998).

Fixations and saccades are linked to one another, and inevitably, are dependent to one another. The duration of fixations determines when the following movement will be made, and saccades determine where the reader will land the next fixation in the text. Just like fixations, it seems like also saccades are related to attention and regions of vision. Researchers are hypothesizing that saccades are being generated after certain characteristics of a word or letters have captured the visuo-spatial attention of the reader. In this sense, the eyes need to have already found their next landing position for fixation, they need to have already found information to elaborate to plan and execute the movement. When readers find the next point on which they will allocate their attention, they program and execute the movement, that is the saccade, to start all over again until the string or text have come to an end (Bellocchi *et al*., 2013).

1.3.1.4 Regressions

Eye movements are not characterized only by a forward motion. There are also moments in which readers need to stop and go backwards to read again a passage of text already analyzed: these phenomena are called *regressions*, micro saccades characterized by a backward movement directed onto the last fixated word or more distant words.

[69] Uttal, W. R. & Smith, P. (1968). "Recognition of alphabetic characters during voluntary eye movements", *Perception & Psychophysics*, volume 3, pp. 257-264.

Regressions are common movements that can be found within skilled readers, 10-15% of the time while reading a text, with this percentage that can vary on the basis of the difficulty of the text, of the writing system features, and of single readers' characteristics (Rayner, 2009b, 1998; Sereno & Rayner, 2003). Most of the times, regressions are caused by comprehension failures or *oculomotor errors* (caused by problems in the elaboration of a previously fixated visual stimulus) (Rayner, 1998). Usually, regressions take place after a longer saccade, confirming the fact that longer movements of the eyes are less accurate and can lead to choose a wrong point for the next fixation (Vitu, McConkie & Zola, 1998[70] in Rayner, 1998).

1.3.2 The Control of Eye Movements in Reading

1.3.2.1 Models of Eye Movements Control

Researchers have developed many models to explain how eye movements in reading work. Two categories of models exist: oculomotor models and processing models. *Oculomotor* models (such as *minimal control* – Suppes, 1990[71], 1994[72] in Reichle *et al*., 2002 - and *strategy tactics* - O' Regan, 1990[73] in Rayner, 1998) hypothesize that eye movements are principally coordinated more by the properties and characteristics of the visual and oculomotor systems, while linguistic processing is secondary to the organization of movements (Reichle *et al*., 2002). On the other hand, *processing* models claim that eye movements are principally programmed on the basis

[70] Vitu, E., McConkie, G. W. & Zola, D. (1998). "About regressive saccades in reading and their relation to word identification", in G. Underwood (Ed.), *Eye guidance in reading and scene perception* (pp. 101-124). Oxford, England: Elsevier.
[71] Suppes, P. (1990). "Eye movement models for arithmetic and reading performance" in Kowler, E. (ed.), *Eye movements and their role in visual and cognitive processes.* Elsevier.
[72] Suppes, P. (1994). "Stochastic models of reading", in Ygge, J. & Lennerstrand, G. (ed.), *Eye movements in reading*. Pergamon Press.
[73] O'Regan, J. K. (1990). "Eye movements and reading", in Kowler, E. (Ed.), *Eye movements and their role in visual and cognitive processes,* pp. 395-453. Amsterdam: Elsevier.

of lexical and comprehension processes (Morrison, 1984[74] in Rayner, 1998). Among others (such as the SWIFT model – Engbert *et al*., 2002[75] in Rayner, 2009b), the E-Z Reader Model (Reichle *et al*., 1998 in Rayner, 2009b; Rayner *et al*., 2006; Rayner, 1998) is a serial attention shift model that can be accounted as the most accepted model due to the fact that it explains that eye movements are planned and guided by the "serial lexical processing of words" (Rayner, 2009b; Rayner *et al*., 2006; Reichle *et al*., 2002), describing efficiently both global and local mechanisms behind eye movements in reading and well integrating with the dual-route model (Hawelka *et al*., 2010).

In *Figure 10* we can observe that the first stage in the model consists in the absorption of the visual features of the fixated word, which are then sent to the visual cortex for the identification. After a pre-attentive early processing of the visual features (which is important for saccadic programming and the following more accurate analysis), word identification comes into play when the reader bring the focus of attention (referring to "the process of integrating features that allows individual words to be identified" and not to spatial attention – Reichle *et al*., 2002; page 452) on the lexical item, determining if this word will be fixated or skipped by analyzing its boundaries (Rayner, 2009). The word identification system is made up of two lexical stages, where the first one is the orthographic analysis of the word (L_1), and the second is linked to the phonological and semantic recognition of the word, the stage in which lexical access is activated (L_2). After these two stages have completed their task, attention shifts on word +1 through a saccade, starting again the process of word recognition. The serial "word +1" mechanism can be exceeded in certain cases, such as in front of words with high predictability or frequency, which determines a re-program in the saccadic movement (Rayner, 2009). In this sense, the E-Z Reader model has its basis on lexical processing.

[74] Morrison, R. E. (1984). "Manipulation of stimulus onset delay in reading: Evidence for parallel programming of saccades", *Journal of Experimental Psychology: Human Perception and Performance,* volume 10, pp. 667-682.
[75] Engbert, R., Longtin, A. & Kliegl, R. (March 2002). "A dynamical model of saccade generation in reading based on spatially distributed lexical processing", *Vision Research*, volume 42, n° 5, pp. 621-636.

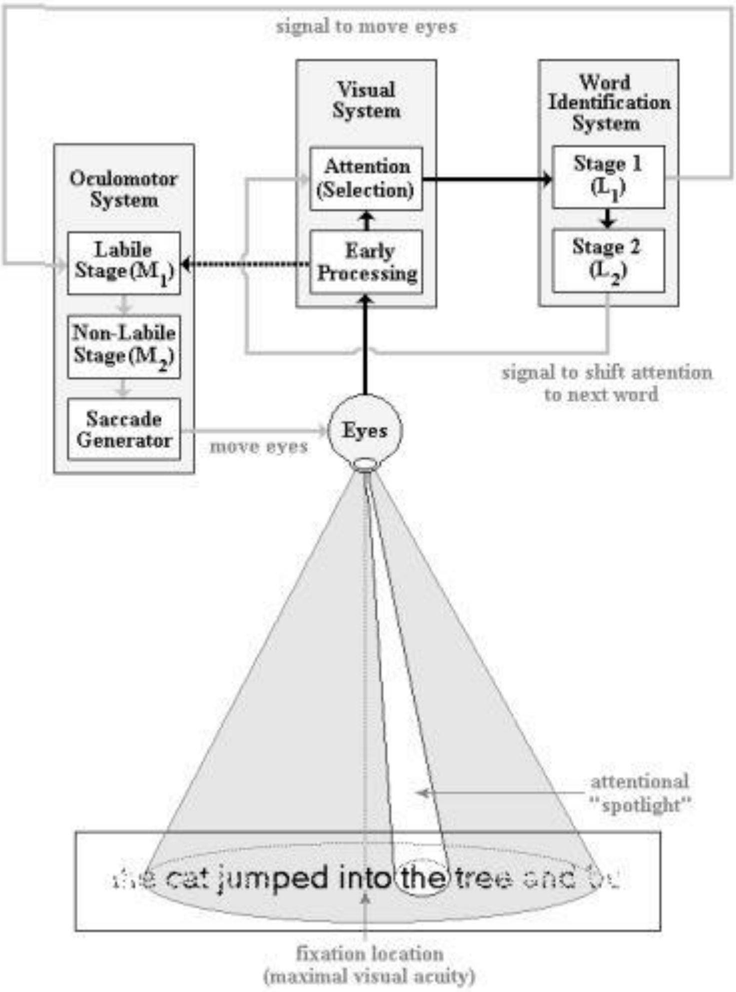


Figure 10. A schematic description of the *E-Z Reader Model 7* (Reichle *et al*., 2002; page 451). It is evident that lexical processing is the drive for eye movements.

By observing the stages found in the oculomotor system, from the scheme in *Figure 10* we can see there are two steps which precede the actual saccadic movement: M_1 (*Labile Stage*) and M_2 (*Non-Labile Stage*). During M_1, the system which regulates eye movements undergoes a general preparation and the length of the saccade from the last fixation point to the next is found. Finally, the information gathered in the M_1 stage is sent to the motor system which executes the saccadic movement during the M_2 stage.

1.3.2.2 When and Where Do the Eyes Move?

Considering languages with shallow orthographies such as Italian, we have already discussed about the moment in which the eyes move: many scholars (e.g., Rayner, Liversedge, White & Vergilino-Perez, 2003) agree that cognitive processes have a strong influence on the moment in which the eyes move.

Concerning instead what guides the eyes in the next positions for the fixations, researchers have discovered that the landing position in the words is guided by a series of factors, such as lexical effects such as the frequency and the predictability of such word, but many of them tied with the lexical properties and the characteristics of the fixated word (Rayner, 1998), which also influence the fixation time. In these languages, saccades are influenced mostly by the length of the fixated word and the elements to its right (e.g., Inhoff, Radach, Eiter & Juhasz, 2003[76] in Rayner, 2009b; Rayner, 1998), spaces included, as a study made by Morris, Rayner & Pollatsek, 1990[77] (in Rayner, 2009b) underlined. Spaces are extremely important when it comes to delineating the length of the words, and with the help of parafoveal vision saccades and landing positions are programmed. In fact, the previously cited study indicated this aspect by administering texts without spaces, which resulted in a general decrease in reading speed of about 30-50%. For what concerns the landing positions, it has been demonstrated that the reader tends to try positioning the eyes in the middle or at the beginning of a word: this position is usually indicated as the *preferred viewing location* (PVL), but usually it results in the fact that the eyes land in a different position compared to the center of a word (McConkie *et al*., 1988[78]; Rayner, 1979 in Rayner *et al*., 2009b). PVL can vary depending from which was the previous launch site, creating a chain of dependencies between previous launch site and following landing site, but it also depends on the word length effect, which brings the eyes to fixate the same word into two different sites, at the beginning and at the end (Rayner, 1998). PVL is also in contrast with what is called the *optimal viewing position* (OVP), which is the point of

---

[76] Inhoff, A. W., Radach, R., Eiter, B. M., & Juhasz, B. (2003). "Distinct subsystems for the parafoveal processing of spatial and linguistic information during eye fixations in reading", *Quarterly Journal of Experimental Psychology*, volume 56A, pp. 803–828.

[77] Morris, R. K., Rayner, K., & Pollatsek, A. (1990). "Eye movement guidance in reading: The role of parafoveal letter and space information. *Journal of Experimental Psychology: Human Perception and Performance*, volume 16, pp. 268–281.

[78] McConkie, G. W., Kerr, P. W., Reddix, M. D., & Zola, D. (1988). "Eye movement control during reading: I. The location of initial fixations in words", *Vision Research*, volume 28, pp. 1107–1118.

the word where recognition time is at the lowest, and recognition is faster (Rayner, 2009b).

1.3.3 Eye Movements in Dyslexic Readers

We have already observed how the progress made in the process of automatization of reading is observable by analyzing eye movement patterns. Children perfect their visual skills with time while - since the very first steps - they make practice to master the reading process (Bellocchi *et al*., 2013). It has been observed that children undergo a change in the eye movements through the school years, following the continuous reading exercise. In first grade, children display longer fixations (that can last up to 350 msec), which can be more than one if they are about to read a longer word, short saccades and a higher rate in regressions (30%). On the other hand, at the end of primary school (fourth – fifth grade), children read text suited for their age showing fixations that last less time in comparison to what was observed in first grade, the number of saccades has stabilized (Rayner *et al*., 2006), while the rate of regressions continues diminishing until adolescence, reaching a rate of occurrence of 10-15% (Rayner, 2009b).

Like children and less skilled readers, dyslexic readers' eye movements are characterized by longer fixations, shorter saccades and a higher rate of regressions in comparison to more skilled neurotypical readers (Bellocchi *et al*., 2013; Ashby, Rayner & Clifton, 2005[79] in Rayner, 2009b; De Luca *et al*., 2002; Rayner *et al*., 2006; Rayner, 1998). This eye movement pattern (especially referring to long fixations) is ascribable to the inefficiency of the whole-word recognition subprocess typical of the lexical route (Hawelka *et al*., 2010). This fragmented pattern in eye movements not only slow the reading process, also highlighting the difficulties of dyslexic readers in decoding and automatization, but it also affects text comprehension, overloading the working memory

[79] Ashby, J., Rayner, K. & Clifton, C. (2005). "Eye movements of highly skilled and average readers: Differential effects of frequency and predictability", *Quarterly Journal of Experimental Psychology*, volume 58A, pp. 1065-1086.

and impeding the construction of network of inferences within the information inside the text (Rayner, 1998).

Focusing on Italian, the study conducted by Zoccolotti and colleagues in 1999 on dyslexic readers underlined how their eye movement patterns were extremely different from the one displayed by neurotypical readers. They were characterized by very short saccades and long fixations (20% longer in comparison to neurotypical readers – Judica *et al*., 2002), suggesting that they were proceeding grapheme after grapheme, using the sublexical route (Zoccolotti *et al*., 1999). In the same year, De Luca and colleagues conducted a study which aimed at describing eye movement patterns in Italian dyslexic readers administering both linguistic and non-linguistic tasks. Results highlighted the presence of the reading speed deficit typical of Italian dyslexic readers, along with a high number of fixations. While dyslexic readers tended at fixating most of the words present in the administered text (even the short ones) for more time, neurotypical readers displayed a more strategic and quicker approach to text by scanning it through short fixations. The dyslexic readers' eye movements behavior supported the hypothesis of a deficit at the level of lexical route; moreover, the use of the non-linguistic task confirmed that behind dyslexic readers' difficulties there were not deficits at the oculomotor system, since fixations were steadier, and saccades were more regular and comparable to the pattern displayed by neurotypical readers (De Luca *et al*., 1999). De Luca and colleagues confirmed their previous findings in another study conducted in 2002, this time using a linguistic task in which dyslexic readers needed to read words and pseudowords (De Luca *et al*., 2002).

Still concerning the eye movement patterns in more transparent languages, discrepancies can be found in languages such as Italian and German, analyzing for example the nature of Italian and German syllables (e.g., Hyönä & Olson, 1995[80]; Lefton, Nagle, Johnson & Fisher, 1979[81] all in Hutzler & Wimmer, 2004; Rayner, 1998). The fragmented and slow pattern of reading is also evident in dyslexic readers native speakers of German (Hawelka *et al*., 2010; Hutzler & Wimmer, 2004). However, comparing data collected from German dyslexic readers with data from English and Italian studies, Hutzler and Wimmer in 2004 observed that participants at their study

[80] Hyönä, J. & Olson, R. K. (1995). "Eye fixation patterns among dyslexic and normal readers: Effects of word length and word frequency", *Journal of Experimental Psychology: Learning, Memory and Cognition*, volume 21, n° 6, pp. 1430-1440.
[81] Lefton, L. A., Nagle, R. J., Johnson, G. & Fisher, D. F. (1979). "Eye movement dynamics of good and poor readers: Then and now", *Journal of Reading Behavior*, volume 11, n° 4, pp. 319-328.

showed a pattern in eye movements in general similar to the one of Italian dyslexic readers - with a high number of fixations and a generally small number and size of regressions -, but also, some dissimilarities between German and Italian dyslexic readers were noticed. In this sense, data collected by Hutzler and Wimmer supported the hypothesis of a deficit at the level of the lexical route even for German dyslexic readers. Instead, the discrepancies in the duration of fixations reported between German and Italian dyslexic readers could be ascribable to the linguistic differences, especially for what concerns the nature of syllables and their assembly. German, in fact, presents more complex and numerous consonant clusters in comparison to Italian, making more arduous the already deficient reading process (Hutzler & Wimmer, 2004). Hawelka and colleagues (2010) found very similar results in their data collected from a group of German dyslexic readers, with longer and more numerous fixations (extended gaze duration), a strong effect of word length and wider saccades. Moreover, researchers hypothesized three possible *loci* in the dual-route reading model from which the reading speed problem originated, that is at the early visual analysis level (in which the features of the single graphemes are examined), at the orthographic or phonological input levels or at a visuo-attentional level in the processing of letters (Hawelka *et al*., 2010).

Many researchers hypothesized that the cause of the different eye movement patterns in dyslexic readers could be ascribable to a deficit localized in the magnocellular pathway (or dorsal visual stream), which is responsible for the automatic orientation of attention and the control of eye movements (Bellocchi *et al*., 2013; Facoetti *et al*., 2000). For a reason not yet identified, some researchers believe that dyslexic readers did not develop an automatic shifting from distributed attention to a more focused attention. The development of this shifting is an essential step in the acquisition of the lexical route in children (Facoetti *et al*., 2000). In this sense, the lexical route would consist in "the ability to build a sublexical representation automatically" (Bellocchi *et al*., 2013; page 454), which finds its basis in the graphemic selection typical of the sublexical route. Moreover, in this process of automatization, readers need to learn how to dose the quantity and the quality of all the elements that need to be processed around the one that is being fixated. It could be also concluded that dyslexic readers could find difficult in managing the foveal and parafoveal processes that intervene in reading, supporting the hypothesis of a visuo-attentional deficit

(Ducrot & Grainger, 2007[82] in Bellocchi *et al*., 2013). In fact, researchers agree on the fact that dyslexic readers are found more sensible at the letter crowding effect in comparison to neurotypical readers. This means that these readers are not able to properly position their focused attention in space, increasing the crowding effect. On the other hand, researchers also observed that increasing the space between letters and words in sentences and texts reduces the crowding effect, improving the quality of reading in dyslexic individuals (Bellocchi *et al*., 2003). In support of these hypotheses there are reports (such as blurred lines or inversion of letters) described by dyslexic readers and errors committed while reading, all collected in the literature (for a review, see Boden & Giaschi, 2007[83] in Bellocchi *et al*., 2013). For example, Facoetti and his group (2000) observed that dyslexic readers displayed the typical eye movement patterns described earlier. Moreover, they discovered that the attention shift towards elements presented in the parafoveal portion of vision of dyslexic readers was not as automatic as the one observed in neurotypical readers. Elaborating the collected data, authors concluded that the deficit behind the failed automatization of attention shifting could be related or to the impairment of two operations - namely the process of stimuli in the parafoveal region - or the low speed in the shift of attention. In any case, the deficit of the attention process has effects on the programming of eye movements, especially saccades, which - in fact – result being deficient in dyslexic children (Facoetti *et al*., 2000).

[82] Ducrot, S. & Grainger, J. (2007). "Deployment of spatial attention to words in central and peripheral vision", *Perception & Psychophysics*, volume 69, n° 4, pp. 578-590.
[83] Boden, C. & Giaschi, D. (2007). "M-stream deficits and reading-related visual processes in developmental dyslexia", *Psychological Bulletin*, volume 133, n° 2, pp. 346-366.

CHAPTER TWO: Theoretical Basis of the SuperReading™ Course

2.0 Introduction

Chapter Two will discuss the structure of SuperReading™ and the existent literature on the research conducted up until now, both in England and Italy.

The first part will focus on a global description of the course, from the organization of the weekly meetings to the administration of the comprehension tests to monitor the changes in the participants' reading process. From a global analysis, the chapter will dive into an overview of the single components, namely metacognition and emotionality, dealing also with a brief description of the main exercise of the course, that is, the Eye-Hop™. Both metacognition and emotionality will be discussed closely by looking at neurotypical individuals and dyslexic individuals to compare the two populations and reflect upon their differences in terms of performances.

The second part of this chapter will explain the important roles that the *coach* and the support between participants have in the economy of the whole course and it will be closed by a brief *excursus* on existent research, posing ground for the analysis conducted in Chapter Three.

2.1 What is SuperReading™?

SuperReading™ is a course designed by Ron Cole in the US that aims at increasing speed in silent reading without undermining comprehension, but rather improving it. Originally, this course was ideated during the 1990s by Ron Cole to fulfill the requests from his clients who worked mainly in the offices of companies located in Silicon Valley, California. The principal need was to optimize the time dedicated to reading during working hours: for this reason, Cole arranged an innovative course, different from common speed reading courses. Cole designed SuperReading™ to include what speed reading courses lacked, since they optimized only the speed with which individuals read a text. This original course included the teaching of metacognitive strategies for reinforce text comprehension and a particular exercise, called *eye-hopping*, that helped to increase reading speed (Scagnelli *et al.*, 2018). Soon, Cole became aware of the massive advancements especially made by dyslexic readers, whose overall improvement was greater than the one made by neurotypical readers. The improvement consisted in a significant reduction of time spent on reading a text and a general improvement in reading comprehension (which goes under the term *Reading Effectiveness*; it is measured by multiplying words per minute – reading speed – and percentage of correct answers) (Cooper, 2009, 2012). The observation of this significant improvement in both non-dyslexic readers and dyslexic readers in the courses held in the US encouraged Ron Cole to start a collaboration with universities in England (London South Bank University - LLU+) and in Italy (International University of Languages and Media - IULM, Milan) in order to begin new experimentations and verify if even in British and Italian participants could be found an improvement in *Reading Effectiveness* in the ten weeks of the course equal to the one observed in the American participants.

Generally, the course is organized into 6 meetings of three hours each, which are held in a span of ten weeks. The course pays specific attention to three main components:

1. Metacognition applied to text comprehension;
2. The emotional sphere that comes into play within the reading process;

3. The *Eye-Hop*™ exercise (Cooper, 2009).

All these components are equally trained during the meetings by learning and practicing peculiar strategies to improve globally *Reading Effectiveness*.

The course works on strengthening on a general level silent reading and text comprehension. This choice was made by Cole since silent reading is the most common mode of more skilled readers, while reading aloud is usually used during the first steps of the learning process of this ability. Moreover, silent reading is a faster mode of reading in light to the fact that there is no aloud vocalization of the material an individual is reading, saving time and energies used in programming and executing movements for speech production (Kim *et al*., 2011). The course contains many reading strategies and memorization techniques that facilitate the storing up and retrieval of information. Specifically, strategies are taught to build a solid base for the development and the awareness of metacognition, that is, the ability of individuals to reflect upon their personal cognitive processes, the strategies they apply (and their effectiveness) to reach a goal (Fisher, 1998). These strategies – such as the *preview* techniques, used by readers to foresee what information is coming next in a text before reading it by scanning its structure – are important when it comes to maximize text comprehension. In fact, for a reader being conscious of the existence of mechanisms and methods that helps regulating the efficacy of cognitive processes is essential to the reading (and learning) process. In an academic environment, metacognitive strategies are used when individuals need to recall the most important information in the text (Cooper, 2012). But if we think about it, this approach to a text can be used in everyday life while reading a book for pleasure or an article in the daily newspaper. We are therefore not surprised to see the raising to awareness of these strategies in a course like SuperReading™. Directly involving Cooper's words (2009), "learning to preview and ask questions of the text are generally considered good reading-for-meaning skills. So, the strategies that might account for some of the improvement are part and parcel of good transferable reading strategies. Therefore, rather than be discounted as alternative explanations for reading improvement, they could be considered a legitimate part of the improved skills being evidenced" (page 15).

Another important goal of the course is to work on the individuals' self-confidence promoting the use of positive affirmations. Concerning this last point, scholars agree on the fact that individuals with a diagnosis of *Specific Learning*

Disabilities (SLD, which are characterized by pervasive difficulties with the abilities acquired through formal education: reading, writing and mathematical calculations) such as dyslexia are affected by low self-esteem and anxiety (Scagnelli, Oppo, Santulli, 2014). For this reason, the course not only provide the support to all participants through the adoption of positive affirmations given by a *coach*, but also motivational help between participants through the practice called the *buddy* system.

The most important exercise that needs to be practiced daily is called *Eye-Hop*™ (*Example 1*). Using written texts with a special layout, the reader needs to hop with the index finger between the center of groups made up of 2 or more words, following the movement of the finger with the eyes. This movement need to be performed as fast as possible, still maintaining comprehension.

ROSSO MALPELO	Malpelo si
chiamava così	perché aveva
i capelli	rossi; ed
aveva i capelli	rossi perché
era un ragazzo	malizioso
e cattivo,	che prometteva
di riescire	un fior di
birbone.	

Example 1. Eye-Hop™ 2 layout - extract from the *novella* “Rosso Malpelo” (Giovanni Verga, 1878). This layout is divided into two columns: each column contains from one to three words depending on the length of the words of the text (and depending on the difficulty the reader is dealing with).

This exercise aims at gradually absorbing more words (and information) through single fixations of the eyes. The difficulty of the exercise can be increased by adding more words to the groups in each column (the layouts can contain up to an average of 5 words). At the same time, another purpose of this exercise is to reduce the prevalent sub-vocalization which can be found during silent reading in most readers. It is suggested to practice daily with the exercises the course provides (40 minutes per day are recommended) (Cooper, 2009; Scagnelli, Oppo, Santulli, 2014) and it is reasonable to think that this could be the principal cause of the increment in reading speed. The Eye-Hop™ exercise also aims at deleting the phenomenon of sub-vocalization mentioned in Chapter One. In fact, one of the most important aims of the exercise is to help readers getting rid of interior voice that slow down the reading process. Moreover, if readers focus more on listening the voice in their heads, they lower their attention to the text, undermining comprehension.

Improvements are monitored by administering a test during every meeting of the course. Participants need to read a 400-words text one time and then they need to answer 10 open questions about names, dates and specific information contained in the text to test comprehension. Then readers – now knowing the questions and the contents of the text – read the same text a second time (*review*) and answer the same questions without having the possibility to see what they have written during the first reading. The time readers spend to read the text is measured during both sessions. After finishing the test, participants take note of percentage of correct answer and multiplying the total percentage of both first and second reading for words read per minute (thanks to the help of a table given during the course), they come across the value of *Reading Effectiveness*. The values that are observed to measure the improvements are:

1. Time and speed of first and second reading;
2. Percentage of comprehension of first and second reading;
3. *Reading Effectiveness* of first and second reading.

Between scheduled meetings, the coach recommends participants to use the techniques that have been explained during the course in everyday situations and to exercise daily with Eye-Hop™ to assimilate this different visual approach to texts and to work towards the improvement of *Reading Effectiveness*.

As it was previously mentioned, Cole observed in his courses held in the US that both neurotypical and dyslexic readers improved significantly their *Reading Effectiveness* after attending the lessons. Interestingly, Cole also reported that dyslexic readers showed a greater improvement in all the measured variables compared to neurotypical readers: for this reason, experimentations in Europe also began to try to give an explanation behind the improvement observed in dyslexic readers. Research on SuperReading™ is just beginning, scholars have yet to understand which reason is behind the general improvement of both neurotypical and dyslexic participants and which role every component plays in the process of improvement.

The aim of this study - carried out in collaboration with Professor Francesca Santulli and Dr. Melissa Scagnelli from IULM University in Milan - is to isolate a component, in this case the main exercise that is included in the course - the Eye-Hop™ - and identify the effects of *eye-hopping* exercises on reading speed and *Reading Effectiveness*, independent from the contribution of the whole program. For this study, a five-week training was programmed during which participants needed to exercise daily with the most peculiar technique of the course up to 20 minutes. Every week a comprehension test was scheduled to examine the progress in speed in silent reading and in *Reading Effectiveness*.

In the next paragraphs of this chapter will be analyzed the single components that constitute SuperReading™; moreover, a brief overview over the existent literature of studies on the course will be accounted.

2.2 Metacognitive Component

The first component of SuperReading™ to be analyzed is metacognition applied to text comprehension. Metacognition has an extensive literature and it is one of the most discussed topics in research linked to formal education, due to its connection to effective comprehension of a written text and learning. First, a general definition will be given, mentioning the principal researchers who examine the nature of metacognition and its relationship with cognition, reading and learning. Then, it will be explained the relevance of awareness of metacognition in the reading process and how it can be improved by readers with the help of teachers and specific tools.

2.2.1 General Definition

Knowledge on metacognition has been expanded since the first investigations which started in late '70s of the last century, but there are some characteristics that still need to be explained. Scholars do not completely agree on some aspects of metacognition, including its definition and components. In general, most researchers define metacognition as "thinking about thinking" (underlining the unique capacity of humans of reflecting about themselves and their actions - e.g., Fisher, 1998[84]) or "higher-order cognition about cognition" (Veenman *et al.*, 2006; page 5), highlighting the fact that metacognition is used by individuals to control cognition (Schraw, 1998). But what is cognition? Quoting Miller & Wallis (2009[85]),

> *"Cognitive, or executive, control refers to the ability to coordinate thought and action and direct it toward obtaining goals. It is needed to*

[84] Fisher, R. (1998). "Thinking About Thinking: Developing Metacognition in Children", *Early Child Development and Care*, volume 141, n° 1, pp. 1-15.

[85] Miller, E. K. & Wallis, J. D. (2009). "Executive Function and Higher-Order Cognition: Definition and Neural Substrates", *Encyclopedia of Neuroscience*, volume 4, pp. 99-104.

> *overcome local considerations, plan and orchestrate complex sequences of behavior, and prioritize goals and subgoals"* (Miller & Wallis, 2009; page 1).

Scholars tend to divide metacognition in two subcomponents: even though on one hand there is a consensus upon one subcomponent, namely *metacognitive knowledge*, on the other hand, researchers have not yet found an agreement regarding the second subcomponent, which can be identified as *metacognitive regulation* (e.g., Schraw, 1998; Pintrich, Wolters and Baxter, 2000[86]) or *metacognitive skills* (e.g., Veenman *et al*., 2006). Metacognitive regulation refers to all the activities employed to monitor cognitive activities, while metacognitive skills refers to a practical knowledge a person has on how to approach and regulate learning activities and problems (Veenman *et al*., 2006). Finally, the definition of metacognitive knowledge can be related for large part to what Flavell (1979) affirmed in his paper. He has been one of the first researchers interested in analyzing the topic, and in 1979 he published an influential paper in which he described the characteristics of metacognition, illustrating also the implications of this new field of study in an educational environment. In general, with the term "metacognition" Flavell referred to a person's awareness, knowledge and regulation of cognitive activities, that is, "situations which stimulate a lot of careful, highly conscious thinking" (Flavell, 1979; page 908). Following his ideas, these activities are monitored through the interaction of four phenomena:

1. *Metacognitive knowledge*: it refers to the beliefs one person have of other "people as cognitive creatures" (Flavell, 1979; page 906) based on their experience and knowledge of the world, recognizing that people have different goals, tasks, actions and experiences compared to themselves. It is further divided into three categories – *person* (a person's beliefs about her/his own nature and about all other individuals as "cognitive processors"; Flavell, 1979, page 907), *task* (which is linked to the information that is available in the learning process) and *strategy*;

[86] Pintrich, P. R., Wolters, C. A., Baxter, G. P. (2000). "Assessing Metacognition and Self-Regulated Learning", in *Issues in the Measurement of Metacognition*, Chapter 2, pp. 43-97.

2. *Metacognitive experiences*: they can be accounted as cognitive and affective experiences – sensations and emotions, as Flavell seems to describe them - that could manifest before, during or after a cognitive activity, stimulating individuals to reflect upon what they are doing. Such situations imply to consciously think about how to plan or evaluate experiences, setting new goals or deleting old ones, at the same time using the most appropriate strategies to reach specific goals. Metacognitive experiences are moments in which individuals explicitly monitor the use of strategies and learning process, affecting metacognitive knowledge by modifying and enriching it. In later studies (e.g., Flavell, Miller & Miller, 1993), metacognitive knowledge and metacognitive experiences will be referred as *metacognitive monitoring* and self-regulation (Sperling *et al*., 2001);
3. *Goals* (and *tasks*): this category implies that a person would recognize the varying demand required by different cognitive processes in a learning situation to reach the objectives of the cognitive activities;
4. *Actions* are the *strategies* (or approaches) applied to achieve objectives in a learning situation (Flavell, 1979; page 906).

Soon after Flavell's paper (1979), many other scholars tackled this topic, giving their contribution to the field, enriching the literature (e.g., Jacobs & Paris, 1987 and Schraw, 1994 among others) and creating debates that are still discussed. For example, Schraw (1998) in his paper affirmed that metacognition "is necessary to understand how the task was performed" (Garner, 1987[87], in Schraw, 1998; page 113), but in distinguishing the two components, he separated knowledge of cognition from *regulation* of cognition. According to Schraw's view, knowledge of cognition includes three different subcomponents, namely declarative (knowing *about* things), procedural (knowing *how* to do things; it includes strategies that have been already used during cognitive tasks and have contributed positively in a learning situation - Pressley, Borkowski & Schneider, 1987[88]; Glaser & Chi, 1988[89] in Schraw, 1998) and conditional

[87] Garner, R. (1987). "Metacognition and Reading Comprehension", Norwood, NJ: Ablex Publishing.
[88] Pressley, M., Borkowski, J. G. & Schneider, W. (1987). "Cognitive strategies: Good strategy users coordinate metacognition and knowledge", in Vasta, R. & Whitehurst, G. (ed.), *Annals of Child Development,* volume 4, pp. 89-129.
[89] Glaser, R. & Chi, M. T. (1988). "Overview", in Chi, M., Glaser, R. & Farr, M. (ed.), *The Nature of Expertise*, pp. xv-xxviii. Hillsdale, NJ: Erlbaum.

knowledge (knowing the *why* and *when* aspects of cognition). Regulation of cognition has a fundamental role in monitoring cognitive activities and the learning process: in environments such the scholastic one, students need to know regulation of cognition exists and that has a prominent role in learning. For this reason, students not only need to be aware of its existence, but also, they need to possess a set of skills that help them controlling the learning process for it to be effective. Three main skills are included in regulation: the first is *planning*. It consists in selecting and using the appropriate strategies, resources and attention before beginning a task, for example making predictions about the content and the type of information in the text before reading. The second skill is *monitoring*, that is the ability of a person of observe and be constantly aware of their comprehension of the text while reading, for example periodically testing comprehension by re-elaborating the most relevant information of the text through summaries. The third and last skill is *evaluation*, which consists in estimating the self-efficacy and what has been achieved in terms of goals and acquired information during a reading or a learning session, e.g., re-evaluating one's goals and conclusions (Jacobs & Paris, 1987[90] in Schraw, 1998).

2.2.1.1 Relationship Between Cognition and Metacognition

In relation to its definition, the fact that metacognition is defined as "higher-order cognition about cognition" (Veenman *et al*., 2006; page 5) leads the discussion on which is the relation of cognition with metacognition and which characteristics permit to differentiate them. While Flavell in 1979 affirmed that cognitive knowledge and metacognitive knowledge may not at all be different, due to the fact that the main difference between the two lies in how the information is used (Livingston, 2003), later scholars agreed that a first distinction could be made saying that while cognition and cognitive skills are essential to organize, perform and fulfill a task, metacognition is used to understand, monitor and evaluate how the task was performed and how the reading or learning process was conducted, which strategies were used, and if the goals

[90] Jacobs, J.E. & Paris, S.G. (1987). "Children's metacognition about reading: Issues in definition, measurement, and instruction", *Educational Psychologist,* volume 22, pp. 255–278.

were met (Garner, 1987 in Schraw, 1998; Gourgey, 1998[91]; Akturk & Sahin, 2011). This means that cognition and metacognition are complementary to each other, with awareness of metacognition that is essential for cognitive effectiveness (Gourgey, 1998): in this perspective, metacognition comes into play before cognitive activities (planning how to approach a task), during activities (monitoring the performance during the task) or after activities (evaluating the performance and the goals reached). To better explain this relationship, take as an example a student who is reading a text: the student is aware whether s/he can or cannot comprehend the text s/he is reading (metacognition), and s/he knows that to enhance comprehension s/he can use specific strategies such as preparing conceptual maps or making summaries (Akturk & Sahin, 2011). Then, it is clear that an individual cannot use her/his repertoire of metacognitive skills without being engrossed in cognitive activities (such as – in this case – reading). Moreover, without cognition, metacognition cannot be used to regulate task performance. On the other hand, cognitive activities are subject to metacognition, for instance, to ongoing monitoring and evaluation processes. It is therefore essential for learning to keep this circular process of metacognitive and cognitive activities alive (Veenman *et al*., 2006).

2.2.2 Development of Metacognition

In his study, Flavell (1979) affirmed that children attending preschool and elementary school have a more immature metacognitive system compared to older students. This justifies their often-wrong judgment upon the learning process and their approach in monitoring cognitive activities, emphasizing a limited knowledge of metacognition. On the other hand, adolescents and adults usually possess and use way more strategies to acquire new information, and these strategies constantly change in function of the type of information a person is dealing with in a text (Kuhn, 2000). Where does general metacognition start developing then? Which are the main causes at the base of these changes?

[91] Gourgey, A. F. (March 1998). "Metacognition in basic skills instruction", *Instructional Science*, volume 26, n° 1-2, pp. 81-96.

Researchers demonstrated that children's awareness of their own cognitive processes undergoes a progressive development since the early years of life, with children that will become more and more conscious of metacognition and mental functions, modifying, adding or deleting skills useful to text comprehension and learning process (Kuhn, 2000; Veenman *et al.*, 2006). This progressive discover is extremely important not only for gain knowledge about the world and themselves as creatures capable of thinking and reflecting, but also for later educational goals: children learn how to effectively use strategies to process new information to become more efficient readers and learners. The first important step that a child takes towards the later awareness of metacognition is the development of what is called the *Theory of Mind*. The Theory of Mind is an ability that helps individuals in attributing different *mental states* (which are, desires, beliefs and pretence) to all the other individuals surrounding them to interpret their behaviour (Leslie, 2001[92]). As Kuhn (2000) and Veenman and colleagues (2006) account, Theory of Mind develops rapidly between the age of 3 and 5 years: in detail, a child begins of being aware of her/himself and the people s/he is surrounded by as thinking individuals by the age of 3. By the following year (age 4), a child come to understand that these other individuals can have personal beliefs and goals, which could be different or even wrong compared with theirs. Metacognitive knowledge then continues developing not only after age 5 but continue to do so during the entire life of a person. Various studies[93] then have hypothesized that a crucial point for the start of the development of metacognitive skills is posited around the age of 8-10 years, during the beginning of primary school. From these studies have emerged that not all metacognitive skills develop at the same time, but they develop at different ages: take as examples the actions of monitoring and evaluating personal cognitive activities, which appear to mature at later moments compared to others, like planning. Other studies[94] instead demonstrated that "very young children (say, 5 yr. old) may reveal elementary forms of orientation, planning and reflection if the task is appropriated to their interests and level of understanding" (Veenman *et al.*, 2006; page 8). It is clear that more research in this field needs to be done, but what can be seen

---

[92] Leslie, A. M. (2001). "Theory of mind", *International Encyclopedia of the Social & Behavioral Sciences*, pp. 15652-15656, https://www.sciencedirect.com/topics/neuroscience/theory-of-mind).

[93] To mention some, Berk, 2003; Veenman & Spaans, 2005; Veenman *et al.*, 2004 (all cited in Veenman *et al.*, 2006; page 8).

[94] E.g., Whitebread (1999; EARLI conference in Cyprus, 2005 – both cited in Veenman *et al.*, 2006; page 8).

from the existing literature is that with high probability metacognitive knowledge and skills develop linearly during the school years: starting from the very first years of school, children begin developing very basic levels of metacognition, refining their knowledge during the years of formal education and adapting it depending on the task that needs to be dealt with. Kuhn (2000) and Veenman and colleagues (2006) hypothesized that the components of metacognition undergo a life-span development. This continuous change is based on a feedback system. For example, in a reading task, certain strategies will be applied to gain as much useful information as possible, and to do so, the feedback system will notify the reaching of comprehension, inhibiting less effective strategies and activating most effective ones more easily. In this way, in a following reading task, some strategies will be used if the previous performance was positive, otherwise other strategies will be activated to guarantee text comprehension. Behaviour and beliefs also change over time, with the feedback system working with the same principles found in the choice of strategies, making adults in a way more efficient than children in developing and modifying their metacognition (Kuhn, 2000).

It could seem that this process proceeds in parallel with the development of the intellectual ability of students. Research conducted by Veenman and colleagues (2004) have proven that intelligence and IQ are the starting point for the development of metacognition for students, being extremely important at the beginning of skills acquisition, but it does not really affect later development in incoming scholastic years, not affecting latter stages of learning as much as home, school and metacognitive training programs (Veenman *et al*., 2004; Ackerman, 1987[95] in Schraw, 1998). However, great knowledge of skills and strategies can compensate for different IQ between students (Akturk & Sahin, 2011) and can contribute to learning performance (Veenman *et al*., 2006). For these reasons, most scholars agree upon the fact that metacognition undergoes a development that can be observed during life span, agreeing also that metacognition awareness and the knowledge of strategies are extremely important in learning environments.

In summary, awareness and development of metacognition and metacognitive skills are rather fundamental in all contexts for individuals, because it can have positive effects not only in environments in which the learning process is activated such as the scholastic one, but also in situations in which a wide repertoire of strategies and general

[95] Ackerman, P. C. (1987). "Individual differences in skill learning: An integration of the psychometric and information processing perspectives", *Psychological Bulletin*, volume 102, pp. 3-27.

skills are fundamental for problem-solving (Veenman *et al*., 2004; Paris & Winograd, 1990[96] in Mokhtari & Reichard, 2002). For this reason, metacognition should be presented as an opportunity to "provide [individuals] with knowledge and confidence that *enables* them to manage their own learning and *empowers* them to be inquisitive and zealous in their pursuits" (Mokhtari & Reichard, 2002; page 22).

2.2.3 Awareness of Metacognition

Metacognition enters into play even before cognition to enhance learning and better regulate the cognitive activities that follows (Livingston, 2003). For this reason, it is extremely important for individuals to be aware of the existence of metacognition and its role in reading and learning processes.

In general, educational settings are the environments in which individuals usually learn about metacognition, especially through instructions provided by teachers or simply experimenting by themselves. Giving an example from the literature, Hartman & Sternberg (1993[97] in Schraw, 1998) signaled four ways to increase awareness of metacognition in classroom. First, teachers should promote general awareness by explaining the difference between cognition and metacognition to improve students' self-regulation. Self-regulation is fundamental to achieve effective learning: Zimmerman describes it as "the extent to which learners are metacognitively, motivationally and behaviorally active participants in their own learning process" (Zimmerman, 1986[98] in Furnes & Norman, 2015; page 273). This definition implies that learners should be explicitly aware of the mechanisms involved in the reading and learning process, knowing which strategies are stored in their repertoire and how they approach a text to acquire new information. Self-regulation is a complex entity composed of three components (or self-regulatory processes, which involve conative,

---

[96] Paris, S. G. & Winograd, P. (1990). "How metacognition can promote academic learning and instruction", in Jones, B. F. & Idol, L. (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 15-51). Hillsdale, NJ: Erlbaum.

[97] Hartman, H.H. & Sternberg, R.J. (1993). "A broad BACEIS for improving thinking", *Instructional Science,* volume 21, pp. 401–425.

[98] Zimmerman, B. J. (1986). "Becoming a self-regulated learner: Which are the key subprocesses?", *Contemporary Educational Psychology*, volume 11, n° 4, pp. 307-313.

emotional, social and volitional subprocesses), which are standards of thought, feeling, or behavior that individuals endorse, mentally represent, and monitor; sufficient motivation to invest effort into reducing discrepancies between standards and actual states (monitoring); and sufficient capacity to achieve this in light of obstacles and temptations along the way (coping activities) (Bagozzi, 1992; Hofmann, 2012). Second, teachers should foster beneficial environments in which students can ample their repertoire of strategies and ameliorate their strategy use and regulation (Schraw *et al*., 1995).Third, teachers should explicitly teach and promote general skills to acquire universal strategies which enhance learning in any domain – and improving knowledge of cognition with the use tools and questionnaires as the *Strategy Evaluation Matrices* (SEM[99] - Schraw, 1998). Fourth - and last way to bring improvement by teachers - is to help students ameliorate regulation of cognition using tools such as the *Regulatory Checklist* (RC)[100].

Linked to tools and questionnaires, many other methods have been used to explore and bring awareness in metacognition and self-regulation in individuals, from interviews (Swanson, 1990[101] in Sperling *et al*., 2001) to checklists (e.g. Manning *et al*., 1996[102] in Sperling *et al*., 2001), even though with many disadvantages linked to the difficulty to observe directly metacognitive processing. If until not many years ago questionnaires and interviews were the most common methods to be administered to students to let them explicitly reflect on their way to approach learning, nowadays are also used online methods, such as direct observation, diaries in which students take notes on their strategy use, and specific software that give the opportunity to observe students engaged in learning in authentic contexts (Zimmerman, 2008). Students benefit by using these tools that are also extremely important to researchers to understand how metacognition and its components work. Among questionnaires can be found the *Index*

---

[99] SEM: *Strategy Evaluation Matrix* (Schraw, 1998). SEM presents a table which contains a small description of how, when and why use that specific strategy (e.g., skim, activation of prior knowledge and diagrams). After a first approach, students need to revise regularly the matrix to observe any change in their use of strategies. Among the strengths of SEM, we can find promotion of strategy use and explicit metacognitive awareness even in younger students; moreover, SEM encourages students to actively construct knowledge about how, when and where to use strategies.

[100] "The purpose of RC is to provide an overarching heuristic that facilitates the regulation of cognition. (…) The RC enables novice learners to implement a systematic regulatory sequence that helps them control their performance with a series of questions that stimulates the observation of planning, monitoring and evaluating" (Schraw, 1998; page 120).

[101] Swanson, H. L. (1990). "Influence of Metacognitive knowledge and aptitude on problem solving", *Journal of Educational Psychology,* volume 82, n° 2, pp. 306–314.

[102] Manning, B. H., Glasner, S. E. & Smith, E. R. (1996). "The self-regulated learning aspect of metacognition: A component of gifted education", *Roeper Review,* volume 18, n° 3, pp. 217–223.

of Reading Awareness (Jacobs & Paris, 1987), *Learning and Study Strategies Inventory* (LASSI - Weinstein, Schulte and Palmer, 1987[103]), the *Motivated Strategies for Learning Questionnaire* (MSLQ - Pintrich, Smith, Garcia and McKeachie, 1993[104]), and the *Self-Regulated Learning Interview Scale* (SRLIS - Zimmerman & Martinez-Pons, 1986[105], 1988[106]) (Schraw, 1998; Mokhtari & Reichard, 2002; Zimmerman, 2008). These instruments are intuitive and often present scales such as "most of the time" or "is typical of me" that allow students to choose the most representative and closer answer to how they feel about themselves. Online measurements have been developed to reach faster and a wider population of students: an example can be the software *gStudy*, which gives the opportunity to the students not only to upload any text and make notes, elaborate diagrams and conceptual maps, but also chat and collaborate with other students and receive advices from tutors (Zimmerman, 2008; page 170).

2.2.4 Metacognition in Dyslexia

The status of metacognition in dyslexic readers has been also analyzed by researchers, and what emerged is that metacognitive skills are comparable to the one found in beginning readers and less skilled readers. Moreover, researchers have concluded that dyslexic readers can benefit from awareness of metacognition and its enhancement, improving in this way reading comprehension through strategy instruction (Gersten *et al*., 2001[107] in Furnes & Norman, 2015). McLoughlin in 1997[108]

---

[103] Weinstein, C. E., Schulte, A., & Palmer, D. (1987). "Learning and study strategies inventory", Clearwater, FL: H & H.

[104] Pintrich, P. R., Smith, D. A. F., Garcia, T. & McKeachie, W. J. (1991). "A manual for the use of the motivated strategies learning questionnaire (MSLQ)", Ann Arbor, MI: University of Michigan, National Center for Research to Improve Postsecondary Teaching and Learning.

[105] Zimmerman, B. J. & Martinez-Pons, M. (1986). "Development of a structured interview for assessing student use of self-regulated learning strategies", *American Educational Research Journal,* volume 23**,** pp. 614–628.

[106] Zimmerman, B. J. & Martinez-Pons, M. (1988). "Construct validation of a strategy model of self-regulated learning", *Journal of Educational Psychology,* volume 80**,** pp. 284–290.

[107] Gersten, R., Fuchs, L. S., Williams, J. P. & Baker, S. (2001). "Teaching reading comprehension strategies
to students with learning disabilities: A review of research", *Review of Educational Research*, volume 71, n° 2, pp. 279–320.

and Simmons and Singleton in 2000 underlined the fact that dyslexic readers' under-developed metacognitive skills would lead them to choose inappropriate strategies or even to not employing any strategy. For this reason, it would be advantageous for them to be trained to be more aware of metacognitive awareness and strategies to enhance text comprehension. In their study, Furnes and Norman (2015) compared some subcomponents of metacognition in neurotypical and dyslexic readers, collecting data by administering self-report questionnaires and a standardized questionnaire. From results emerged a clear difference, with dyslexic readers who displayed lower levels of metacognitive knowledge (reading abilities, reading skills and low reading motivation) and knowledge of reading strategies (though groups did not differ to apply deep and surface reading strategies in text reading) compared to their neurotypical peers. Strategy instruction enhance reading comprehension, and strategies just like previewing and reviewing a text can help individuals to compensate their pervasive difficulties with reading by increasing their recall of relevant information: their difficulties undermine the base of the learning process, but their capacity of learning new strategies is intact, they "can effectively use metacognitive methods to organize their understanding of reading material" (Newby *et al*., 1989; page 378).

A clear framework emerges from other studies such as the one conducted by Trainin and Swanson in 2005: students with learning disabilities in post-secondary education are more likely to encounter failing situations that could lead them even not to conclude their studies the first year, due to high anxiety and lower expectancy value. A positive aspect is that with adequate academic support they can attain normative levels of achievement. Again, the framework Trainin and Swanson (2005) depicted is one in which are highlighted positive aspects, even if already adult students show a pattern of difficulties observed in children with developmental dyslexia (Kirby *et al*., 2008): in fact, these students show achievement and motivation levels similar of those of their peers without learning disabilities. They tend to spend more hours studying, but they even seek help more frequently and – not as surprising as it seems – they are more strategic than students without learning disabilities when it comes to prepare for tests or lessons. This means that they try to compensate for their cognitive difficulties by relying on metacognition, consciously controlling actions that are too complex to be controlled automatically (Trainin & Swanson, 2005; Kirby *et al*., 2008).

---

[108] McLoughlin, D. (1997). "Assessment of adult reading skills", in Beech, J.R. & Singleton, C.H. (Ed.), *The Psychological Assessment of Reading*, pp. 224–237. London: Routledge.

Metacognitive strategies aim at making readers – with no distinction between neurotypical and dyslexic readers – more efficient in their comprehension (optimizing the reading process) and – by extension – better learners. Therefore, educators have the responsibility to improve metacognition awareness and metacognitive skills because there is a real "need for all students (especially struggling ones) to become 'constructively responsive' readers (Pressley and Afflerbach, 1995[109]) and 'thoughtfully literate' individuals (Allington, 2000[110]) who are engaged, motivated readers in control of their own learning (Alvermann & Guthrie, 1993[111])" (Mokhtari & Reichard, 2002; page 251).

[109] Pressley, M. & Afflerbach, P. (1995). "Verbal protocols of reading: The nature of constructively responsive reading". Hillsdale, NJ: Erlbaum.
[110] Allington, R. (2000). "What really matters for struggling readers: Designing research-based programs". New York: Longman.
[111] Alvermann, D. E. & Guthrie, J. T. (1993). "Themes and directions of the National Reading Research Center: Perspectives in reading research, No. 1". Athens, GA: University of Georgia and University of Maryland at College Park.

2.3 Emotional Component

The second important aspect that the SuperReading™ course look after is the one that concerns the emotional sphere of students, who are learners and readers. Many studies across fields of research (such as psychology and didactics) have proven that emotionality is a strong factor which can influence reading and learning processes in the scholastic environment, especially in those people with dyslexia. In fact, existent literature has underlined the fact that dyslexic readers can be affected by negative emotional it when dealing a task such as reading aloud, because they can feel to be judged by their peers, or even bullied for their difficulties. As we will see, the difficulties and the emotions (both negative and positive) those people encounter during the entire course of their scholastic and working career could later affect their entire life if not correctly dealt with. If we consider this, educators should consider that each student has different needs based not only on personal inclinations and emotional status, and, students with learning disabilities should never be alone to face these strong emotions, but they should also be always supported by teachers and other students.

In this perspective, SuperReading™ gives tools not only to all learners and readers to approach with the right attitude the tasks of reading and learning. For example, if a student has a positive attitude towards learning, it can overall affect positively an individual: a positive attitude motivates students and let them feel self-efficient, posing the basis to become greater learners in comparison to those individuals who do not possess the right attitude to approach learning. This positive attitude can be applied also to reading and how students approach that task: for example, students who are more or less confident about their abilities approach in different ways situations in which their identity could be undermined by others' judgment, such as tests or reading a text aloud (Scagnelli *et al.*, 2018). It will be explicitly tackled the role of the spectrum of emotions and the way of coping with the reading deficit in dyslexic students from childhood to adulthood, the consequences that positive and negative experiences during school could be brought to individuals, the role of educators and parents in the dyslexic individuals should have to help them facing their difficulties.

2.3.1 Growing Up with Dyslexia

The behavioral and emotional load that students with dyslexia or other learning disabilities have to deal with is usually burdening. An example in support of this assumption is the study conducted in 2018 by Livingston and colleagues which focused on examine dyslexics' experiences and emotions linked to their difficulties thorough their lives. General results indicated that developmental dyslexia had a general negative impact on the quality of life, in some cases causing excessive stress, anxiety and sadness, which could also bring a later diagnosis of depression to individuals. More than language difficulties, dyslexics reported that what determined most of the times is how other people perceive their difficulties, stereotypes and the way other students approach their dyslexic peers, often bullying them and underlying their difficulties mocking them. Of course, each individual has a personal way of coping and approaching dyslexia: as it was signaled by many studies (e.g., Endler and Parker, 1999[112] in Alexander-Passe, 2006), individuals with developmental dyslexia can present three different types of behavior to cope with their difficulties.

1. Individuals who show a *task-based* way of coping display a self-confident attitude and are actively engrossed in overcoming their difficulties by trying new participants, strategies and tasks and celebrating their success by attributing it to their abilities (Wszeborowska-Lipinska, 1997[113] in Alexander-Passe, 2006);
2. Other individuals can display more negative ways of coping, such as *emotional-based* method - which exploits in frustration, pervasive lack of confidence, and in extreme cases, aggressiveness, refusing help from others and self-blaming for their incompetence comparing themselves to peers - and *avoidance-based* coping, in which individuals with learning disabilities avoid situations that could implicate a need of enter competitions or reaching potential, at the same time giving the wrong impression to teachers who think that these individuals are lazy or even immature with their language use (Endler and Parker, 1999[114] in

[112] Endler, N. S. & Parker, J. D. A. (1999). "Coping inventory for stressful situations: CISS manual" (2nd ed.), New York: Multi-Health Systems.
[113] Wszeborowska-Lipinska, B. (1997). "Dyslexic students who succeed", unpublished paper, University of Gdansk.
[114] See note 112 above.

Alexander-Passe, 2006). This way of coping can be also linked to stress caused by the severity of their difficulties and the reaction of a single person, triggering *under-reactions* such as withdraw and extreme anxiety, with general low self-opinions of themselves and of their capacities, tending to generalize every aspect of their life as a failure, or *over-reactions*, such as displaying silly behaviour and a couldn't-care-less attitude in many situations, especially in class, or even disruptive behavior (Thomson, 1996[115] in Alexander-Passe, 2006).

Not only dyslexia itself could cause problems to individuals, but also how others perceive their difficulties which affects individuals by lowering self-esteem, reflecting negatively on self-image (Alexander-Passe, 2006). Literature on this topic have underlined the fact that very often children suffer from stress caused more by external factors - such as the misconduct of other children who bully and mock their evident difficulties - rather than from stress caused by a personal negative attitude towards dyslexia. The way other students mock these children influences their self-perception and can have direct consequences on behavior and achievements, bringing them even to underestimate their actual abilities. It has been proven that this negativity and emotional load not only affects children during the educational path in school but can also be the cause of greater problems in adolescence and adulthood. As Livingston and colleagues (2018) remark, "as individuals with developmental dyslexia experience failures in school and other areas of life they may feel like something is wrong with them and later feel inferior in comparison to their peers. To some, these failures are traumatic. This often involves difficulties being misattributed to personal characteristics including work ethic, emotional state or intelligence (McNulty, 2003[116]; Siegel, 2013[117], 2016[118])" (Livingston *et al.*, 2018; page 10).

The overview on the emotional sphere of children with learning disabilities and developmental dyslexia which was presented to researchers was not positive. In fact,

---

[115] Thomson, M. (1996). "Developmental dyslexia: Studies in disorders of communication", London: Whurr.

[116] McNulty, M. A. (2003). "Dyslexia and the life course", *Journal of Learning Disabilities*, volume 36, n° 4, pp. 363–381.

[117] Siegel, L. (2013). "Understanding dyslexia and other learning disabilities", Vancouver, BC: Pacific Educational Press.

[118] Siegel, L. (2016). "Not stupid, not lazy: Understanding dyslexia and other learning disabilities", Vancouver, BC: International Dyslexia Association.

from research it has emerged that children face everyday situations that can highlight their difficulties and bring them to feel that they are inferior or less competent to other students since the very first years in school (especially between age 7 and 11), due to the fact that they are slower when a task is proposed, gravely damaging their self-esteem, undermining positive outcomes in learning and chronic difficulties with the damaged ability (Wigfield *et al*., 1997[119] in Ingesson, 2007; Livingston *et al*., 2018). Thus, combining an emotional sensitivity with the child's bewildering feeling that something is very wrong, it is no wonder that self-esteem is low in children who fail to learn to read or write during the first years of school. Many researchers (e.g., Thomson and Hartley, 1980[120]; Riddick, 1996[121] and Humphrey, 2002[122] all in Ingesson, 2007; Bender and Wall, 1994; Long, 2007) have found that individuals with developmental dyslexia (children, adolescents and adults) tend to have lower self-concept (used "in reference to an individual's cognitions and feelings about the self" - Humphrey, 2002; page 1) and self-esteem levels than those without difficulties. Moreover, they are more subject to feel a range of negative emotions such as disappointment, shame, sadness, and even anger towards themselves due to their difficulties. In a study by Ingesson (2007), 75 people were interviewed about their experience with dyslexia during school years. It was highlighted that generally children with dyslexia suffered for their difficulties during the first five or six years of school, while they were moving the first steps towards the assimilation of the reading process. These children showed low self-esteem and undermined well-being, an increased risk of loneliness and bullying. The feeling of being different, inferior and stupid in comparison to their classmates was a common experience.

Adolescence is a period of life during which individuals with learning disabilities reported both improvements in the psychological and emotional sphere, or a worsening in their emotional status since elementary school. In general, adolescent students generally present lower academic self-regulation and motivation compared to

[119] Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Yoon, K. S., Arbreton, A. J. A. and Blumenfeld, P. C. (1997). "Change in Children's Competence Beliefs and Subjective Task Values Across the Elementary School Years: A 3-Year Study", *Journal of Educational Psychology,* volume 89, pp. 451–97.

[120] Thomson, M. E. & Hartley, G. M. (1980). "Self-Concept in Dyslexic Children", *Academic Therapy,* volume 26, pp. 19-36.

[121] Riddick, B., Sterling, C., Farmer, M. and Morgan, S. (1999). "Self-Esteem and Anxiety in the Educational Histories of Adult Dyslexic Students", *Dyslexia,* volume 5, pp. 227–48.

[122] Humphrey, N. (2002). "Teacher and Pupil Ratings of Self-Esteem in Developmental Dyslexia", *British Journal of Special Education,* volume 29, pp. 29– 36.

their neurotypical peers. Moreover, the higher levels of anxiety detected in children are still present in adolescents with learning disabilities, with the same negative impact outcomes in school, pushing them to show a behavior that can negatively foster isolation and depression. On the long run, individuals with learning disabilities' emotional insecurity and low self-esteem can lead to a decrease in motivation and success, posing actual limits to their confidence and academic positive results (Livingston *et al*., 2018). At the same time, however, adolescents are more mature students who show to use other abilities and strategies to overcome their difficulties and improve their academic career (Bender & Wall, 1994). In 2006, Alexander-Passe conducted a study in which he examined self-esteem (CFSEI: *The culture-free self-esteem inventory* - Battle, 1992 in Alexander-Passe, 2006; page 261), coping methods (CISS: *The coping inventory for stressful situations* - Endler & Parker, 1999 in Alexander-Passe, 2006; page 261) and depression (BDI-II: *Beck depression inventory* - Beck *et al*., 1996 in Alexander-Passe, 2006; page 261) of both female and male teenagers with a diagnosis of developmental dyslexia by using three standardized tests. In general, what emerged from results is a substantial difference between female and male emotional and psychological sphere. On one hand, female dyslexic teenagers suffered from low academic self-esteem and moderate depression; to cope with their difficulties, they tended to use emotional and avoidance-based coping strategies. On the other hand, male dyslexic teenagers presented totally different ways of coping, levels of self-esteem and depression: while they scored normal academic self-esteem or just below normal, they also used task-based coping with little use of emotional and avoidance coping, resulting in minimal depression. These differences brought the researcher to suggest that individuals with learning disabilities should consider counseling to better face their difficulties and to know how to manage the emotional sphere that could be fragile.

Other studies, such as the one conducted by Ingesson in 2007, have showed different patterns from the one observed by Alexander-Passe (2006) and Bender and Wall (1994). While these last studies demonstrated that social and emotional development of individuals with learning disabilities could undergo a progressive worsening with increasing age, Ingesson observed that adolescents with learning disabilities in his study showed a general improvement in scholastic success and in the overall emotional sphere. He found that they were more consciously aware of their difficulties and their knowledge of their specific difficulties. The diagnosis was certainly a turning point on various levels, starting from the fact that they were followed by specialists who helped them also giving them the possibility to understand dyslexia. In this way, there was a gradual change in the emotional sphere of these individuals because they were helped in discovering their strengths and needs. Moreover, growing up and entering adulthood, they chose more consciously ways to control situations, occupations or participants that could hamper their emotional status, picking out instead the ones that were more akin their capacities (Spekman *et al*., 1992[123] in Ingesson, 2007).

2.3.2 The Role of Educators

What can be done to make children and teenagers avoid a negative approach to learning disabilities? One of the first steps is certainly to understand the role of the emotions and feelings in these individuals, and the relationship between dyslexia and its negative impact on the quality of life. This needs to be planned to prevent wrong attitudes to learning disabilities not only from children, but also from parents and educators. Unfortunately, it is common to hear that many educators in schools are ignorant about learning disabilities, their characteristics and the individuals' needs. The lack of knowledge about learning disabilities bring them to have prejudice and stigma and to think that these individuals are less intelligent, more difficult to teach or lazy, unconsciously affecting the scholastic performances of these students and lowering their self-esteem. For these reasons, it should be of primary importance to inform all those parents and educators on what learning disabilities are, which are the characteristics of the different disabilities and how they can help children and adolescents, at the same time ameliorating their attitude towards their both practical and emotional difficulties (Livingston *et al*., 2018). As Ingesson (2007) wrote in his study, "negative emotions are

[123] Spekman, N. J., Goldberg, R. J. and Herman, K. L. (1992). "Learning Disabled Children Grow Up: A Search for Factors Related to Success in the Young Adult Years", *Learning Disabilities Research and Practice,* volume 7, pp. 161–70.

never totally avoidable, but parental and professional support can reduce the frequency and intensity of the negative experiences" (page 586; from McNulty, 2003[124]).

One of the aspects that Alexander-Passe underlined in his paper in 2006 is the importance educators have in sustaining students. Before teachers, it is extremely important an early identification of developmental dyslexia and description of its mechanisms to the students by speech-language therapists. This is essential when it comes to educators: they can help students in acquiring a positive attitude towards their approach at their difficulties, academic career and general experiences as dyslexic individuals, paying particular attention to the different coping mechanisms of female and male students. This is especially important in mainstream schools, where often students with learning disabilities cannot find a dedicated course of personal specialized teachers to help them; in fact, it has been observed that in these schools have been found a higher percentage of negative experiences reported by students with a diagnosis of SLD, while in dedicated schools or structures with more inclusive programs were reported more positive social and emotional outcomes (Thomson, 1990; Humphrey, 2002). In this way, traumatic and humiliating misunderstanding about learning difficulties will be prevented and academic and emotional well-being will not drop under the pressure built by their difficulties. In these cases, it is extremely important that not only speech-language therapists, but also parents, educators, classmates and friends need to be informed by the reasons and the mechanisms behind these individuals' difficulties. In order to create a safe environment and avoid situations which imply bullying and mocking (which are one of the main causes of negative reactions by individuals with a diagnosis of SLD), educators have the responsibility to instruct students for what concerns learning disabilities, and the important role to support students with SLD to overcome their difficulties by helping them – for example - discover and reinforce metacognition and strategies (Long *et al.*, 2007).

Moreover, research have confirmed that instructing educators on inform the scholastic staff and students had a positive impact not only the general emotionality of classrooms (all students included), but also the environment itself (Livingston *et al.*, 2018). This process of education is fundamental especially when it comes to secondary education – which is a crucial moment for changes in the development of students' needs on many levels, such as social, educational and – indeed – emotional levels (Long

[124] For a full reference, see note 116, paragraph 2.3.1.

et al., 2007). It is clear now why educators have such a fundamental role in students' emotional well-being: it is important not only to fight against the negative aspects of ignorance – such as creating environment safe from bullying and exploring students' negative perceptions - but also working on a more personal level, enhancing their confidence by praising their success and their effort, creating "significant opportunities to increase self-awareness of these students so that they reevaluate themselves as successful individuals in their own right, and not as 'dyslexics'" (Long, 2007; page 134).

2.4 The Eye-Hop™ Exercise

SuperReading™ aims at promoting effective reading comprehension and at increasing reading speed. To do so, the course points at improving reading skills by reinforcing neurotypical and dyslexic readers already present resources - the holistic and visual strengths - rather than attempting to remediate their weaknesses, for example the perceived phonological 'deficit' of dyslexic readers. For these reasons, participants are taught to develop better visual absorption of information through a peculiar exercise, the Eye-Hop™. It is the first exercise to be taught during the course because it has a massive impact on the way a reader approaches any text, increasing reading speed and diminishing the time employed to read a text. With this exercise, participants abandon the common way of reading a text linearly, word after word, taught in formal education to adopt a new method, which consists in reading increasingly more numerous groups of words.

The exercise consists in reading a text with a peculiar movement of the eyes that promotes visual absorption of information by reading groups of words literally *hopping* between columns. This movement is helped by the *hops* of the index finger between the middle of each groups of words to guide the eyes and focused attention on each groups of words during reading (*Example 2*).

ROSSO MALPELO	Malpelo si
chiamava così	perché aveva
i capelli	rossi; ed
aveva i capelli	rossi perché
era un ragazzo	malizioso
e cattivo,	che prometteva
di riescire	un fior di
birbone.	

ROSSO MALPELO Malpelo   si chiamava così perché
aveva i capelli rossi;   ed aveva i capelli
rossi perché era un   ragazzo malizioso e
cattivo, che prometteva   di riescire un fior
di birbone.

Example 2. Eye-Hop™ 2 layout (previous page) and Eye-Hop™ 4 layout (above) – opening lines of the *novella* "Rosso Malpelo" (Giovanni Verga, 1878). Layouts of texts can vary based on the readers' preference.

Example 2 presents the opening lines of *Rosso Malpelo*, a famous *novella* written by the Italian author Giovanni Verga in 1878. Even if with a small difference between the two examples – the alignment of the words is not the same for the two types of exercise, one on the right and the other on the left - the text is organized in two columns. Each column is divided into two parts made up of small groups of words. Depending on the complexity and the experience the participants have with the exercise, the columns can have a distinct difficulty based on the number of words contained in the groups, starting from two up to four/five in Italian. It is necessary to specify the language of the text since Italian and English have different characteristics and orthographic regularity that could also affect the way in which the Eye-Hop™ layouts are structured and the technique influence the quantity of words and information absorbed (Scagnelli, Oppo and Santulli, 2014).

To carry out the exercise, readers need to jump with their index finger and their eyes between the middle of each groups of words of variable complexity while silently reading as fast as they can, still maintaining comprehension. In this exercise, the index finger has a leading role guiding the movements of the eyes, at the same time helping in focusing attention of readers. This is the opposite to what teachers say to children who are doing practice to reach a certain degree of automatization of the reading process. Teachers tend to scold children who have been practicing reading for long time but still use their finger, because it does not help them further progressing in the automatization of the process. In fact, the use of the finger is linked to the sequential decoding typical of the first steps in the learning of the reading process, and it is abandoned as soon as the faster decoding route based on the global identification of words is sufficiently developed.

As it is evident, along with a special layout, readers exercise an uncommon type of visual approach to reading: this technique aims at developing visual absorption of information by reading groups of words rather than reading word after word in a text, aiming at saving time and eliminating a distress for the eyes caused by the “linear” decoding of the traditional reading process. Moreover, the technique encourages readers to abandon the sub-vocalization common in silent reading, saving time and energy spent on phonetic attack or repair, gradually moving from phonetic decoding to visual reading (Cooper, 2009).

It is recommended to practice for 30-40 minutes every day with this technique (Cooper, 2012; Scagnelli, Oppo and Santulli, 2014).

2.4.1 Eye Movements and *Eye-Hops*™

Many researchers conducted studies in which they developed projects aiming at rehabilitating oculomotor movements in dyslexic readers. Some of these studies reported positive effects on reading (e.g., Solan, 1985[125] in Rayner, 1998). An example can be considered the project elaborated by Judica and colleagues in 2002. The training was planned for dyslexic participants to read (silently or aloud) with a single fixation isolated words of varying length when they appeared on a screen for a very brief moment, then they had to type the word they just had read. Results underlined how dyslexic readers benefitted from this training: with time and practice, participants showed a different pattern in eye movements and reading speed increased. However, all the scores in the analyzed variables remained in a pathological range and some tasks did not undergo a change (e.g., comprehension rates remained unaltered probably due to the nature of the practice), demonstrating a certain resistance to the training (Judica *et al.*, 2002; page 195). It needs to be noted that dyslexic readers who participated at this study benefitted from the training in terms of fixation duration. In fact, reading speed

[125] Solan, H. A. (1985). “Deficient eye movement patterns in achieving high school students: Three case histories”, *Journal of Learning Disabilities*, volume 18, pp. 66-70.

increased while fixation duration diminished, underlining that "the participants were more efficient in picking up information from the string of letters composing the word" and that "overall, training did not change the prevalent mode of processing in these participants but increased speed and accuracy of stimulus processing" (Judica *et al.*, 2002; page 195).

On its part, SuperReading™ includes the Eye-Hop™, an exercise with its particular structure and execution that aims at improving silent reading speed surpassing the linear decoding method taught in formal education. Research conducted on the efficacy of SuperReading™ have underlined the fact that both populations included in the course benefitted from the exercise and techniques taught (e.g., Cooper, 2009, 2012; Scagnelli, Oppo, Santulli, 2014; Santulli & Scagnelli, 2017), but it is still not clear which component influence more the scores of a specific variable, and on which degree. For this reason, the principal aim of the study included in this thesis is to analyze and describe the effects of one of the Eye-Hop™. The starting point for this analysis is the fact that *eye-hopping* practice in fact influences silent reading speed in both neurotypical and dyslexic readers by promoting a global analysis of written stimuli. Moreover, it is not clear if the exercise creates a new pattern in the eye movements, in contrast with the linear decoding pattern taught by formal education. For this reason, this paragraph will begin analyzing the exercise and its structure, trying to explain how the exercise works. However, it will only be a theoretical analysis because we did not have the opportunity to collect data from eye trackers.

To facilitate the theoretical explanation of the mechanisms of the exercise, we will compare extracts of texts with two different Eye-Hop™ layouts used in the practice sessions. The first is an extract from "The Little Prince" by Antoine de Saint-Exupéry organized with an Eye-Hop™ layout with groups made of one-three words (Eye-Hop™ 2):

Niente di	lui mi dava
l'impressione	di un bambino
sperduto nel	deserto, a
mille miglia	da qualsiasi
abitazione	umana.

Instead, the following example was extracted from the same text, but it is organized an Eye-Hop™ layout with groups made of two-five words (Eye-Hop™ 4):

	Niente
di lui mi dava l’impressione	di un bambino sperduto
nel deserto, a mille	miglia da qualsiasi
abitazione umana. Quando	finalmente potei parlare
gli domandai: “Ma	che cosa fai qui?”

Comparing the two extracts, it easy to notice that the position of words, the spacing and the general layouts are designed to facilitate certain types of eye movement patterns. Research has underlined that certain typographical elements affect readers’ eye movements, facilitating or complicating the fluency with which written stimuli are elaborated. For example, dyslexic readers are sensible to crowding effects, that is, they find difficult to properly position their focused attention in space (see paragraph 1.3.3). This effect arises especially when the written stimuli are positioned one beside the other very tightly: this position can create a blurred effect in the eyes of dyslexic readers, further complicating the execution of the reading process. This effect can create difficult also to skilled readers in terms of slowing down the reading process due to the necessity to employ more resources to focused attention (resulting in longer fixations and shorter saccades – Rayner, 2009b). For this reason, research indicated several solutions to reduce this effect in texts, such as choosing simplified fonts and widen the spacing between letters and words (e.g., Morrison & Inhoff, 1981[126] in Rayner, 1998).

Observing now the types of words in both layouts of Eye-Hop™ 2 and Eye-Hop™ 4, we can notice that each group in the columns are made up of a certain number of content and function words. From studies conducted with data collected from eye trackers have emerged that there is a discrepancy between content words (nouns, adjectives and verbs) and function words (articles, determiners, prepositions) when it comes to fixations: in general, content words are fixated about 85%, while function words are fixated about 35% of the time (Rayner, 2009b). The role of function words in

[126] Morrison, R. E. & Inhoff, A. W. (1981). “Visual factors and eye movements in reading”, *Visible Language*, volume 15, pp. 129-146.

languages is to create a grammatical structure in which content words (used to produce a mental image of a situation or a story[127]) are connected[128]. While content words tend to be longer in terms of letters, function words are usually shorter, made up of two-four letters. Researchers observed that function words are fixated less frequently than content words because of their reduced size: in fact, it has been observed that as length increases, the probability of fixating a word increases (Rayner & McConkie, 1976[129] in Rayner, 1998). Words can be skipped also on the basis of their frequency: in fact, research underlined how high frequency words are skipped in higher percentages in comparison to low frequency words (Rayner *et al*., 1996[130] in Rayner, 1998). The decision of skipping a word or not on the basis of their characteristics, such as length, type (content or function word) and frequency is made with the assistance of the *preview effect*, which consists in a first global identification of words at the right of the fixation point, located in the parafoveal region (Warren, 2013; Rayner, 2009b; Brysbaert & Vitu, 1998[131] in Rayner, 1998). Preview effect contributes in acquiring information about certain characteristics of words, such as the position of letters and codes regarding orthography and phonology, but not about semantics, which means that readers are not able to process the meaning of the word in the parafoveal region due to its degraded characteristics. Moreover, this effect has different degrees of benefit on the basis of the complexity of the fixated word (Rayner, 2009). This effect helps skilled readers in accelerating the planning and execution of fixations, along with the preparation of the length of saccades. These processes in the parafoveal region occur without readers being consciously aware of them (Ashby *et al*., 2012). The benefits in presence of parafoveal information consist in an increase of reading speed in the elaboration of written stimuli (30-50 ms) equal to 20-40% faster in comparison to texts in which there is no parafoveal information available (Ashby *et al*., 2012; Rayner, 2009; Sereno & Rayner, 2003). The acceleration of reading speed is visible in the reduction of number and duration of fixations especially in silent reading (Rayner, 2009). As Ashby

[127] Source: "Content and function words in sentence stress", < https://pronuncian.com/content-and-function-words/ >.
[128] Source: "Parts of speech", < https://www.towson.edu/ows/ptsspch.htm >.
[129] Rayner, K. & McConkie, G. W. (1976). "What guides a reader's eye movements", *Vision Research,* volume 16, pp. 829-837.
[130] Rayner, K., Sereno, S. C. & Raney, G. E. (1996). "Eye movement control in reading: A comparison of two types of models", *Journal of Experimental Psychology: Human Perception and Performance*, volume 22, pp. 1188-1200.
[131] Brysbaert, M. & Vitu, F (1998). "Word skipping: Implications for theories of eye movement control in reading", in G. Underwood (Ed.), *Eye guidance in reading and scene perception* (pp. 125-148), Oxford, England: Elsevier.

and colleagues proved in a study conducted in 2012, skilled readers showed a facilitation especially in silent reading (increase equal to 59 words per minute in silent reading in contrast with an increase equal to 16 words per minute in oral reading) which was reflected on higher speed when the sentences in the experimental task were provided with parafoveal information. On the other hand, researchers observed how slower readers benefitted less in terms of reading speed from the availability of parafoveal information in comparison to faster readers. Similar data was collected by other researchers (e.g., Rayner *et al*., 2010[132]; Chace *et al*., 2005[133] in Ashby *et al*., 2012), who attributed this reduced benefit in slower readers to the different distribution of attentional resources. In fact, it is well-known that slower readers dedicate more resources to the foveal processes while reading; this contributes to a partial development in the distribution of the attentional resources, presumably linked to a more marked support on the sublexical route (Ashby *et al*., 2012).

A very similar behaviour can be appointed to dyslexic readers, who share approximately the same characteristics with slower and less skilled readers (see paragraph 1.3.3). The fact that dyslexic readers display long fixations and very short saccades lead to the hypothesis that they could be devoting more attentional resources to foveal processes due to their difficulties, affecting also the quality of the benefits derived from parafoveal processing and the preview effect. Moreover, Jones and colleagues (2008[134], in Jones, Branigan & Kelly, 2009) in their research highlighted the fact that dyslexic readers are able to process information in the parafoveal region, but it can lead them to more have more difficulties to manage all the additional information along with the stimuli posited in the foveal region. In this sense, with its peculiar structure, the Eye-Hop™ exercise could help especially dyslexic readers to manage the information and the processes occurring in the parafoveal region, at the same time developing a certain degree of automatization of the reading process, while skilled readers will strengthen the already mature process. In this way, all readers will be able to increase their reading speed. Observing the structure of an *hopified* text, it can be assumed that the way the groups of words are distributed and organized stimulates the

---

[132] Rayner, K., Slattery, T. J. & Bélanger, N. N. (2010). "Eye movements, the perceptual span, and reading speed", *Psychonomic Bulletin & Review,* volume 17, pp. 834-839.

[133] Chace, K. H., Rayner, K. & Well, A. D. (2005). "Eye movements and phonological parafoveal preview: Effects of reading skill", *Canadian Journal of Experimental Psychology,* volume 59, pp. 209-217.

[134] Jones, M. W., Branigan, H. P. & Kelly, M. L. (June 2009). "Dyslexic and nondyslexic reading fluency: Rapid automatized naming and the importance of continuous lists", *Psychonomic Bulletin & Review*, volume 16, n° 3, pp. 567-572.

parafoveal region, activating the preview effect. For this reason, it can be hypothesized why dyslexic readers benefit more from this exercise in comparison to their neurotypical peers, because they learn to allocate attentional resources outside the small foveal region, helping in the automatization of the reading process by moving a step away from the use of the only sublexical route and beginning to stimulate certain processes contained in the lexical route, which research have proved to be present, but not entirely accessible (see paragraph 1.3.3). At this point it needs to be underlined that it is essential the use of the finger, as the Eye-Hop™ establishes. In fact, it can be hypothesized that it helps readers in keeping a specific pattern in the fixations. Moreover, it can be predicted that it helps with the improvement in the automatization of eye movements, strengthening parafoveal processes and the preview effect which are flawed in dyslexic readers.

Many studies underline the fact there is a strict correlation between reading speed and text comprehension, even if researchers have not yet found the exact nature of this relation (e.g., Bell, 2001[135]). One of the points on which researchers agree the most is the fact that slow readers generally achieve low comprehension scores. Due to their low speed, slow readers' memory is not able to hold for the necessary time information already collected back in the text, loosing parts or the totality of the message contained (Bell, 2001). For this reason, it can be hypothesized that the Eye-Hop™ exercise is counterbalanced by the presence of metacognitive strategies in SuperReading™. In this sense, metacognitive strategies help skilled readers in having tools to better manage the most important information before and during reading, balancing the effects of *eye-hopping* on speed. On their part, dyslexic readers are slow because they use the decoding of single graphemes, causing problems in comprehension due to an overload of the memory and a wrong use of their mental resources. In this sense, if dyslexic readers possess and practice an exercise to read faster, but do not have anything that is counterbalancing it, comprehension will be improved as well as reading speed. Metacognitive strategies are essential especially for dyslexic readers, and it is recommended that they should be placed side by side to Eye-Hop™ practice.

All the hypotheses described in this paragraph are purely theoretical and are not confirmed by actual data. Part of this paragraph was included in the dissertation as a

[135] Bell, T. (April 2001). "Extensive reading: speed and comprehension", *The Reading Matrix*, volume 1, n° 1, pp. 1-13.

starting point for future research that could be expanded with the help of eye trackers and data acquired explicitly in a context in which a sample of individuals have agreed upon following a training that includes only the Eye-Hop™ exercise. To further understand all the mechanisms behind the improvements of participants, it is important to continue researching on Eye-Hop™ and the other components singularly.

2.5 Coaching and *Buddy-ing*

Coaching and *buddy-ing* play an important role in the framework of the course. SuperReading™ is led by a *coach*, a trained person who helps participants to discover the various metacognitive strategies and guides the readers through the entire course, encouraging them to "strengthen their personal abilities and competence" (Scagnelli, Oppo, Santulli, 2014; page 183). At a first impression, coaches could be seen as teachers, but this figure presents differences from the traditional characteristics that can be found in educators. First, coaches involved in education and teaching found its basis in the business field (Fletcher, 2012), drawing near to the figure of a facilitator more than an instructor and giving students the appropriate tools to enhance their learning process (Griffiths, 2005[136] in Devine *et al.*, 2013). Several coaching approaches exist (for example, behavioral coaching, solution-focused coaching, etc. – Devine *et al.*, 2013) and they are based upon building and reinforcing the strengths of the single students, helping them acquiring new skills and ameliorating the ones already present, at the same time surpassing the scholastic and academic tradition by enhancing general wellbeing of the students, and – at the same time - learning, creating in this way a positive circle which brings overall positive effects on students (Seligman, Ernst, Gillham, Reivich & Linkins, 2009[137] in Devine *et al.*, 2013). The attitude of coaches also brings positive effects overall on the educational settings (Seligman & Csikzentmihalyi, 2000[138] in Devine *et al.*, 2013) and on the emotional sphere of the students: differently from traditional teachers, coaches aim at increasing hope and coping skills, at the same time decreasing levels of negative sensations.

Many studies have been conducted with the involvement of coaches in schools around the world (see Devine *et al.*, 2013 – e.g., The Sandwell project in the UK, Passmore & Brown, 2009[139]; in Australia, Campbell & Gardner, 2005[140]; Green *et al.*,

---

[136] Griffiths, K. (2005). "Personal coaching: a model for effective learning", *Journal of Learning Design*, volume 1, pp. 55-65.

[137] Seligman, M. E. P., Ernst, R. E., Gillham, J., Reivich, K. & Linkins, M. (2009). "Positive education: positive psychology and classroom interventions", *Oxford Review of Education*, volume 35, pp. 293-311.

[138] Seligman, M. E. P. & Csikszentmihalyi, M. (2000). "Positive psychology: An introduction", *American Psychologist*, volume 55, pp. 5-14.

[139] Passmore, J. & Brown, A. (2009). "Coaching non-adult students for enhanced examination performance: a longitudinal study", *Coaching: An International Journal of Theory, Practice and Research*, volume 2, pp. 54-64.

2007[141]), and results are evidently in favor of the presence of such figure in the educational environment. So, it is not a coincidence that the figure in the SuperReading™ course is a coach. There is no need to have a figure like the one of the traditional teachers, from the moment that the coach gives advices during the meetings, and also keeps the motivation up by emailing positive messages to the participants and providing support during the period in which the readers are acquiring new strategies to enhance reading.

Another system that has been included in the SuperReading™ course is the one called *buddy*. The buddy system (or peer support – Cooper, 2012) has already been tested in research in the educational environment (e.g., Devine *et al*., 2013), and its positive influence has already been discovered. This system is founded on a very simple principle: every participant of the course is a buddy for another participant, posing ground for an equal relationship between individuals and promoting inclusion between neurotypical and dyslexic readers. The principal role buddies have is to remind their partner to exercise daily by sending a message or calling weekly each other, working on keeping high motivation, regularity and interested in exercising with *eye-hopping* (Scagnelli, Oppo, Santulli, 2014; Cooper, 2012).

These figures are extremely relevant in the economy of the SuperReading™ course, and they are fundamental for the emotional and motivational well-being of all participants.

[140] Campbell, M. A., & Gardner, S. (2005). "A pilot study to assess the effects of life coaching with Year 12 students", in M. Cavanagh, A. Grant & T. Kemp (Eds.), *Evidence-based coaching* (pp. 159-169). Brisbane: Australian Academic Press.

[141] Green, S., Grant, A., & Rynsaardt, J. (2007). "Evidence-based life coaching for senior high school students: Building hardiness and hope", *International Coaching Psychology Review*, volume 2, pp. 24-32.

2.6 Previous Studies on SuperReading™

Research on SuperReading™ aimed at identifying the specific causes behind the improvement of all readers and begun with the standardization of collected data around 2009, when the course was brought in England by Ron Cole. During that year, Dr. Ross Cooper from London South Bank University (LLU+) conducted a research on a group of 15 dyslexic readers to evaluate the effects of the course on individuals with a certified diagnosis of dyslexia, particularly interested in the global improvement in reading in this specific population, at the same time laying the foundations for further research. He measured the changes in three variables (Combined *Reading Effectiveness* – which corresponds to the sum of *Reading Effectiveness* calculated from first reading and *Reading Effectiveness* calculated from second reading – Scagnelli, Oppo, Santulli, 2014 - *Comprehension* and reading speed) during the course by using short essays made up of 400 words, maintaining also the modalities of administration established by SuperReading™. Moreover, Dr. Cooper employed two different tests before and after the course – WRAT4 Reading and Comprehension (*Wide Range Achievement Test 4*. Standardized with participants of different age range from the US, it is used in clinics as an assessment tool to observe a person's ability to read letters, words and sentences, to write and to solve mathematical problems - *Scagnelli et al*., 2018) and TOWRE Sight Word and Nonwords (*Test of Word Recognition Efficiency*. This standardized test is employed to observe the ability of reading and recognizing words and nonwords and diagnose reading disabilities in a population with an age range of 6 – 24 years old - *Scagnelli et al*., 2018). WRAT4 was used to test comprehension. This test showed three limitations for the research. First, WRAT4 was designed to test single words and isolated sentences reading, excluding the level of text and discourse. Second, it was reported by participants a widespread difficulty in finding the right word to complete the sentences during the weekly test, increasing factors such as stress and motivation. Third, this test – and the TOWRE – was standardized with American participants and therefore was not entirely reliable for individuals living in England. The TOWRE test, instead, was used to evaluate the ability to read and recognize words and non-words. For all these reasons, the method to test the variables were changed in following studies.

In his analysis of the collected data, Dr. Cooper confirmed previous findings made by Ron Cole and found out that Combined *Reading Effectiveness* underwent a significant increase for all participants from the first session of the course to the last (average increase equal to 110%, $p < 0.002$), with the 'non-compensating' group that showed more progress than the 'compensating' group (140% compared to 80%). Reading speeds and comprehension scores also changed significantly in both readings from the first test to the last test: moreover, the 'non-compensating' group of participants outperformed the scores of the 'compensating' group of participants collected during the administration of the first test. For what concerns the WRAT4 and TOWRE tests, only values collected from the TOWRE Sight recognition and Nonword (which is sensitive to reading speed) improved significantly (especially in speed and accuracy – Scagnelli, Oppo, Santulli), signaling that practicing with Eye-Hop™ improved print stability and contributed to diminish visual misrecognition (Cooper, 2009). Unexpectedly, the WRAT4 Reading Comprehensions scores remained stable. This was due probably to participants' difficulties in word retrieval and grammatical expression which consequently influenced comprehension rates, apparently not confirming the initial prediction of the benefits that SuperReading™ would have brought even to comprehension. In general, data from the two standardized tests suggested major improvement in all participants, but especially in participants with phonological decoding difficulties (Cooper, 2009; Scagnelli, Oppo, Santulli, 2014). Moreover, dyslexic readers who showed major difficulties in reading scoring the lowest points on all measures at the beginning of the course, had a more remarkable improvement in comparison to all other participants. Something that in Cooper's opinion generated the improvement in all participants is the acknowledgement of the *preview* techniques that helped enhance comprehension. The improvement observed in these participants can be included in the literature which concerns positive effects of metacognitive awareness and efficient reading: as Dr. Cooper says, "teaching preview skills is an important metacognitive strategy" (Cooper, 2009; page 15), and this statement can be held true both for neurotypical and dyslexic readers. Especially for the population last mentioned, it was observed that "readers with phonological decoding difficulties made better progress by building on their strengths rather than trying to remediate their weaknesses" using all the tools the SuperReading™ course possessed, confirming the importance of awareness of metacognition and explicit knowledge of strategies (Cooper, 2009; page 10).

Dr. Cooper later organized other courses, updating previous data acquired from dyslexic readers and publishing a new paper (2012). Once again, Dr. Cooper found out that significant improvement was present in all variables measured (*Reading Speed, Comprehension, Reading Effectiveness* from both reading sessions and Combined *Reading Effectiveness*), with median dyslexic readers' scores that exceeded the non-dyslexic scores, confirming the previous study. Dr. Cooper also confirmed that Eye-Hop™ was the most important component among all the techniques in the course and that the participants who practiced the most, benefitted the most. Even if the participants did not respect the recommended 40 minutes of daily practice (average minutes of practice was attested around 20 minutes), the improvement was significant. It was also clear that participants who practiced the most with this exercise, benefitted the most in terms of reading speed. For this reason, Dr. Cooper admitted that

> *(…) The visualization and visual approaches to absorbing meaning are a good fit with dyslexic strengths. (…) There is also no attempt to 'remediate' any perceived 'deficit', which can feel demeaning and frustrating and, in this way, undermine progress* (Cooper, 2012; page 40).

The Italian branch of research on SuperReading™ began soon after the first steps made by Dr. Cooper towards the evaluation of the improvement. In 2014, Scagnelli, Oppo and Santulli introduced the first results of the Italian experimentation of SuperReading™. Two groups of participants participated at this research: university students with a certified diagnosis of dyslexia and neurotypical readers (adults interested in topics concerning SLD and dyslexia or with experience in teaching and pedagogy). Even though it was clear from statistical analysis that not everyone practiced regularly with Eye-Hop™ (correlating percentage of improvement in *Reading Effectiveness* and minutes dedicated to *eye-hopping* practice), results were congruent with the one observed by Dr. Cooper in England, with an improvement in performance between baseline and the end of the course. The difference in scores in *Total Reading Effectiveness* from first to last test in both groups was proven to be statistically significant, with an important remark that *Total Reading Effectiveness* observed after the end of the course of dyslexic participants was comparable to *Total Reading Effectiveness* in baseline of neurotypical readers. Both first and second *Reading Time* improved significantly, showing a decrease in seconds employed to read. While *Comprehension* during first reading showed no significant change, *Comprehension* during review increased significantly in dyslexic participants, reaching – after the end of the course - the same percentage of comprehension (correct answers) of neurotypical readers. It needs to be underlined that neurotypical readers' performance measured during baseline was extremely good, with a high percentage of correct answers (90,5%); for this reason, it can be possible not to observe any significant improvement after the end of the course (91%) due to a ceiling effect (Scagnelli, Oppo & Santulli, 2014; page 191). The current study presented data that was acquired with the use of an eye tracker ("a technologic instrument that can monitor and register dilatation and contraction of the pupils; moreover, it is able to track the path of the eyes at the sight of a visual stimuli and to register in which areas visual attention lingered more" - Scagnelli, Oppo, Santulli, 2014; page 193. Translation made by the author) before the beginning and after the end of the course. The main objective was to analyze the eye movement patterns of participants while reading and to monitor the path of the gaze to detect differences between dyslexic readers and neurotypical readers. Moreover, scholars wanted to observe if there was a change in the ocular pattern caused by the practice with Eye-Hop™ and the other techniques. Results collected during both baseline and post-course signaled an evident improvement in both groups in the quality of visual attention on the text, underlining a more strategic approach to text after the end of the course, evident by the schematic search of information. Moreover, the change in the ocular pattern is especially evident in dyslexic readers: if during baseline collected at the second reading dyslexic readers showed a not-so-planned behavior when reading a text, at the second reading after the end of the course eye movements were more precise, more regular in their search of information, showing also an ocular pattern more similar to the one of neurotypical readers during review reading. It is worth noting that the general improvement was attributed at the efficacy of the course overall, and it was not specified which component brought this improvement and drastic change in eye movements.

Another Italian study (Santulli, Scagnelli, Oppo, 2016) expanded the existing data and confirmed previous results of 2014. Adolescents were included in the research along with adults: in addition, both groups of participants involved the participation of dyslexic and neurotypical readers. Results from this research confirmed the trend observed in previous literature. A constant decrease in *Reading Time* was detected in both groups, with a significant improvement from baseline to after the end of the course. Dyslexic students' performance especially benefitted from the training of the course: after the end of the lessons, it was evident that their reading speed could be compared to the one observed in dyslexic adolescents and adults, and that the improvement was greater in dyslexic adolescents than in dyslexic adults. Analyzing the neurotypical readers' group, adolescents display a greater decrease in seconds than adults, underlying that their improvement is greater (and still significant, -68% versus -33% of reduction in seconds spent on reading). Even though *Comprehension* showed no significant change in both groups of adolescents and adults, *Reading Effectiveness* during both sessions of reading exhibited a continuous increment from Test 1 up to Test 6, with dyslexic students that scored a higher *Reading Effectiveness* during Test 6 than the one of neurotypical students at the baseline, and with adolescents that collected better scores compared to adults.

Following the steps from the study conducted in 2014, data from 16 adults and 4 adolescents was collected with the use of an eye tracker following the same procedure adopted for the administration of the weekly test. Researchers observed the mean heat maps, the number of saccades (the real movements of the eyes during which no new information from the text is acquired) and the reading pattern for each subject, along with the collection of the original variables observed in SuperReading™ from both groups. Analyzing heat maps and mean fixations collected from dyslexic adults, it was evident that after the end of the course reading was significantly more efficient compared to baseline (respectively, $p = 0.010$ and $p < 0.010$). On the other hand, the reading pattern and behavior of the small group of adolescents observed during second reading at the baseline were not homogeneous; at the end of the course instead, the reading pattern during review has been uniformed, and adolescents are faster compared to baseline. In conclusion, data acquired with the eye tracker confirmed that participants showed a significant improvement in all variables observed.

The firsthand conclusion of this study concerned the differences in improvement between adolescents and adults, accounting that adolescents (neurotypical and dyslexic participants) benefitted more from the course and techniques in comparison to adults, who – however – still enhanced their reading speed and *Reading Effectiveness*. This discrepancy in improvement between groups can be accounted by the fact that adolescents' general abilities and knowledge of metacognitive strategies are less refined than the one possessed by adults. Moreover, adults participating at the course were mostly university students, teachers and participants with high competencies, cognitive and metacognitive resources, which could have already developed certain types of reading strategies ignored by less mature adolescents. Therefore, adolescents can benefit the most from a solid course such as SuperReading™ to become better readers and learners (Santulli, Scagnelli, Oppo, 2016).

The aim of the following study by Santulli and Scagnelli (2017) was to summarize data collected from all SuperReading™ courses in Italy: in this paper, they discussed the results from statistical analyses and confirmed results from previous literature, suggesting also to search other objective methods to measure reading skills. Finally, Scagnelli *et al*. (2018) presented a new research on SuperReading™ which included a battery of tests for the diagnosis of dyslexia, the BDA 16-30 (*Batteria per la Diagnosi della Dislessia, Disortografia, Disturbo di comprensione in adolescenza e in età adulta* - Ciuffo *et al*., in print). This innovative battery was employed to demonstrate the efficacy of SuperReading™ through the use of a standardized test, already calibrated on a large population. This standardized test is different from previous ones developed for adolescents and adults. It contains – among other components - tests to analyze speed during silent reading and fluency while talking; also, while previous batteries for the diagnosis of adolescents and adults were made from the adaptation of the batteries for children, this was made from scratch, becoming the first battery to test populations otherwise excluded by a late diagnosis of dyslexia (Scagnelli et al., 2018; page 41). The battery was administered before the beginning and after the end of the course to the population of the study – 3 neurotypical readers and 27 dyslexic readers for the experimental group, and 20 neurotypical readers and 2 dyslexic readers for the control group. Results were – once again – positive for what concerned the efficacy of the course: improvement has been detected in all variables considered in both groups (dyslexic and neurotypical readers; *Reading Time*, $p < 0.001$; *Comprehension*, $p < 0.001$; *Reading Effectiveness*, $p < 0.001$), and it was also confirmed by the BDA 16-30 battery (statistically relevant improvements were found in silent reading of a short text and in reading speed, both $p < 0.001$). Since the results of this study indicated a persistent problem within the reading sphere even in adults, researchers hinted to use SuperReading™ as a tool to approach dyslexia in adulthood (and late adolescence), and to continue the research on SuperReading™ by enlarging the Dyslexic reader of participants (lesser in number than neurotypical participants) and by comparing data from Italian and British researches.

2.7 Why Does SuperReading™ Work?

By analyzing previous literature, it has been demonstrated that the unique structure of the course brings many benefits and it is suitable for participants in their adolescence and adulthood, both neurotypical and dyslexic readers. From previous research (both in England and in Italy), it is clear that the course has positive effects especially on the dyslexic population, which benefits from the strengthening of certain subcomponents of the reading process.

The following points are a small recap of the strongest points of the course:

- Visual aspects: Eye-Hop™ "practice stimulates a different eye movement during reading, probably enhancing visual information processing, an aspect that is crucial in silent reading" (Santulli & Scagnelli, 2017; page 11). Though, to confirm the efficacy of the exercise and the precise working principles behind it, more research needs to be programmed and conducted;

- Metacognition: in the development of a learner, metacognitive knowledge and strategies can be assimilated to enhance and achieve text comprehension and learning goals. Research conducted in the educational field supports the notion that strategies – and, more in general, awareness of metacognition – can be taught to students of all ages through teachers' instructions. In first place, they bring awareness in students by using tools as the ones described above and observing previous knowledge of students they use it as a starting point to illustrate strategies, helping them building "domain-specific and domain general strategies, metacognitive knowledge about themselves and their cognitive skills, and how to better regulate their cognition" (Schraw, 1998; page 123), ultimately enhancing text comprehension and learning. Research also supports that implementing the explicit teaching of strategy use is positive for students in terms of text comprehension and learning efficacy. As an example, in a study by Boulware-Gooden *et al*. (2007), conceptual maps (vocabulary webs) were employed by students to learn new vocabulary: results showed that at the end of the training the students who learnt new vocabulary through the use of conceptual maps increased their knowledge in synonyms and antonyms of 40% compared to students who only wrote the word and then used it in a sentence.

Now it is clear why large part of the SuperReading™ course focuses on bringing awareness on the existence of metacognitive strategies that enhance the performance - specifically for this case - in reading comprehension. The fact that these strategies are explicitly explained and taught in a course means that metacognition can be trained. Its awareness and the explicit knowledge of metacognitive strategies play a crucial role in reading comprehension, and this is evident when comparing data before and after the training. A clear example can be the one described by Santulli and Scagnelli (2017), in which *Reading Time* during first and second reading underwent an exponential improvement after the learning of the *preview* techniques. If at the beginning of the course there was only a small difference, after the end of the course, the gap between first and second reading from the first to the last test widened. Time measured during review was reduced to a handful of seconds, giving the impression that readers just scanned the text while searching for the information they needed, lingering only in those parts they did not remember well while answering the questions by using especially previewing and reviewing techniques (Santulli & Scagnelli, 2017);

- Emotional component: dyslexic readers are characterized by low self-esteem and general difficulties for what concerns the emotional sphere. These individuals need to be supported during the years of formal education, with teachers who need to understand their needs and know what dyslexia is to motivate them and never let them think that they are less intelligent than their peers. The course takes care of this aspect with the presence of a coach - that guides all the participants through every aspect dealt during the meetings and motivates them – the buddy system, in which participants remind one another to keep up with the exercise and the promotion of several techniques and positive affirmations. What has emerged from literature and from personal stories told by individuals with a diagnosis of dyslexia is that most of them have had negative experiences linked to their difficulties and how their peers perceived them. These negative experiences involving emotionality and the wrong approach to dyslexia without doubt had effects upon dyslexic students' scholastic and academic achievements: in this sense, researchers and scholars have tried to plan interventions to make better the emotional sphere of students with a diagnosis of learning disabilities, in addition to hoping for more awareness and training of educators on the knowledge of SLD. While some studies which involved education to emotionality, group counseling or a training in cognitive strategies did not show the expected positive results (Bender & Wall, 1994), others presented a more positive framework, with experimental training which improved metacognition awareness and skills along with the emotional sphere. A case study reported by Long and colleagues (2007) is a clear example of an intervention with positive results that conciliate the strengthening of metacognition - by teaching the subject how to reflect upon his own learning style, to empower himself bypassing the difficulties caused by the learning disability exonerating him from reading aloud and dictation exercises and encouraging him to use conceptual maps to study – and the psychological and emotional support given by a mentor. In this group of experimental interventions with positive feedback concerning the amelioration of metacognition and the emotional sphere can be accounted SuperReading™. In fact, the course could be indicated as a valid integration to counseling, and as a great opportunity for inclusion and for growth of the emotional sphere for (neurotypical and dyslexic) teenagers and adults due to its characteristics. In fact, among many reasons – such as complexity of the strategies and tasks taught - participation at the course is recommended for students who are in their adolescence due to its prerequisites. In other words, both neurotypical and dyslexic individuals need to have reached a certain degree of automatization of the reading process that younger students do not have. This course represents the perfect opportunity to develop inclusion in classrooms and work environments, during which individuals learn, discover and improve themselves as readers. Focusing on the emotional component, the course aims at ameliorating self-confidence and self-efficacy, also teaching the participants to control the emotional sphere which can be an obstacle in situations in which they are tested, at the same time improving their approach to cognitive tasks and to solve them more efficiently.

CHAPTER THREE: SuperReading™: Where Does the Improvement Come From? The Effects of *Eye-Hopping* on Reading Speed

3.0 Introduction

At the very beginning of this dissertation it was explained what the SuperReading™ course is, how it is structured, and how the techniques that are taught influence the reading performances of both neurotypical and dyslexic readers. Still, it is not completely clear which component brings many benefits in reading speed and effectiveness and influences the improvement especially in dyslexic readers. For this reason – as a first step in a more complex and articulated research - this study focuses on analyzing the effects brought by the most characteristic exercise, *eye-hopping*. This chapter will focus on describing the original research to answer questions concerning the improvement of silent reading speed and other variables such as *Reading Effectiveness* in participants at the training.

The experimenter attended personally the SuperReading™ course at Ca' Foscari University in Venice for two months, to learn the various techniques SuperReading™ offers, understanding how they work and how the coach guides participants during the course. Later, the experimenter started planning a study to explore which effects of practicing *eye-hopping* would have brought to participants. Following considerations upon previous studies on SuperReading™, a five-week training was programmed to observe if and how eye-hopping practice would have influenced the performance of participants (Scagnelli, Oppo, Santulli, 2014). In Scagnelli, Oppo, Santulli (2014) are listed a series of possible studies to continue the experimentation: one of these suggests putting together a group of participants in which only the Eye-Hop™ exercise is explained and practiced. The improvement is monitored by administering every week a test which consists in reading a short text (400 words) and in answering 10 questions. In addition, it is recommended by the authors to collect data using an eye-tracker to observe the ocular pattern before and after the training. Unfortunately, this last analysis could not be carried out due to the lack of the required tool. However, the research project was based on a six-week training in which the participants needed to exercise every day with the Eye-Hop™ technique following the timing and instructions given by the coach (which is – in this case – the experimenter). To collect data and follow the personal course of improvement of the participants involved, they had to take part to a comprehension test every week.

3.1 Method

3.1.1 Participants

Twenty-one Italian-speaking adult students enrolled at Ca' Foscari (Venice) participated in this study. Participants are 3 males and 18 females, for a total of 21 students, from age 19 to 30 (mean age = 21 years old, SD = 2,85). They were recruited in a university residence in Venice, making easier to support them throughout the training, exercise together and administer the weekly test to all participants in the same moment. Twenty students are neurotypical readers, while only one participant has a certification of developmental dyslexia. For this reason, neurotypical readers were divided from the single dyslexic reader. This subdivision was maintained in data analysis.

All participants were informed on all aspects of the research – from the daily training to the treatment of collected data from the weekly tests – and they all signed an informed consent containing a detailed description of the research, in which they authorized the analysis and the divulgation in scientific environments of the collected data. Data from the weekly tests were filed in paper and digital copies to later elaborate statistical analyses. The research was conducted in full compliance with the Italian law (Decreto Legislativo 30 giugno 2003, n° 196 – Codice in materia di protezione dei dati personali; G. U. n° 190 14 agosto 2004, Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi scientifici e statistici) and the *Ethical Principles for Medical Research Involving Human Subjects* (World Medical Association Declaration of Helsinki).

For a detailed overview on the demographic data of participants, see *Appendix B*.

3.1.1.1 Drop Out

By the end of the current study, 3 participants (S1, S3 and S16) out of 21 did not conclude the research by abandoning the training – respectively – after the first, the second and the third weekly test. The three participants left the research for the same reason – due to incoming exams and study. Drop outs during SuperReading™ courses are a common problem, previous studies conducted by Cooper (2009) and Santulli, Scagnelli and Oppo (2014) show the same phenomenon, and this should not be underestimated. Data from these participants were not considered in the final analysis.

3.1.2 Procedures

The day before the beginning of the training, purpose of the research, the procedure with which the weekly tests would have been administered, and – in general – information about the modality of the training were illustrated to all participants. This training was programmed to be held from May 8th until June 13th, 2018 (for a total of five weeks) and it consisted in exercising every day starting from 10 minutes and concluding the training period with 20 minutes of Eye-Hop™, excluding the rest of the techniques taught during the SuperReading™ course. During the first meeting, informed consents were collected from the participants (see *Appendix C*) and the schedule of the meetings was planned based on their necessities. The aim of this organization was to gather regularly all together in group to exercise for the planned period of time: in this way it could be observed by the experimenter if Eye-Hop™ was delivered with the correct modality by the participants and – most importantly – to observe if all participants would have followed the scheduled timing for the reading exercise.

On the first day of training, the experimenter explained how to execute the *eye-hopping* exercise with a practical explanation. All participants exercised together, they were able to ask question to the experimenter regarding the modalities of execution. On the same day, the first weekly test was administered to the participants to measure the baseline of the considered variables, that is the initial scores of *Reading Time* (calculated in seconds), *Comprehension* (calculated in percentage), *Reading Effectiveness* (calculated by multiplying words per minute and percentage of comprehension) and *Words Per Minute* during first and second reading. During the first week of the training participants practiced with Eye-Hop™ 2 for ten minutes per day, occasionally taking time to rest after five minutes of practicing. A pause was included in the practice time because this exercise implicates a new pattern in the movements of the eyes that could cause distress in participants. In fact, it has been reported that participants from past courses have reported a common feeling of tiredness after few minutes of practicing during the first days of the training, because the movement the eyes make in this exercise is different from the linear way of decoding they are accustomed to. Time dedicated to practice and type of Eye-Hop™ were modified week by week; moreover, between weeks of practicing with a certain type of Eye-Hop™, a week of transition was included before starting practicing with more difficult exercises (Eye-Hop™ 2 and 3 during the second week of training and Eye-Hop™ 3 and 4 during the fourth week of training). This resulted in a more gradual progression to accustom the eyes to absorb more information and words and to gradually eliminate subvocalization during silent reading. *Table 1* illustrates the schedule of the training week by week. As it was already mentioned, the training was set to last 6 weeks (5 weeks of training with the Eye-Hop™ technique plus a follow-up test, a week after the conclusion of the training).

	Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
Eye-Hop 2	10 min. (5 + 5)					
Eye-Hop 2-3		12 min. (6 + 6)				
Eye-Hop 3			14 min. (7 + 7)			
Eye-Hop 3-4				16 min. (8 + 8)		
Eye-Hop 4					20 min. (10 + 10)	Follow Up (no E-H)

Table 1. Schedule for the daily Eye-Hop™ exercise. It is characterized by a gradual increase of minutes dedicated to practicing the technique – from 10 to 20 minutes – and weeks of transition from one type of exercise to another one, more complex and with more numerous groups of words (see Week 2 and Week 4).

After ending of the 5-week training and the collection of data from the six tests, another step in the research have been made by administering another test during a follow up meeting a week after the end of the formal training. This follow up meeting was characterized by the presentation of only one set of the techniques taught in the SuperReading™ course, one that helps readers in the global comprehension of the text and saves seconds dedicated to reading. The set of techniques that was described is called *anteprima*. Its main purpose is to allow readers to have a general idea of what they are going to read, and which are the most relevant of the text/chapter, giving the possibility to visually memorize the most important information contained in the passage they are reading. Under what is called *anteprima* are filed techniques such as the reading of each first sentence with which a paragraph begins: this procedure allows readers to understand and begin to focalize on the contents of the text/chapter they are reading. Other techniques include scanning the text to find words written with a contrasting font, names, dates or numbers; in this way, readers will be able to memorize the relevant information before reading carefully the complete text.

This additional step in the research was planned to observe if knowledge of the techniques included in *anteprima* would have brought further improvement in all measured variables or only in specific ones such as comprehension: this question was posed because previous research on SuperReading™ hinted that Eye-Hop™ influences mainly reading speed.

After having illustrated the various techniques of *anteprima*, the test was administered to the participants: they needed to respect the usual procedure used during previous comprehension tests, but they also had to include *anteprima* in the first 30 seconds of both reading sessions. These 30 seconds were counted as part of the time employed to read the text.

A difference from SuperReading™ that needs to be noted is about the figure of the *buddy*: it was not as strictly intended by the course for obvious reasons, since all participants at this research lived in the same building. The course suggests finding a buddy – another participant – and exchange telephone numbers to contact each other every day as a reminder to exercise and practicing with the techniques learned during the meetings. In this research, the fact that participants and the experimenter lived all under the same roof helped remembering one another to keep on with the exercise daily. *Buddies* were all the participants for one another, as a group. The experimenter – as a *coach* – kept motivating each participant every day, listening to their questions, encouraging them to exercise as much as they could for the day. The fact that some of the participants were roommates helped them to keep practicing every day, *eye-hopping* alone or in company during pauses from studying for exams.

3.1.3 Materials

Every week, one of the six comprehension tests (from A to F) was randomly administered to participants to evaluate the progress in *Reading Effectiveness* and the other variables (*Reading Time*, *Words Per Minute* – henceforth, *WPM* -, *Comprehension*). The first test was administered the day the training started, right before explaining the execution of the exercise. The following comprehension tests were administered week by week each Wednesday, for a total of six comprehension tests. A follow-up test (H, the same for every remaining participant) was administered a week after the end of the training to observe if any effect of *eye-hopping* was still present and if comprehension scores would have increased after having taught a set of metacognitive strategies taken from the SuperReading™ course. Each test contained a 400-word text in a standard format and ten comprehension questions that participants had to answer with few words (numbers, dates, names, etc.) after finishing reading. Participants read the text as fast as they could, preserving comprehension; after finishing reading, they had to take note of the time spent on reading and answer ten questions without the possibility to check the text. This procedure was carried out a second time: participants needed to review the text, take note of the time and answer the same questions another time. The second time the procedure was carried out, participants could not consult the answers they had given while answering the first time. Each participant needed to write down on a score sheet the time taken to read the text, comprehension score of correct answers (expressed in percentage), *Reading Effectiveness* (calculated by multiplying words per minute and comprehension score) and words per minute from both sessions of reading. The revision of correct answers was carried out by following the indications given during the course, and it was effectuated by participants with the help of the researcher. Participants needed to assign

10 points if the answer was correct and 5 points if the answer was partially correct, for a total of 100 points (Santulli & Scagnelli, 2019).

The duration of the weekly test (first silent reading of the text – questions to test the reading comprehension – review of the text - questions to test the reading comprehension) was about of 20-30 minutes, pauses included. The tests were the same that are presented during the official SuperReading™ courses in Italy, designed by a team of translators at IULM University in Milan after having analyzed the ones administered during the course in England. Tests used in the Italian course are comparable to the ones used in the English course by structure and complexity (Scagnelli, Oppo, Santulli, 2014).

3.1.4 Predictions

For this study, many predictions regarding the influence of Eye-Hop™ practice were made.

1. Cole suggests that *eye-hopping* every day for 40 minutes should bring benefits in reading speed, and that *Reading Effectiveness* should double by the end of the SuperReading™ course (Scagnelli, Oppo, Santulli, 2014). The hypothesis is that if there is a statistically significant difference between baseline and post-training tests, Eye-Hop™ should be considered the first and most important source of improvement in reading speed both in neurotypical and dyslexic readers. Moreover, it could be concluded theoretically that the eyes have acquired the movement stimulated by the exercise, leaving behind the traditional linear reading;

2. The SuperReading™ course is organized in 6 meetings held in a span of 10 weeks (approximately two months). This study, however, was organized differently, since the possibility the participants had to exercise with Eye-Hop™ was limited due to the incoming session of summer exams. For this reason, the duration of the training and the maximum minutes of daily exercise were

divided in half compared to the original course, organizing the training for 5 weeks plus a meeting during which a follow-up tests would have been administered, and setting the minutes of daily practice to maximum 20 minutes. If practicing for 40 minutes every day for 10 weeks would double *Reading Effectiveness*, with the current organization of the training, the improvement should be attested around 20-25% in *Reading Effectiveness* and in other variables such as Reading Time and *WPM*.

3. If participants will not respect the schedule of the training by exercising, it can be predicted that improvement could be minimal or could not be statistically significant. If Eye-Hop™ teaches a different pattern of eye movements to participants through practice and habit, but there is no regular exercise, improvement could be less than the one that is expected.

4. Another fact to keep in mind is that the only technique that is practiced in the training for the current study is Eye-Hop™. Except for the techniques part of *anteprima* – that were explained only during the follow-up meeting – no other strategy was mentioned in this study to participants. This means that participants will ignore strategies that catalyze – with the combined action of Eye-Hop™ – reading speed and facilitate the absorption of information by highlighting certain elements in the text or by giving the opportunity to readers to have a general idea of what the text is about. For this reason, it can be predicted that comprehension percentage is not going to improve significantly, at least in tests from 1 to 6.

5. Because during the follow up preview strategies are introduced to observe if there is a further improvement from test 6 (post-training) in all measured variables, it could be predicted a general enhancement. This could happen because preview techniques teach participants how to move across a text, allowing readers to understand globally its topic and to collect information that could be relevant to understand the topic of the text, saving on seconds while reading and improving comprehension.

6. Participants' performances could be influenced by a series of factors such as previous knowledge of a certain topic that may come up in a text, tiredness, stress, motivation, interest, personal tendencies, that cannot be fully controlled by the experimenter nor by the type of test. Certain factors could have been avoided only by the explicit knowledge of metacognitive strategies, which give the possibility to readers to approach texts with objective tools (like preview techniques) to control subjective factors that could influence the performance, for this reason it can be predicted that comprehension rates will not increase significantly.

7. All considerations and predictions made in the previous points can be equally referred to both groups. This means that in the performances of the dyslexic reader should be found significant improvements in the scores concerning reading speed, a decrease in seconds employed in reading a text, and a general improvement of *Reading Effectiveness*. On the other hand, comprehension rates should not be influenced since the lack of teaching and explicit knowledge of metacognitive strategies.

3.1.5 Results

After having recorded the data gathered during participants' weekly tests, descriptive and statistical analysis were conducted. Statistical analyses were ran using the software *R* (version 3.5.1). As a first step before beginning the analysis, the prerequisites for the use of parametric tests were ran on each variable.

After running the *Shapiro-Wilk Test* to evaluate the presence of normal distribution in each variable, it was decided to use a non-parametric test. Only three (time of first reading, comprehension first reading and Reading Effectiveness at first reading) out of ten variables could be analyzed using the paired t-test: under these circumstances it was decided to use the Wilcoxon Signed Rank Test, to conserve homogeneity in the analysis (the same decision was taken for another study – see Scagnelli et al., 2018). The *Wilcoxon Signed Rank Test* (and the *Wilcoxon Signed Rank*

Test with continuity correction) was used to analyze the differences between the performances of participants during the first comprehension test (before the beginning of the training) and the performances during the sixth and last comprehension test (after the conclusion of the training). This decision was taken to maintain consistency during the statistical analysis, even if some variables could be tested using the parametric *Student's Paired T-Test*. When describing the results of the statistical analysis ran with the Wilcoxon Signed Rank Test, it will be reported a V value instead of the wide-known Z value. This is due to a technical reason, that is that the R software and its codes are set up to give the V value in the outputs. However, the way more important p-value will be reported, giving the immediate answer to readers if there is a real change of performance from Test 1 and Test 6. It was also calculated the *effect size* using Cohen's formula elaborated in 1988, this to quantify the "magnitude of a phenomenon[142]", that is how much improvement was made from baseline to post test. Following Cohen's indications, the effect size can be very small (0.01), small (0.2), moderate (0.5), large (0.8), very large (1.2) and huge (2.0) (Sawilowsky, 2009; Cohen, 1998).

To analyze the data acquired from the dyslexic reader was decided to run two different tests. The first one – the *Crawford-Garthwaite* (2007) Bayesian test – was used to compare the data from the single-case to the control group to observe if there was any significant difference between the performances of the two groups. The second one – the *Mellenbergh and van den Brink* (1998) test – was used to compare "the difference between baseline and post-test (of a single-case) to the standard deviation of a control group" (Makowski, 2018). As "standard deviation of a control group" was used the one calculated from data of each variable that was collected during Test 6.

Results from the neurotypical readers are reported in the graphs of the next paragraphs.

[142] Source: *Wikipedia*, "Effect Size", < https://en.wikipedia.org/wiki/Effect_size >.

3.1.5.1 Neurotypical Readers

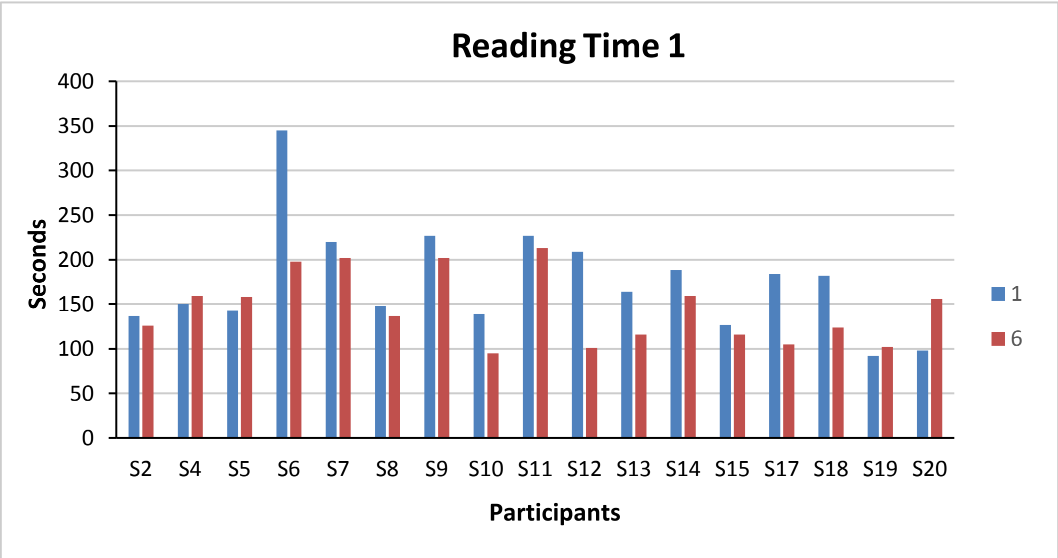
3.1.5.1.1 Reading Time

In general, neurotypical readers spent less time reading in all variables concerning *Reading Time* from Test 1 to Test 6. *Table 2* (following page) summarizes the results from the statistical analyses on the *Reading Time* variables.

	T1	T6	Difference	*p*-value
Reading Time 1	175	145	-17%	$p = 0.01$
Reading Time 2	110	83	-23%	$p = 0.008$
Total *Reading Time*	285	227	-20%	$p = 0.006$

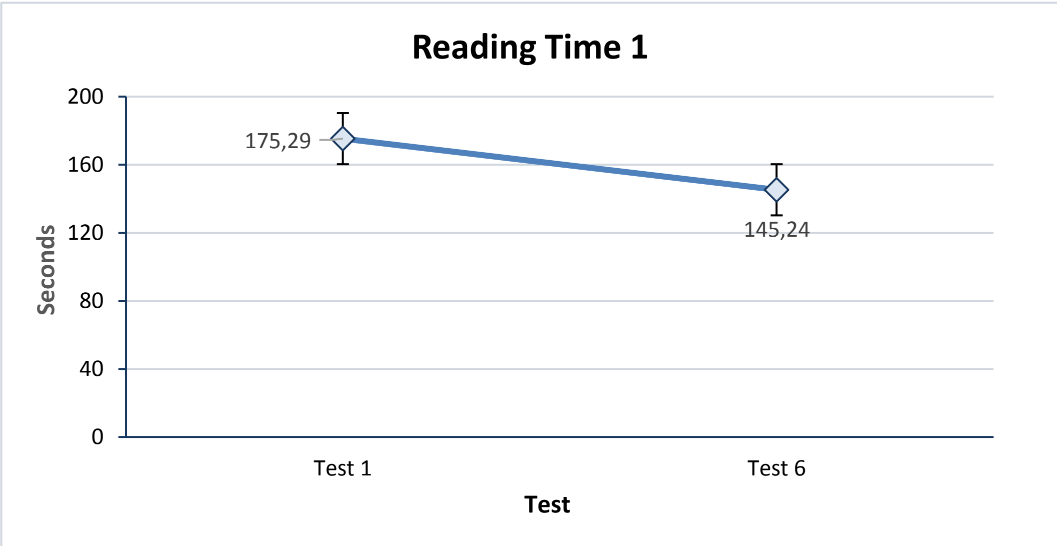
Table 2. Results from statistical analyses on all variables of *Reading Time*.

Graph 1a below shows a decrease in *Reading Time 1* from the first session to the last in 13 participants out of 17.



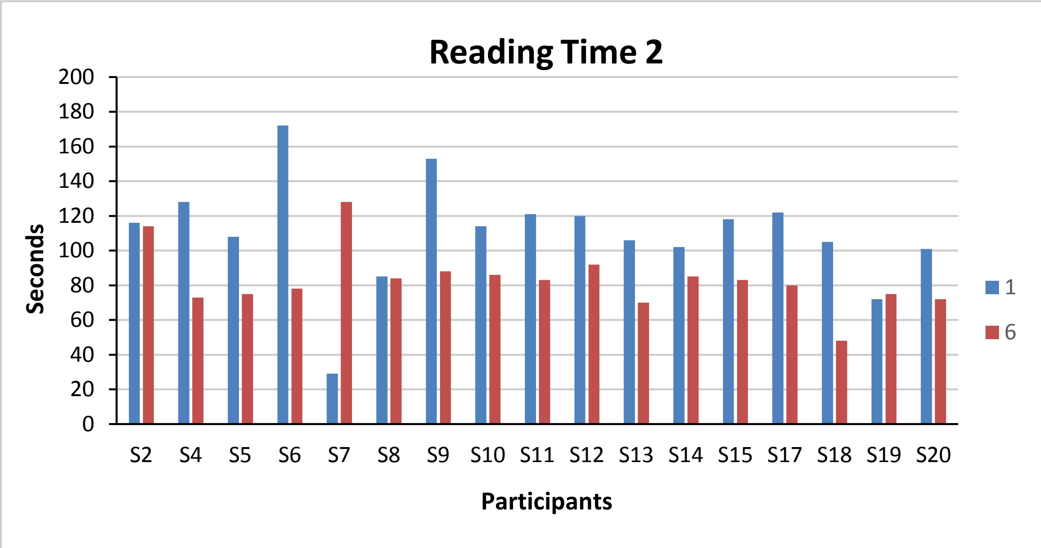
Graph 1a. Analysis of the performance of single participants in *Reading Time 1* in Test 1 and Test 6.

In the group of neurotypical readers, *Reading Time 1* has diminished of 30 seconds, going from an average of 175 seconds (SD: 60,3) in the first test to an average of 145 seconds (SD: 39,6) in the last test (*Graph 1b*). *Reading Time 2* decreased of 27 seconds, going from an average of 110 seconds (SD: 30,9) to an average of 83 seconds (SD: 17,5) (*Graph 2b*). Adding up the seconds taken to read the text the first and the second time, we see that *Total Reading Time* diminished of 58 seconds from the first test before the training, going from an average of 285 seconds (SD: 79,2) to an average of 227 seconds (SD: 47,1) (*Graph 3b*).

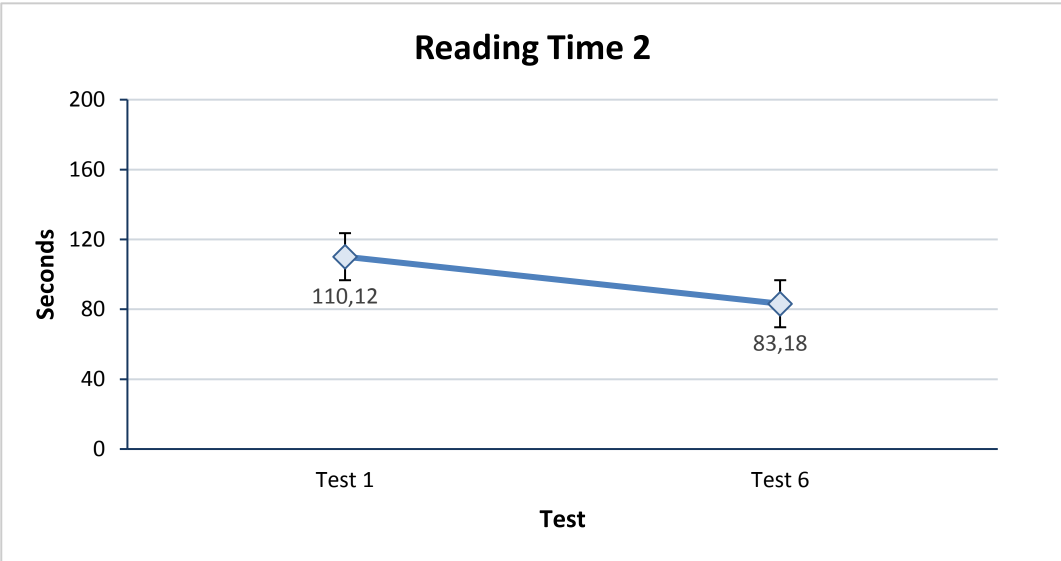


Graph 1b. Reading times (calculated in seconds) for first reading for neurotypical readers in Test 1 and Test 6.

Statistical analyses revealed a decrease in the values of the three variables concerning reading time. The reduction is statistically significant, showing a positive effect of *eye-hopping* practice on time spent on reading. The mean time observed in *Reading Time 1* - Test 6 is significantly lower than the one observed in Test 1 (Wilcoxon V = 129.5, p = 0.01288), a reduction equal to 16,5% (*Graph 1b*), and a medium effect size (Cohen's d: 0.6).

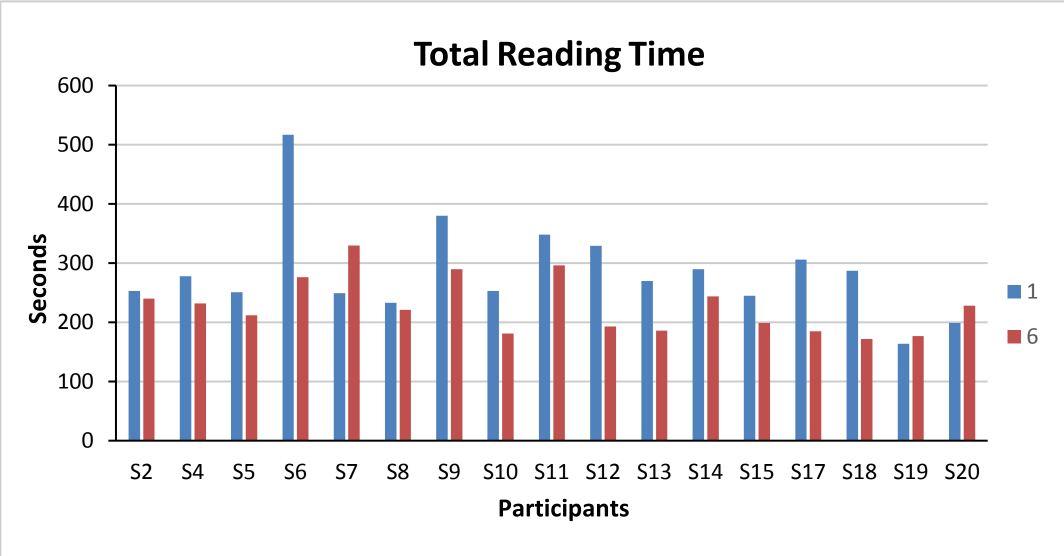


Graph 2a. Analysis of the performance of single participants in *Reading Time 2* in Test 1 and Test 6.



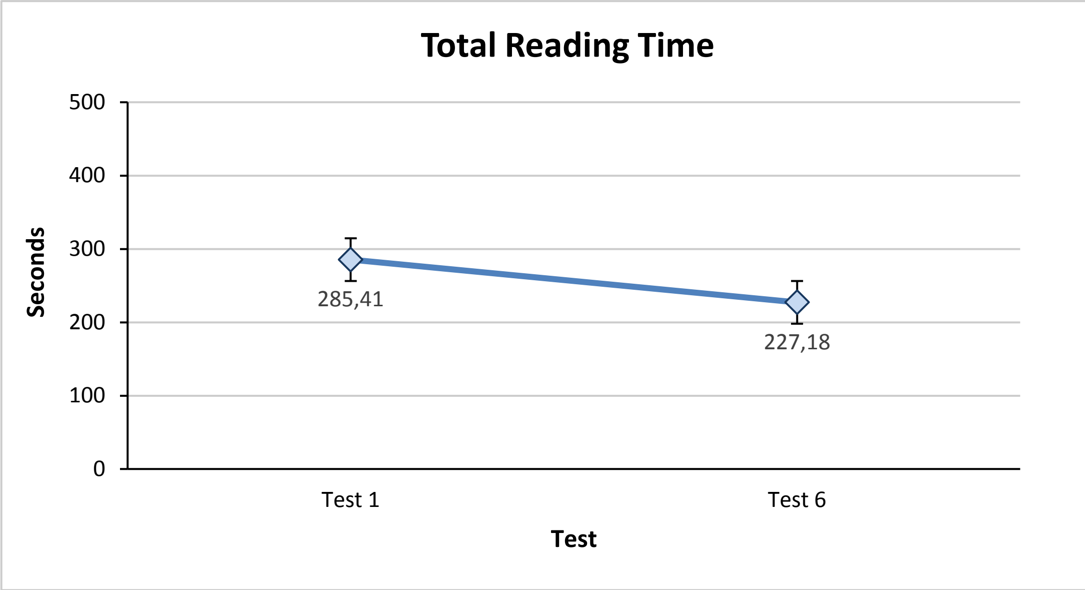
Graph 2b. Reading times (calculated in seconds) for second reading for neurotypical readers in Test 1 and Test 6. Keep in mind that review usually takes less time because of participants already know the text and which information need to search in the text to score 100% comprehension (Santulli & Scagnelli, 2017).

Reading Time 2 scores are characterized by the improvement of 15 participants out of 17 (*Graph 2a*). Scores in *Graph 2b* show a positive difference in performance between first and last test, statistically speaking. The reduction (-23%) between baseline and post-training was proved significant after running the *Wilcoxon Rank Test* (Wilcoxon V = 133, *p* = 0.008018), with an effect size attested at 0.4 (small ES) between baseline and the final test (*Graph 2b*).



Graph 3a. Analysis of the performance of single participants in *Total Reading Time* in Test 1 and Test 6.

Graph 3a shows a decrease in *Total Reading Time* in 14 participants out of 17. In general, a reduction of seconds calculated in *Total Reading Time* (-19,5%) was found to be statistically significant, confirming the real existence of an improvement even in this variable (Wilcoxon V = 135,5, *p* = 0.005585) (*Graph 3b*) and that *eye-hopping* has a real effect on reading speed. For what concerns the effect size of this variable, it is attested at 0.08 (very small ES).



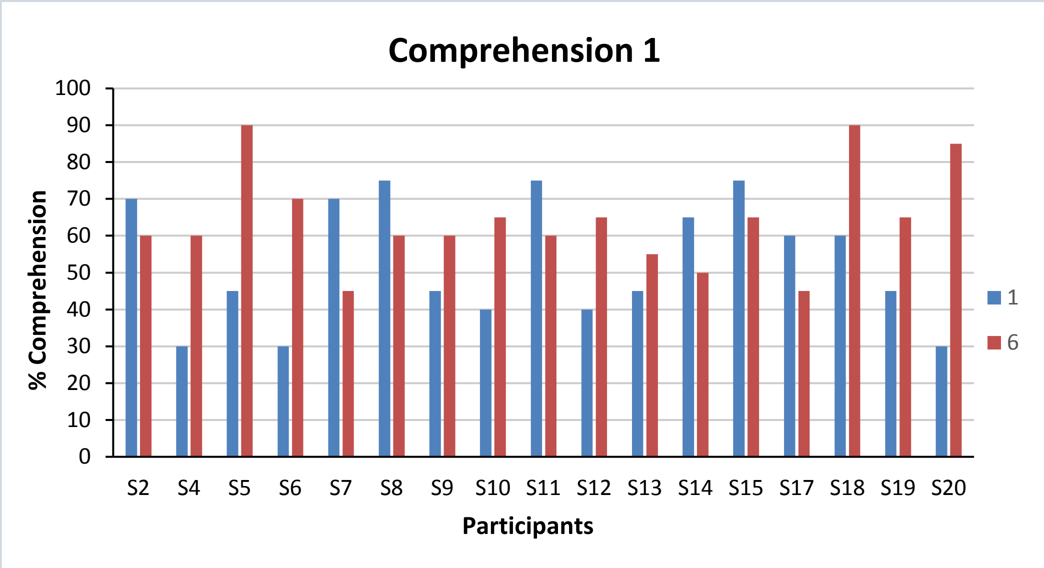
Graph 3b. Reading times (in seconds) calculated by summing up time employed for first reading and for second reading for neurotypical readers in Test 1 and Test 6.

3.1.5.1.2 Comprehension

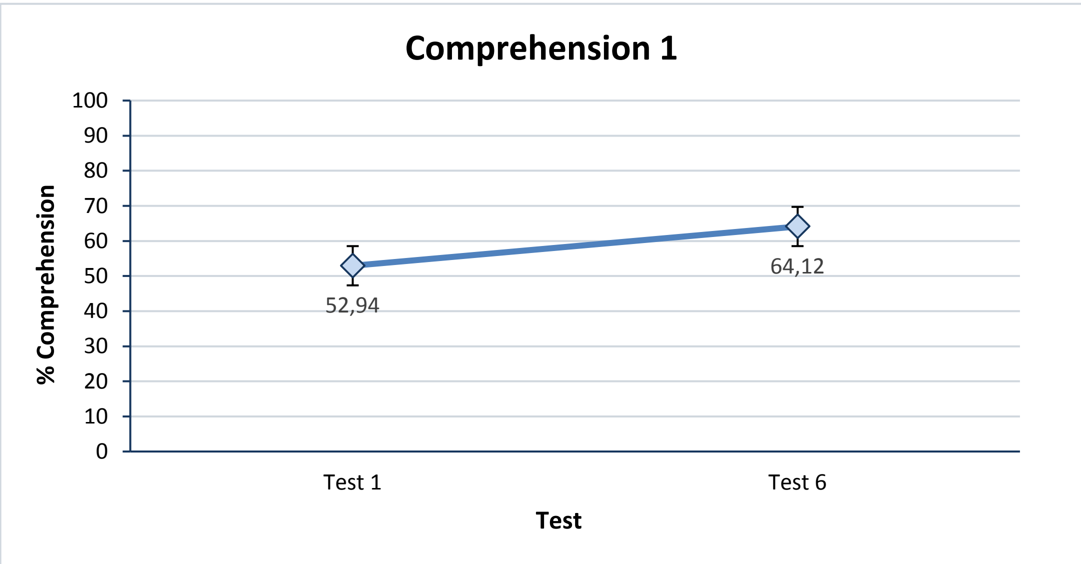
For what concerns performances in comprehension, it can be highlighted that the percentage has generally grown throughout the training, but there was no statistically significant improvement in both variables (*Table 3*).

	T1	T6	Difference	*p*-value
Comprehension 1	53	64	+22%	$p = 0.08$
Comprehension 2	81	90	+10%	$p = 0.06$

Table 3. Results from statistical analyses on all variables of *Comprehension*.



Graphs 4a. Analysis of the performance of single participants in *Comprehension 1* in Test 1 and Test 6.

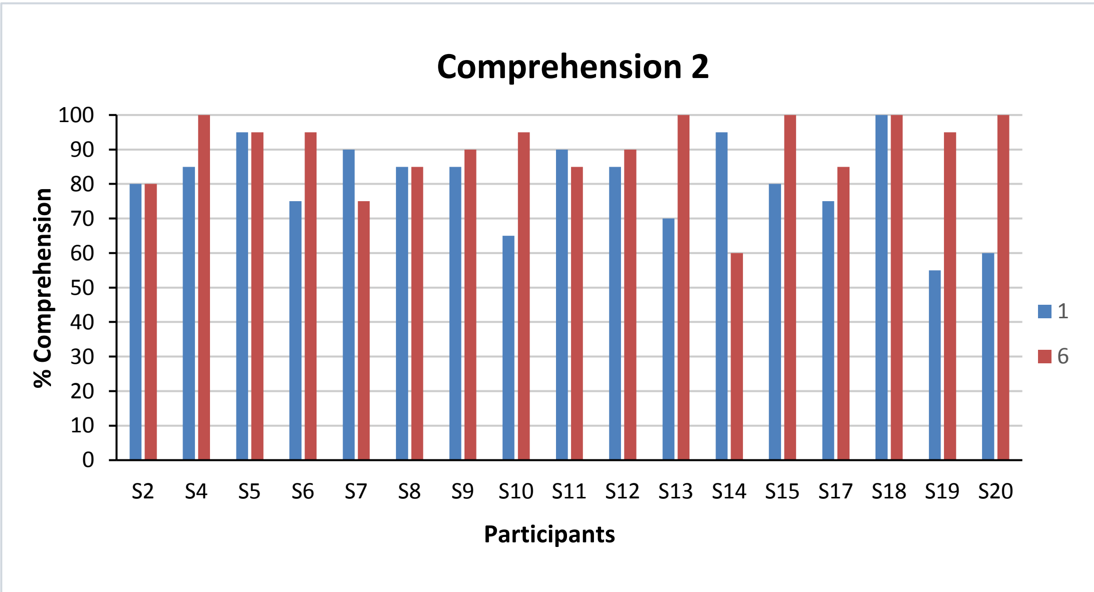


Graphs 4b. Comprehension rates (calculated in percentage) for first reading for neurotypical readers in Test 1 and Test 6.

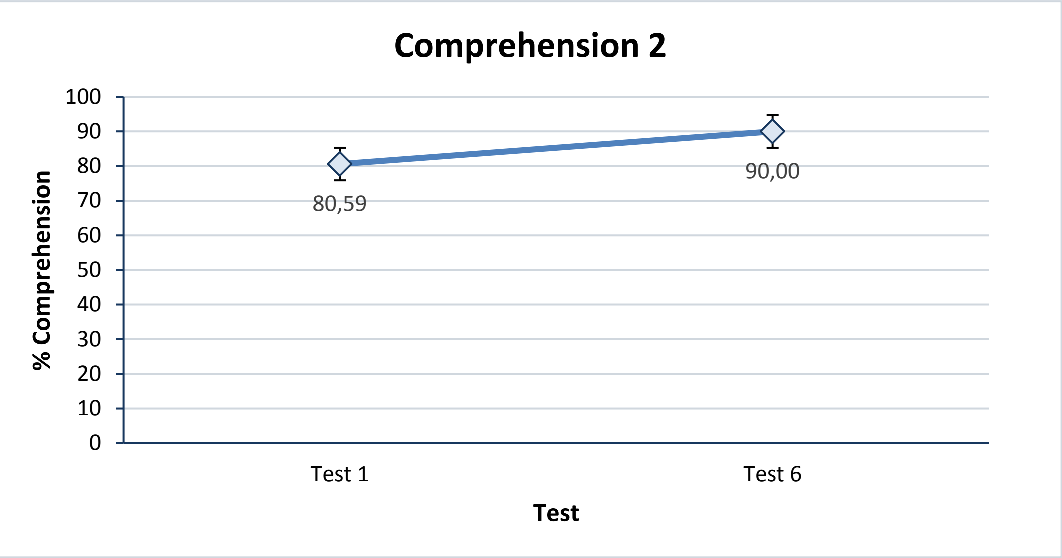
In *Comprehension 1*, 10 neurotypical readers out of 17 increased the comprehension rates (*Graph 4a*). Mean increased from 52,94% (SD: 16,7) to 64,12%

(SD: 13,5), with a growth equal to 22% (*Graph 4b*). On the other hand, in *Comprehension 2* 10 participants out of 17 increased the percentage of text comprehension, 4 participants scored the same rates both in Test 1 and Test 6, while 3 participants worsened their performance since Test 1 (*Graph 5a*). Comprehension rates increased from an average 80,59% (SD: 12,6) to an average 90% (SD: 10,9), with a growth equal to 10% (*Graph 5b*).

Even though there is a visible improvement in comprehension rates, there is no significant difference in both *Comprehension* variables from Test 1 to Test 6 statistically speaking (*Comprehension 1*, Wilcoxon V = 39, p = 0.07863; *Comprehension 2*, Wilcoxon V = 18.5, p = 0.06338), with ES of both variables attested at 0.4, as a small effect.



Graph 5a. Analysis of the performance of single participants in *Comprehension 2* in Test 1 and Test 6.



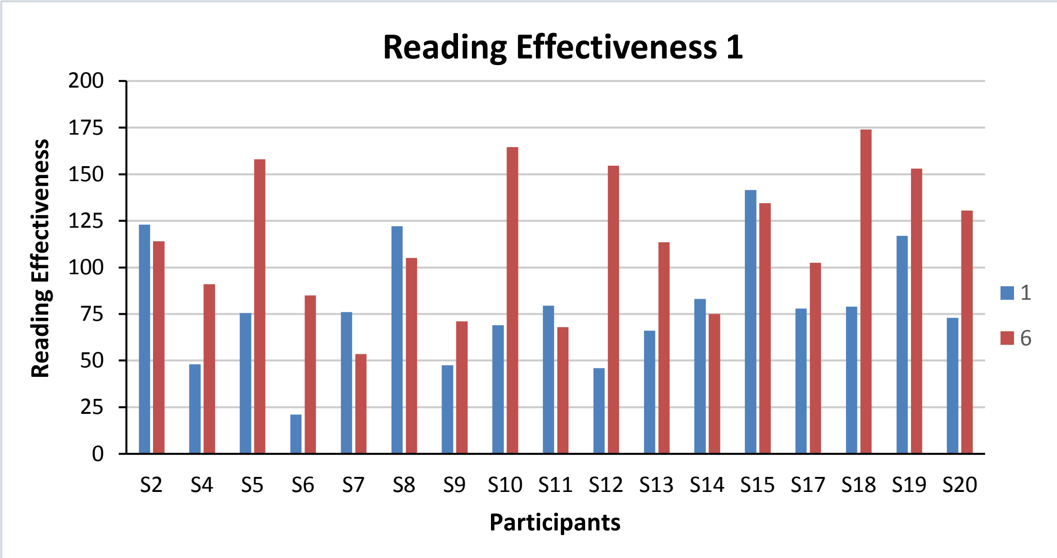
Graph 5b. Comprehension rates (calculated in percentage) for second reading for neurotypical readers in Test 1 and Test 6.

3.1.5.1.3 Reading Effectiveness

For what concerns *Reading Effectiveness*, it can be observed a general improvement in all three variables. In this case, the improvement is statistically significant, as the results signal in *Table 4*.

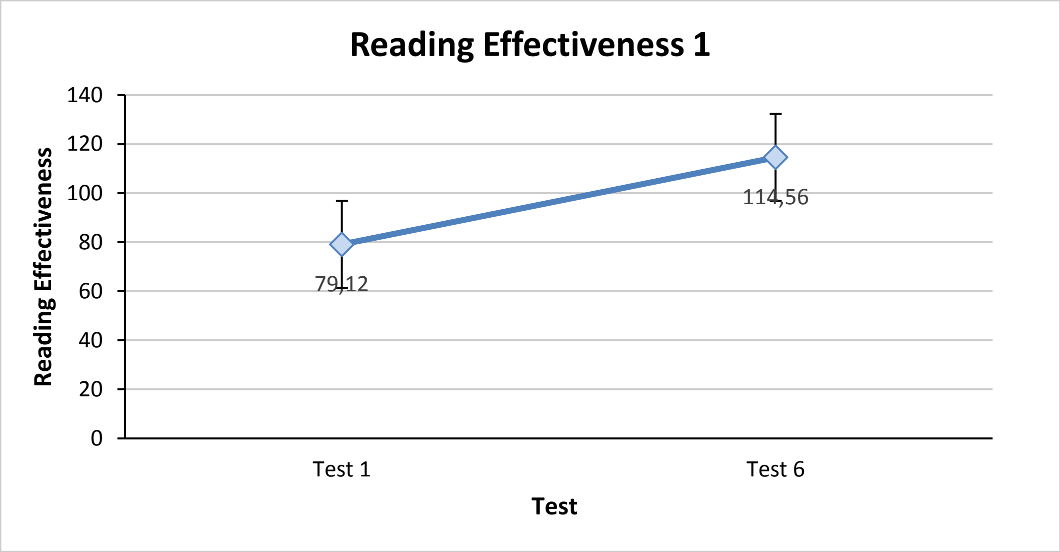
	T1	**T6**	**Difference**	***p*-value**
RE 1	79	115	+46%	$p = 0.007$
RE 2	205	274	+32%	$p = 0.006$
Total *RE*	285	389	+36%	$p = 0.01$

Table 4. Results from statistical analyses on all variables of *Reading Effectiveness*.



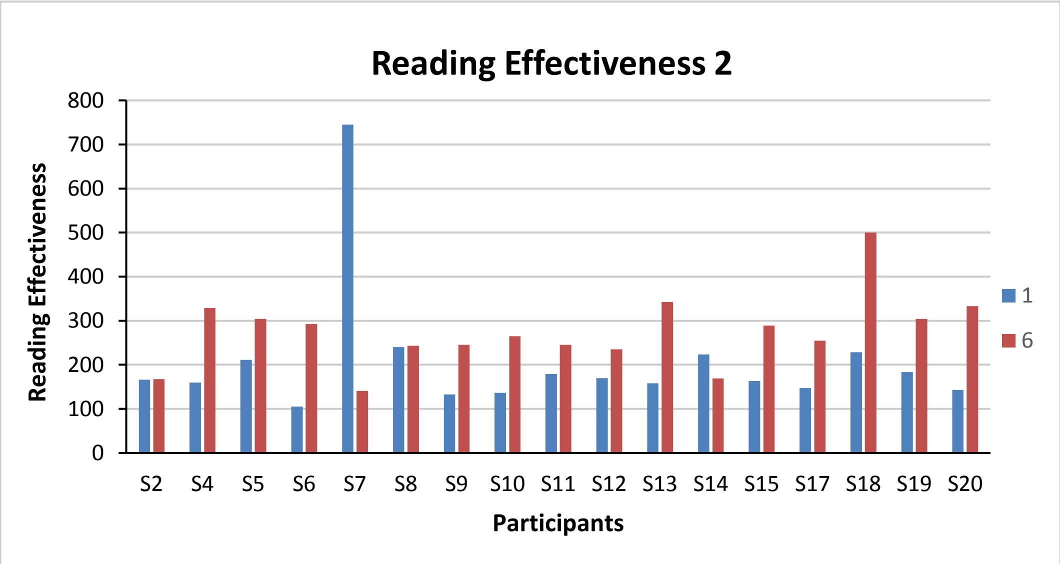
Graph 6a. Analysis of the performance of single participants in *Reading Effectiveness 1* in Test 1 and Test 6.

Reading Effectiveness calculated from first reading increased of an average of 35,44 points (+ 46%), from an average of 79,12 points (SD: 31,5) in the first test to an average of 114,56 points (SD: 37,6) in the last test. Out of the totality of neurotypical readers, 11 participants increased the rates on Reading Effectiveness during first reading (*Graph 6a*). *Reading Effectiveness* during review improved in 13 readers out of 17 (*Graph 7a*). The same variable showed an increment of 32%, from an average of 205,44 points (SD: 143,8) to an average of 274,15 points (SD: 82,7) (*Graph 7b*). Last but not least, Total *Reading Effectiveness* grown of 36%, from an average of 284,56 points (SD: 150,2) to an average of 388,70 points (SD: 108,8) (*Graph 8b*). The variable underwent an improvement in 13 participants out of 17 (*Graph 8a*).



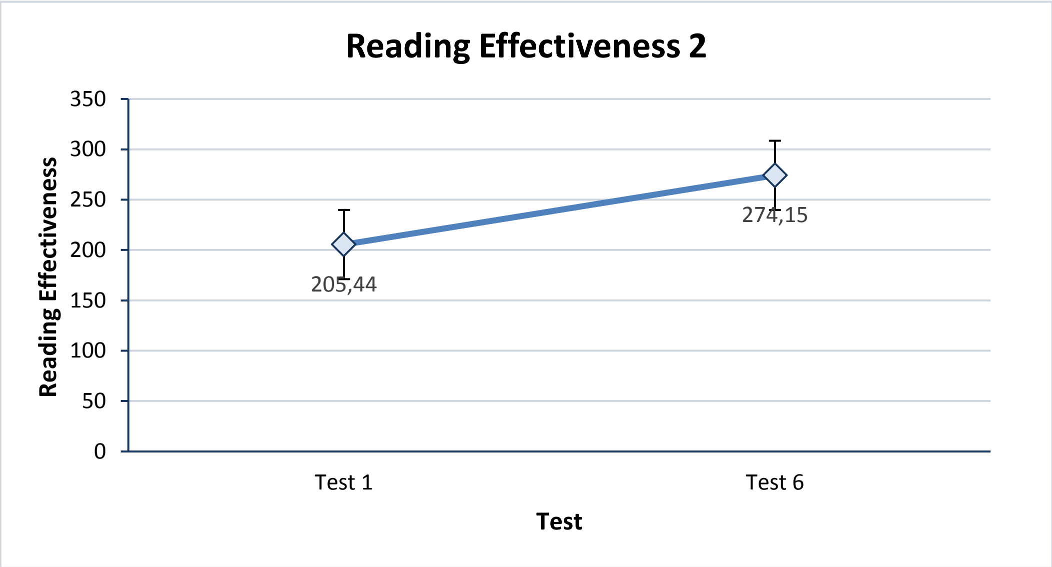
Graph 6b. *Reading Effectiveness* scores (calculated in points) for first reading for neurotypical readers in Test 1 and Test 6.

Graph 6b shows a notable improvement in *Reading Effectiveness 1* that has been confirmed as statistically significant by the statistics (Wilcoxon V = 21, p = 0.006653). For *Reading Effectiveness 1*, the ES has been reported as medium size (0.6).

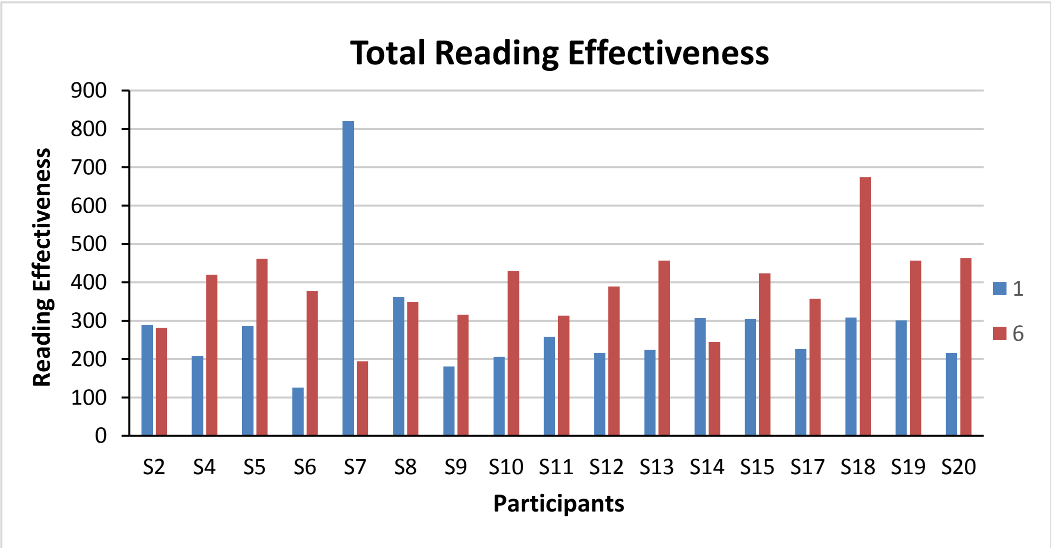


Graph 7a. Analysis of the performance of single participants in *Reading Effectiveness 2* in Test 1 and Test 6.

Graph 7b shows another improvement, the one that concerns *Reading Effectiveness 2*, with a statistically significant increase of points from Test 1 to Test 6 equal to 32% (Wilcoxon V = 20, p = 0.005569): in this case, the ES is attested at a small size, equal to 0.1.

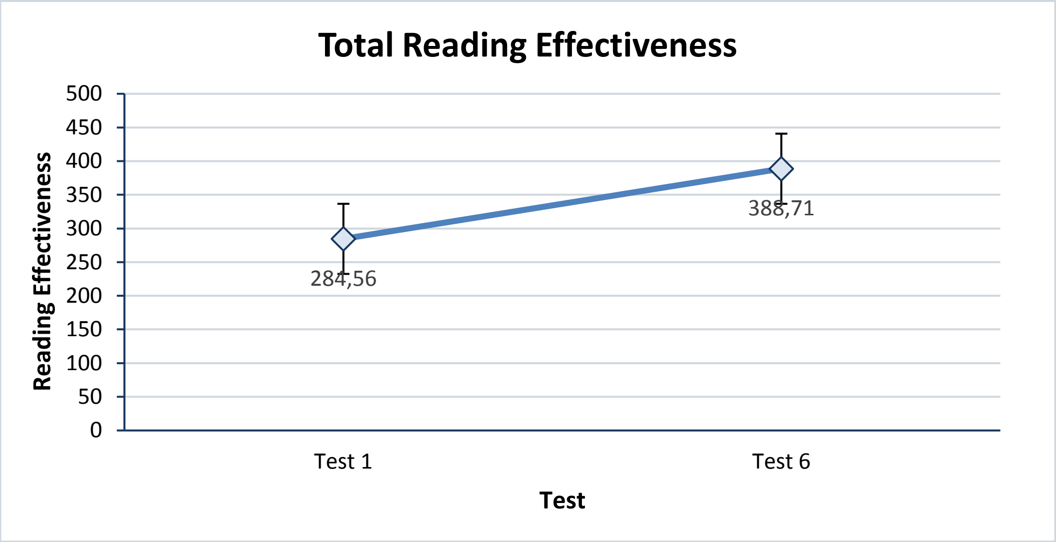


Graph 7b. *Reading Effectiveness* scores (calculated in points) for second reading for neurotypical readers in Test 1 and Test 6.



Graph 8a. Analysis of the performance of single participants in *Total Reading Effectiveness* in Test 1 and Test 6.

From what can be seen in *Graph 8b*, there is a significant improvement even in *Total Reading Effectiveness* (Wilcoxon V = 24, p = 0.01099), equal to a small ES (0.2). The mean values for this variable have grown from an average of 284,56 points in Test 1 to an average of 388,71 point in Test 6, with an increment of 36%.



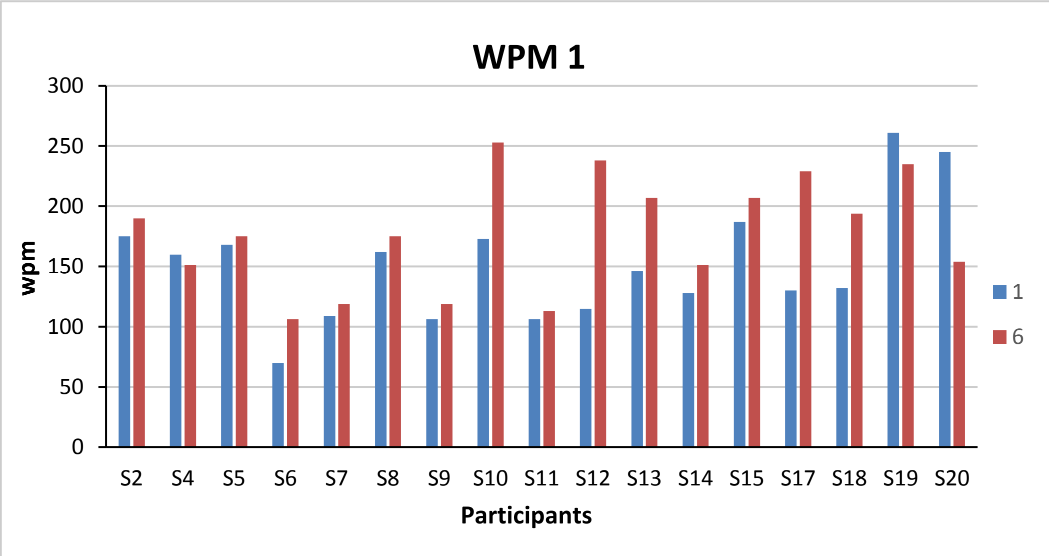
Graph 8b. *Total Reading Effectiveness* scores (in points) calculated by adding points from first reading and from second reading for neurotypical readers in Test 1 and Test 6.

3.1.5.1.4 Words Per Minute (WPM)

The effect of *eye-hopping* exercise on variables such as *Reading Time* and *Reading Effectiveness* has been already proven, statistical analyses are clear. Time diminishes, this means that more words are visualized with this alternative approach to reading that characterize Eye-Hop™. *Table 5* (in the following page) proves that even words per minute improved significantly both in the first reading and in review, highlighting an increase in reading speed.

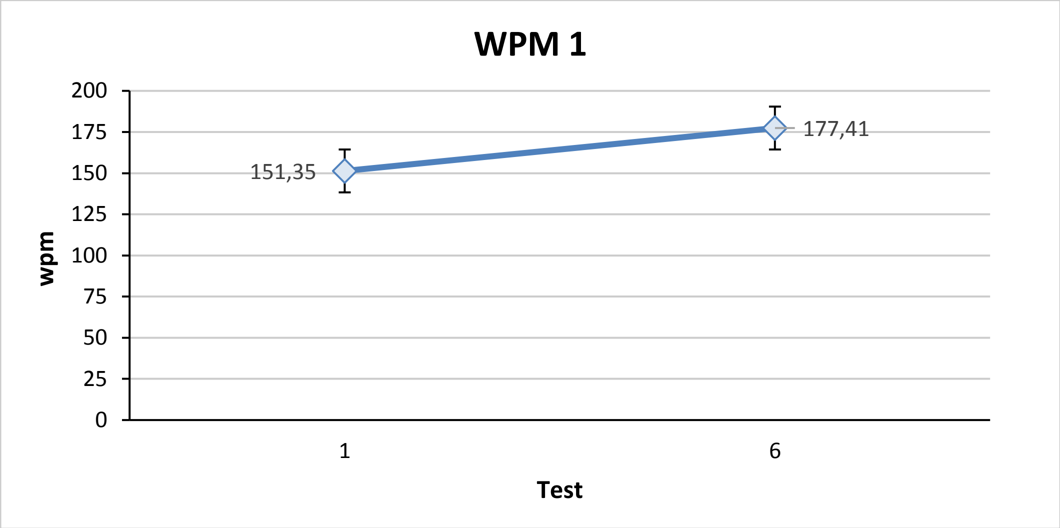
	T1	T6	Difference	*p*-value
WPM 1	151	177	+17%	$p = 0.02$
WPM 2	253	301	+19%	$p = 0.008$

Table 5. Results from statistical analyses on all variables of *Words per Minute*.



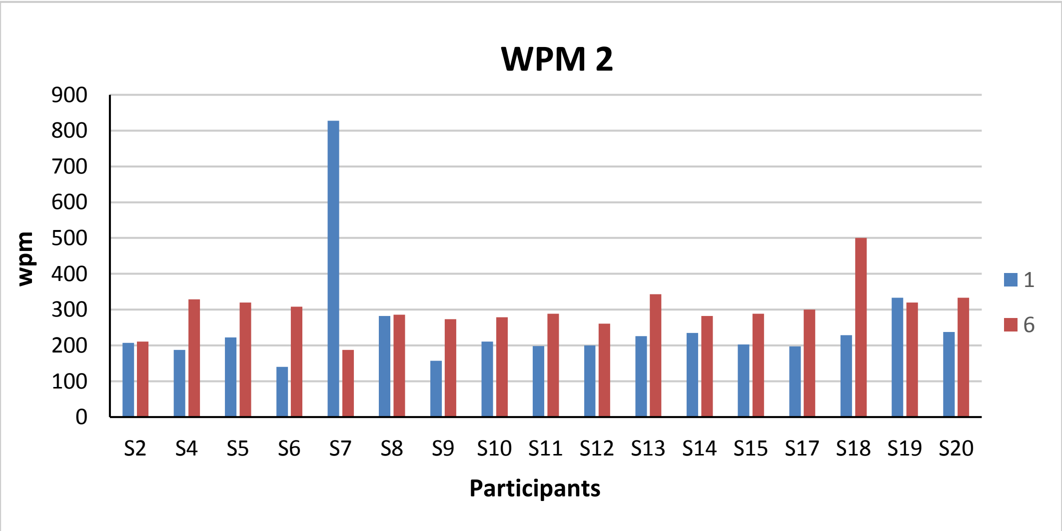
Graph 9a. Analysis of the performance of single participants in *Word Per Minute 1* in Test 1 and Test 6.

Out of 17 neurotypical readers, 14 participants improved the number of words per minute during the first session of reading (*Graph 9a*). In the first test, *WPM* was attested at an average 151,35 (SD: 49,2) during first reading; during the last test, with a growth equal to 17% (an increase equal to an average of 26,06 words), it was attested around 177,41 (SD: 47,1) (*Graph 9b*).



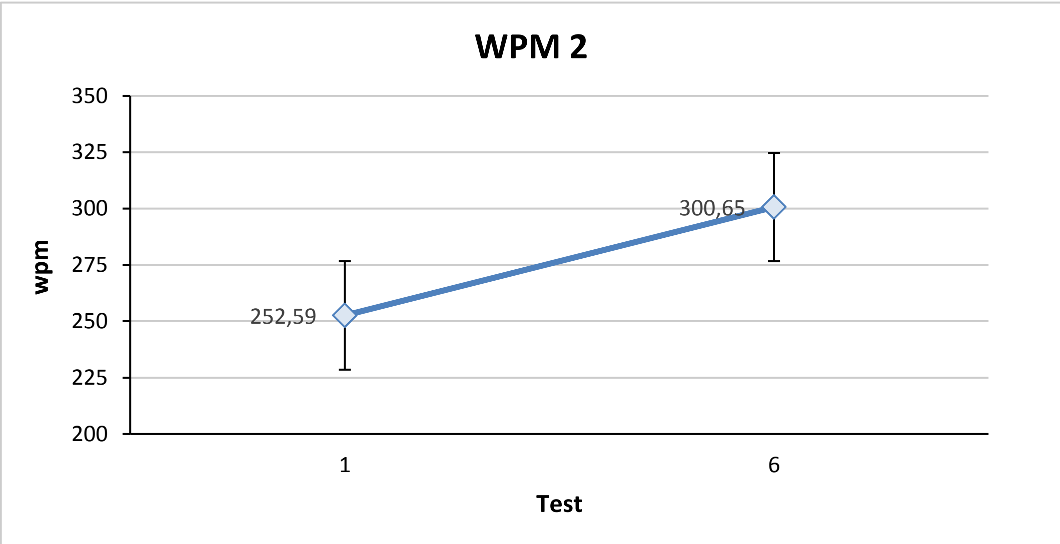
Graph 9b. Number of *Words Per Minute* for first reading for neurotypical readers in Test 1 and Test 6.

Instead, *WPM 2* was in average higher compared to *WPM 1*: in Test 1 was attested around 252,59 (SD: 154,6), during Test 6 – with a growth equal to 19% (increase equal to an average of 48,06 words per minute) - it was attested around 300,65 (SD: 65,4) (*Graph 10b*). For what concerns an analysis of the single participants' performances, 15 neurotypical readers out of 17 increased the number of words per minute during review (*Graph 10a*).



Graph 10a. Analysis of the performance of single participants in *Word Per Minute 2* in Test 1 and Test 6.

Observing baseline and final test, both variables underwent a significant improvement statistically speaking, with an effective increase in number of words per minute (*WPM 1*, Wilcoxon V = 28, p = 0.02303; *WPM 2*, Wilcoxon V = 20, p = 0.008018) (see *Graphs 9b* and *10b*). Last but not least, while *WPM 1* showed a medium effect in ES (0.5), *WPM 2* was characterized by a small ES (0.4).



Graph 10b. Number of *Words Per Minute* for first reading for neurotypical readers in Test 1 and Test 6.

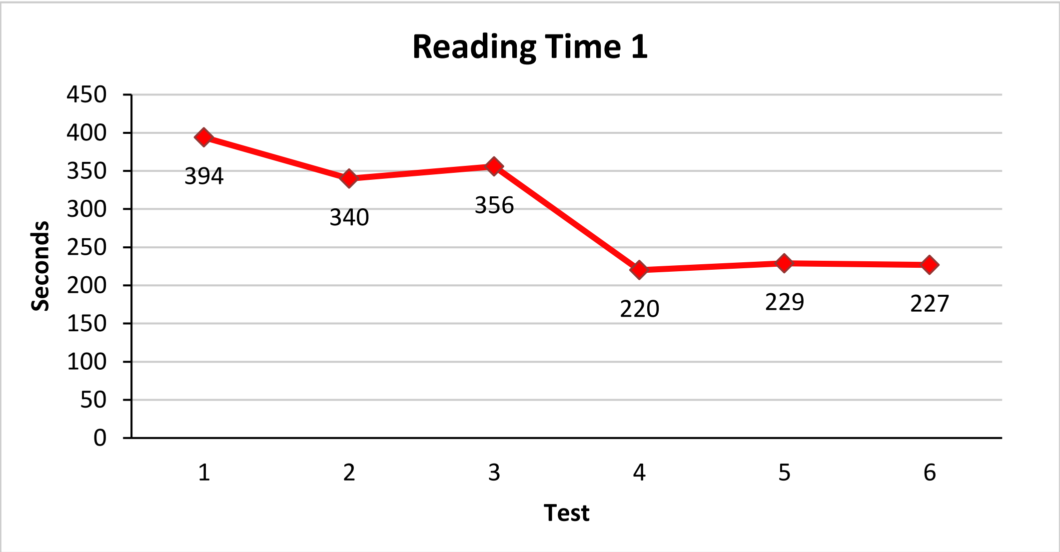
3.1.5.2 Single Case Study: The Dyslexic Reader

3.1.5.2.1 Reading Time

Reading Time variables collected from all tests taken by the dyslexic reader show a general improvement is evident. All the three variables show a decrease in seconds dedicated to reading. The trend from Test 1 to Test 6 in all three variables is visible in *Table 6* (see following page) and from *Graph 11* to *Graph 13*.

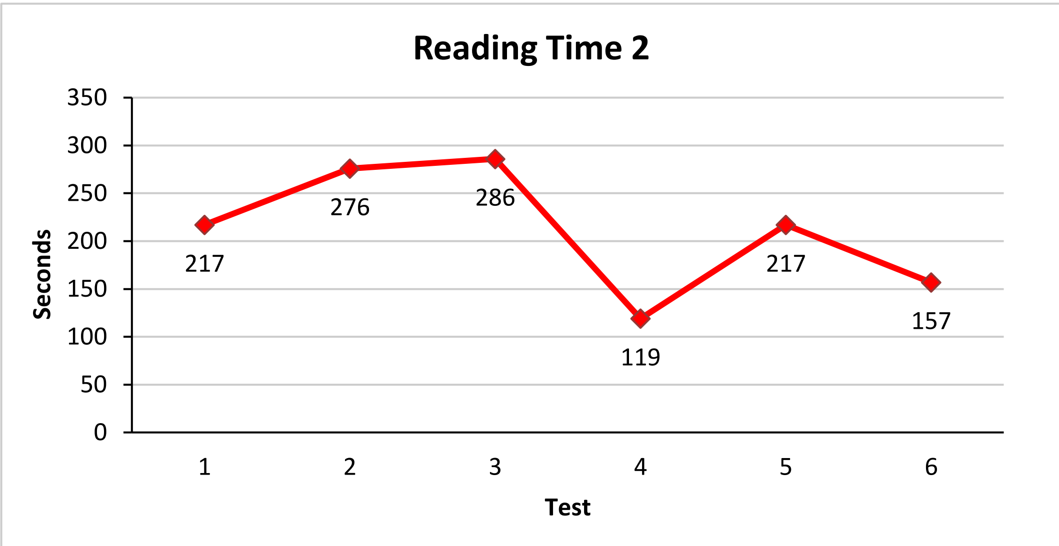
	T1	T6	Difference	*p*-value
Reading Time 1	394	227	-42%	$p < .01$**
Reading Time 2	217	157	-45%	$p < .05$*
Total *Reading Time*	611	384	-37%	$p < .001$***

Table 6. Results from statistical analyses on all variables of *Reading Time*.



Graph 11. Reading times (calculated in seconds) for first reading for dyslexic reader in all sessions (from Test 1 to Test 6).

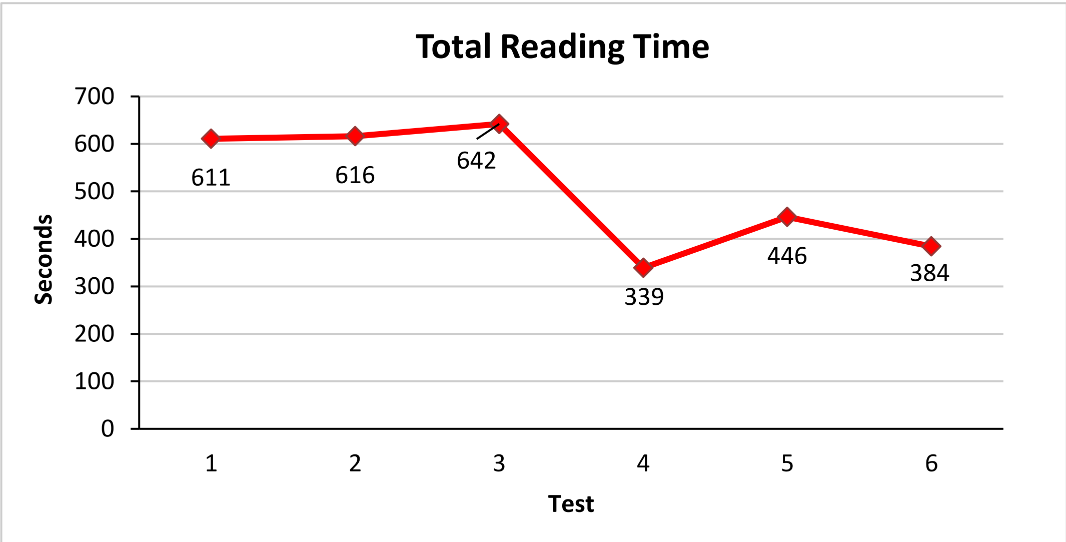
Statistical analyses revealed important information about the nature of data collected from the dyslexic reader. In relation to data from neurotypical readers, in Test 1 the dyslexic reader took more time in reading a text for the first time in comparison to the neurotypical participants (394 seconds employed by the dyslexic reader versus an average of 175 seconds of the group of neurotypical readers). The *Crawford-Howell* (1998) *t-test* has highlighted this difference by reporting a statistically significant difference in the dyslexic reader's score compared to the group of neurotypical readers ($t(16) = 3.53$, $p < .01$**). This means that there is a real difficulty in reading for the dyslexic reader, and that the participant reads more slowly in comparison to the neurotypical participants. Running the *Mellenbergh & van den Brink* (1998) *test* on data collected from both populations during Test 6 has proven that the dyslexic reader has benefitted from *eye-hopping* - reducing seconds employed in reading. This test has signaled a statistically significant change in the scores from Test 1 and Test 6 (z = -2.98, p < .01**) in the dyslexic participant, confirming the improvement in *Reading Time 1*. However, a second *Crawford-Howell* (1998) *t-test* revealed also that the dyslexic reader's score of *Reading Time 1* (227 seconds) in Test 6 is *not* significantly different from the average score of the group of neurotypical readers (t(16) = 2.01, $p = 0.06^{0}$), highlighting that the dyslexic reader's *Reading Time* during first reading can be collocated in the correspondent average *Reading Time* scored by neurotypical readers, confirming the efficacy of the exercise.



Graph 12. Reading times (calculated in seconds) for second reading for dyslexic reader in all sessions (from Test 1 to Test 6).

Reading Time 2 shows a statistically significant improvement, confirmed by the *Mellenbergh & van den Brink* (1998) *test*, from Test 1 to Test 6 (z = -2.43, p < .05*). However, the two *Crawford-Howell* (1998) *t-test* ran on the dyslexic reader's data highlighted that the score of Test 1 (217 seconds) and Test 6 (157 seconds) were significantly different from the average scores collected from the respective tests of neurotypical readers (Test 1: $t(16) = 3.36$, $p < .01$**; Test 6: $t(16) = 4.11$, $p < .001$***). This means that there was an improvement in performance, but that the dyslexic reader's scores are higher than the ones of the neurotypical readers, underlining that the dyslexic participant reads more slowly than its neurotypical peers.

Having already analyzed the improvement in scores of both *Reading Time 1* and *Reading Time 2,* it is obvious to say that the scores of *Total Reading Time* collected from the dyslexic subject's performances underwent an improvement that is statistically significant ($z = -3.41$, $p < .001$***). The improvement from Test 1 (611 seconds) to Test 6 (394 seconds) was calculated running the *Mellenbergh & van den Brink* (1998) *test.* For what concerns the analyses ran with the *Crawford-Howell* (1998) *t-test,* even this time it is highlighted that the dyslexic reader's has difficulties with reading, and that the scores from Test 1 and Test 6 are significantly different from the one collected from the neurotypical readers' group (Test 1: $t(16) = 4.00$, $p < .01$**; Test 6: $t(16) = 3.24$, $p < .01$**).



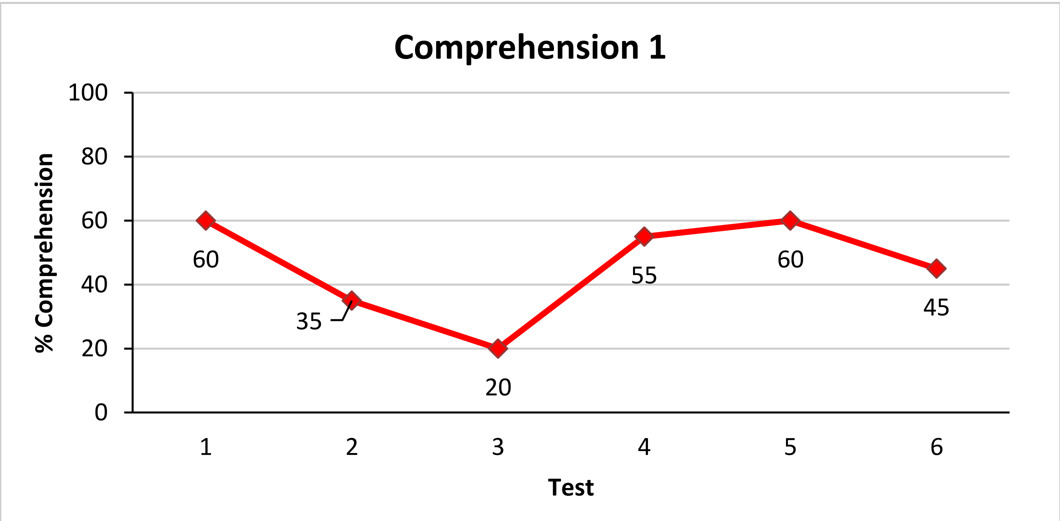
Graph 13. Total reading times (in seconds) calculated by adding reading times of first reading and reading times of second reading for dyslexic reader in all sessions (from Test 1 to Test 6).

3.1.5.2.2 *Comprehension*

Scores collected from comprehension after first reading and after review show that the dyslexic participant's scores underwent a non-linear decreasing from Test 1 to Test 6 in both variables – Comprehension 1 and 2 – collected during first and second reading. However, *Table 7* highlighted a non-significant change in comprehension scores.

	T1	T6	Difference	*p*-value
Comprehension 1	60	45	-25%	p > .1
Comprehension 2	80	70	-13%	p > .1

Table 7. Results from statistical analyses on all variables of *Comprehension*.

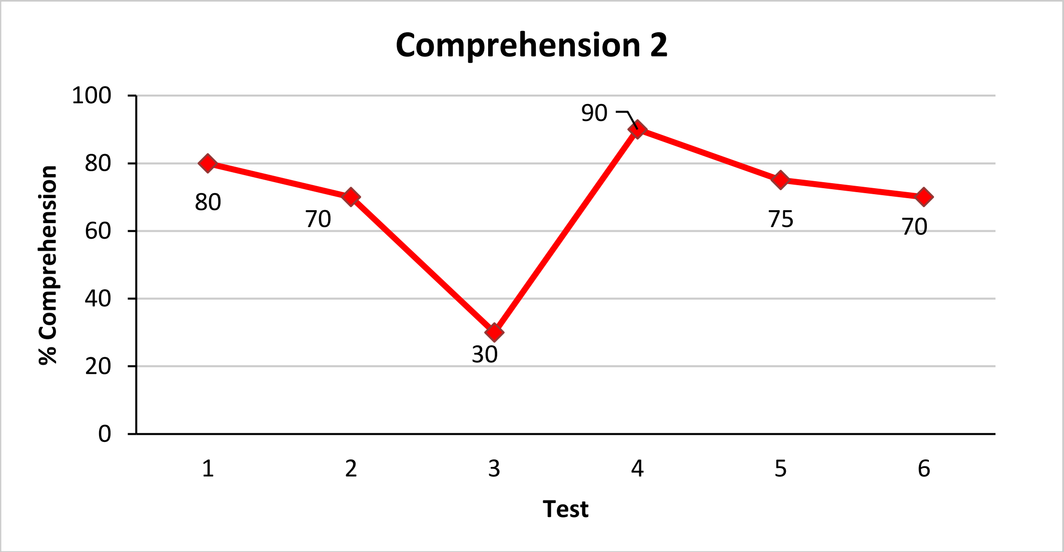


Graph 14. Comprehension rates (calculated in percentage) for first reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

For what concerns *Comprehension 1* (*Graph 14*), the two *Crawford & Howell (1998) t-test* revealed that both scores from Test 1 (60% of correct answers) and Test 6

(45% of correct answers) are not significantly different from the scores collected from the group of neurotypical readers, attesting that comprehension can be compared (Test 1: $t(16) = 0.41$, $p > .1$; Test 6: $t(16) = -1.38$, $p > .1$). Despite the difficulties with reading that manifest themselves through reading slowly, comprehension of the dyslexic reader is very much alike comprehension of participants from the control group.

In addition, the *Mellenbergh & van den Brink* (1998) *test* confirmed that there is no significant improvement in the scores ($z = -0.79$, $p > .1$).



Graph 15. Comprehension rates (calculated in percentage) for second reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

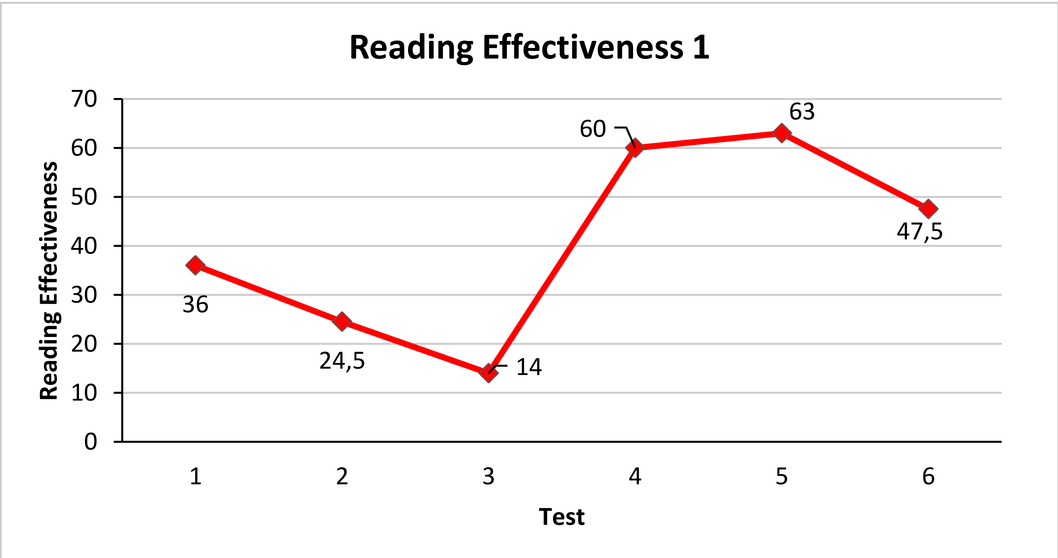
Comprehension 2 (*Graph 15*) shows a similar pattern observed in *Comprehension 1*: the two *Crawford & Howell (1998) t-test* revealed once again that both scores from Test 1 (80% of correct answers) and Test 6 (70% of correct answers) are not significantly different from the scores collected from the neurotypical readers (Test 1: $t(16) = -0.045$, $p > .1$; Test 6: $t(16) = -1.78$, $p > 0.09$*). Even for this variable, the *Mellenbergh & van den Brink* (1998) *test* confirmed that there is no significant change from Test 1 to Test 6 ($z = -0.65$, $p > .1$).

3.1.5.2.3 Reading Effectiveness

From the data summarized in Table 8 and the following graphs (from Graph 16 to Graph 18), it can be observed that all variables of *Reading Effectiveness* benefitted from the training. However, results given by the statistical analyses did not signaled a significant improvement in any of the three variables of *Reading Effectiveness* for the dyslexic reader.

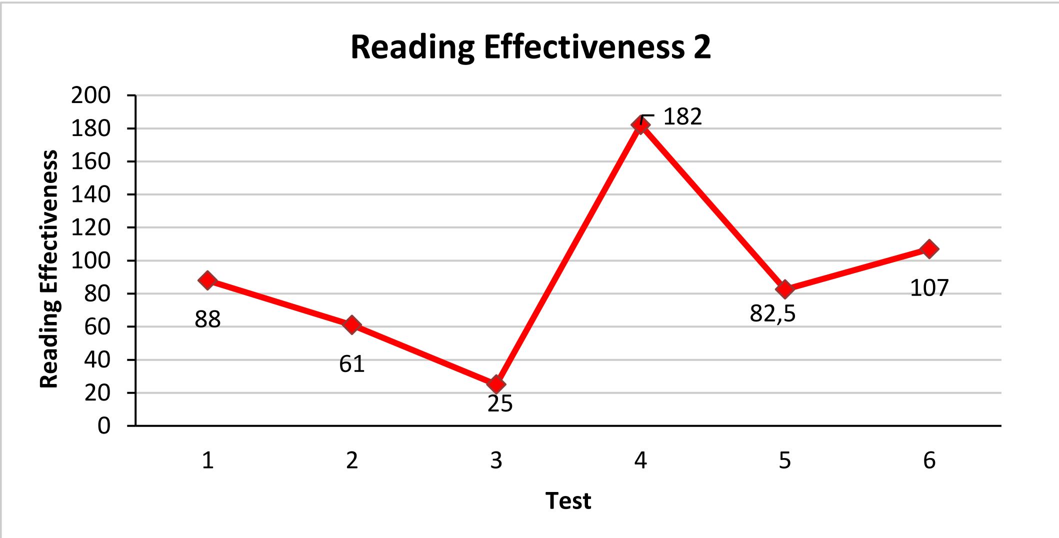
	T1	T6	Difference	*p*-value
RE 1	36	48	33%	$p > .1$
RE 2	88	107	22%	$p > .1$
Total *RE*	124	155	25%	$p > .1$

Table 8. Results from statistical analyses on all variables of *Reading Effectiveness*.



Graph 16. *Reading Effectiveness* scores (calculated in points) for first reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

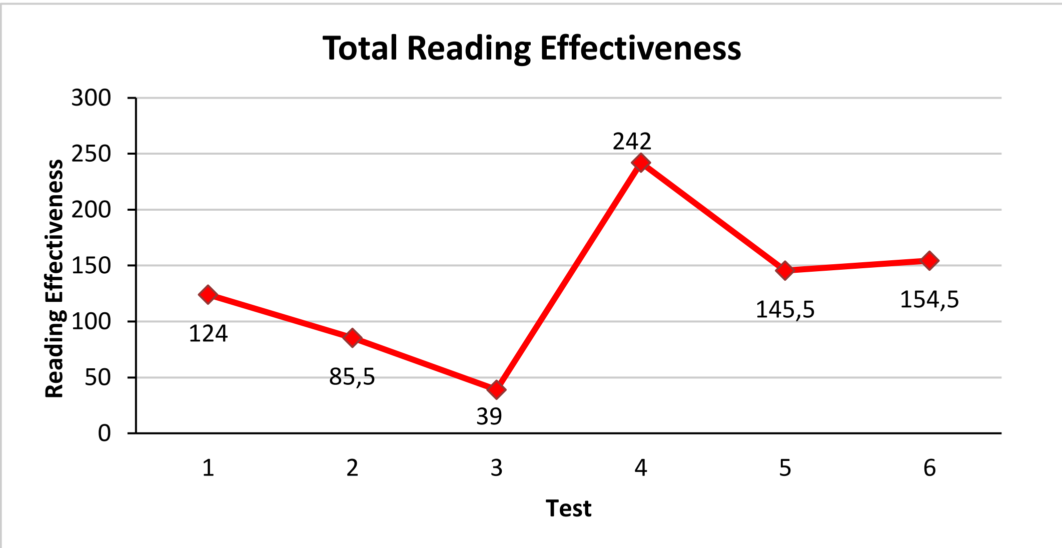
Statistically analyzing the first variable of the group, we can see that – as underlined by the two *Crawford & Howell (1998) t-test* - both scores from *Reading Effectiveness 1* (*Graph 16*) in Test 1 (36 points) and Test 6 (47,5 points) were not significantly different from scores collected from neurotypical readers (Test 1: $t(16) = -1.33$, $p > .1$; Test 6: $t(16) = -1.73$, $p > .1$). Moreover, the *Mellenbergh & van den Brink* (1998) *test* confirmed that there is any real improvement in the dyslexic reader's *Reading Effectiveness* during first reading ($z = 0.22$, $p > .1$), even if the participant has recorded a higher score in Test 6 in comparison to Test 1.



Graph 17. *Reading Effectiveness* scores (calculated in points) for second reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

Reading Effectiveness 2 (*Graph 17*) shows a similar pattern in analyses, with the two *Crawford & Howell (1998) t-test* that indicates that scores from Test 1 (88 points) and Test 6 (107 points) are not significantly different from the scores of participants in control group collected from the same tests (Test 1: $t(16) = -0.79$, $p > .1$; Test 6: $t(16) = -1.96$, $p = 0.07^{0}$). Even in this variable there is no significant improvement – as it is confirmed by the *Mellenbergh & van den Brink* (1998) *test* ($z = 0.16$, $p > .1$), even though the score of Test 6 is higher than the one in Test 1.

The sum of the previous two variables (*Reading Effectiveness 1* and *Reading Effectiveness 2*) results in *Total Reading Effectiveness*: from *Graph 18* is clear that a small improvement has been made by the dyslexic reader, but statistical analyses signaled that the improvement was not as real as it seemed. The two *Crawford & Howell (1998) t-test* show that scores achieved in Test 1 (124 points) and in Test 6 by the dyslexic reader were not significantly different from the one achieved by neurotypical readers (Test 1: $t(16) = -1.04$, $p > .1$; Test 6: $t(16) = -2.09$, $p > 0.05$[0]). The *Mellenbergh & van den Brink* (1998) *test* confirmed that the change from Test 1 to Test 6 is not significant ($z = 0.20$, $p > .1$).



Graph 18. *Total Reading Effectiveness* (in points) calculated by adding scores of first reading and scores of second reading for dyslexic reader in all sessions (from Test 1 to Test 6).

3.1.5.2.4 Words Per Minute (WPM)

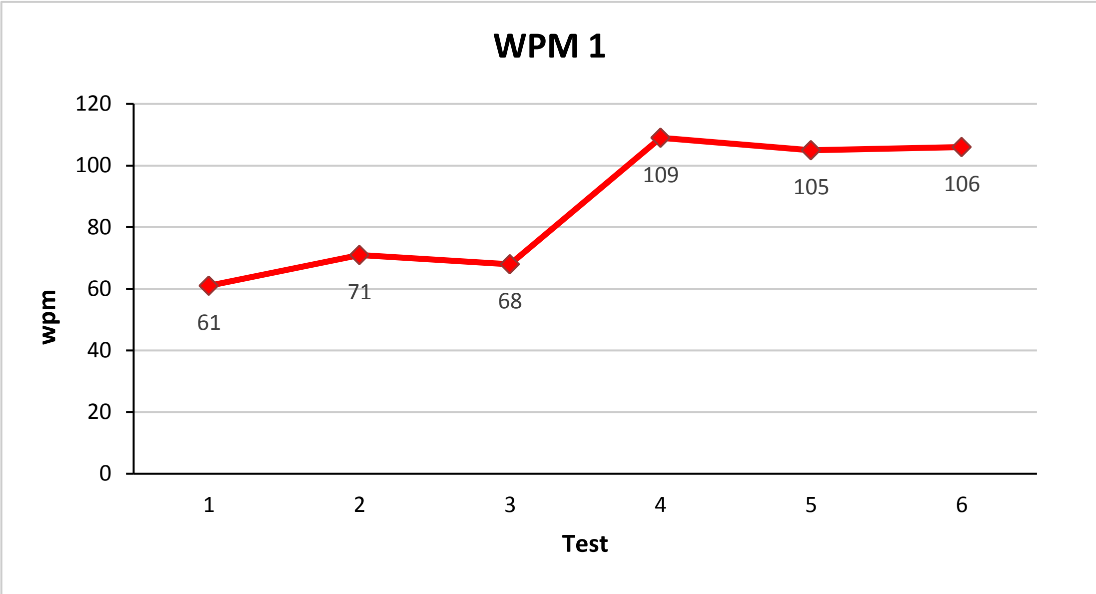
Like for neurotypical readers, it is extremely important to observe if there is an improvement in words per minute, which refers to reading speed. As it was already mentioned, dyslexic participants who speak languages with shallow orthographies suffer from a reading speed deficit (e.g., Hawelka *et al*., 2009).

By observing *Table 9* and *Graphs 19* and *20*, it can be noted that words per minute during first and second reading underwent a growth from Test 1 to Test 6.

	T1	**T6**	**Difference**	***p*-value**
WPM 1	61	106	74%	$p > .1$
WPM 2	111	153	38%	$p > .1$

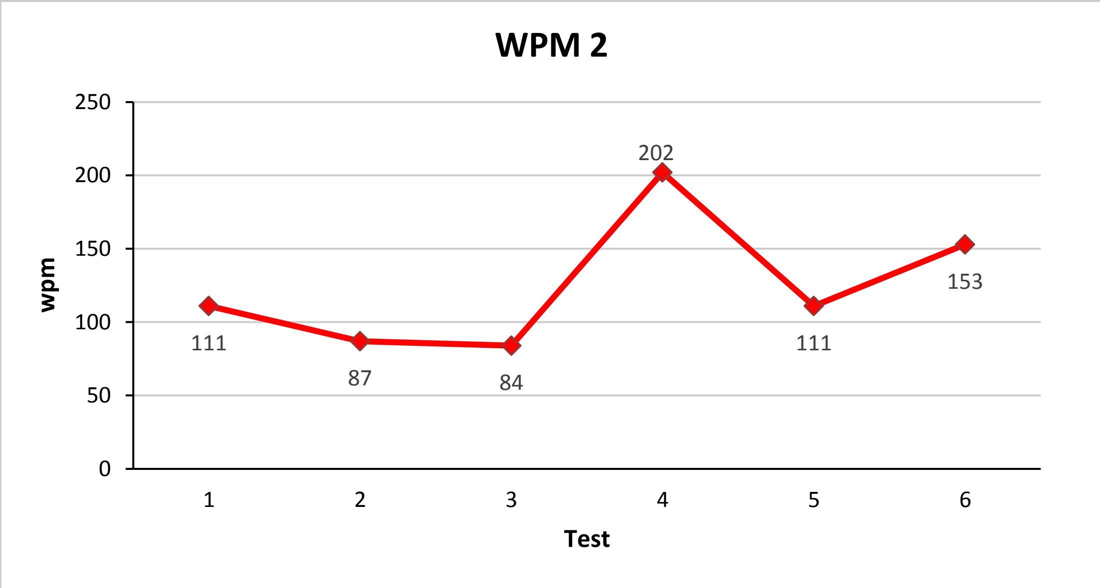
Table 9. Results from statistical analyses on all variables of *Words Per Minute*.

However, the increase in words per minute during first reading (*Graph 19*) was revealed to be not significant by the *Mellenbergh & van den Brink* (1998) *test* ($z = 0.58$, $p > .1$). Moreover, the two *Crawford & Howell (1998) t-test* suggested that scores from Test 1 (61 wpm) and Test 6 (106 wpm) were not significantly different from scores collected from neurotypical participants (Test 1: $t(16) = -1.78$, $p = 0.09^{\circ}$; Test 6: $t(16) = -1.47$, $p > .1$).



Graph 19. *Words Per Minute* for first reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

Observing the following graph (*Graph 20*), it can be said that even *WPM 2* underwent an improvement from Test 1 (111 wpm) to Test 6 (153 wpm), but after having ran statistical analyses on collected data it could not be confirmed a real improvement in this variable. The *Mellenbergh & van den Brink* (1998) *test* suggested that there was not a significant change from baseline to the post-training test (z = 0.45, $p > .1$). Moreover, the two *Crawford & Howell (1998) t-test* showed interesting results: score from Test 1 (111 wpm) was not significantly different from scores collected from the neurotypical readers' group ($t(16) = -0.89$, $p > .1$), but score from Test 6 (153 wpm) was proven to be significantly different from scores of neurotypical readers ($t(16) = -2.19$, $p < .05$*), underlining a constant difficulty in reading.



Graph 20. *Words Per Minute* for second reading for dyslexic reader collected from all sessions (from Test 1 to Test 6).

3.1.5.3 Follow Up

In this paragraph will be analyzed the data collected from participants during the follow-up meeting held the week after the end of the training. Unfortunately, many participants were not able to take part in the follow-up due to their absence in the residence. Furthermore, in the following graphs the scores collected from the dyslexic reader (S21) will be presented along the remaining participants from the group of the neurotypical readers, for a total of 12 participants: S2, S4, S5, S7, S8, S10, S12, S13, S14, S17, S18. Statistical analyses were ran keeping the separation between the two groups of readers. In the graphs, scores gathered in each session are signaled by three different colors (blue for Test 1, red for Test 6 and green for Follow Up).

3.1.5.3.1 Reading Time

Tables 10, *11* and *12* illustrate the results of statistical analysis conducted on the three variables of *Reading Time* to observe if the scores underwent any significant change from Test 6 to follow-up. As we will see later in detail, the tables underline that only one variable - that is, *Reading Time 2* – was affected by a change after the adoption of the *anteprima* technique, both in neurotypical and dyslexic readers.

***Reading Time* 1**

	Neurotypical	**Dyslexic**
T6	135	227
FU	139	283
Difference	+3%	+25%
***p*-value**	$p = 0.8$	$p > .1$

Table 10. Results from statistical analysis on the variable *Reading Time 1* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

***Reading Time* 2**

	Neurotypical	**Dyslexic**
T6	85	157
FU	61	230
Difference	-28%	+46%
***p*-value**	$p = 0.03$	$p < .05$*

Table 11. Results from statistical analysis on the variable *Reading Time 2* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

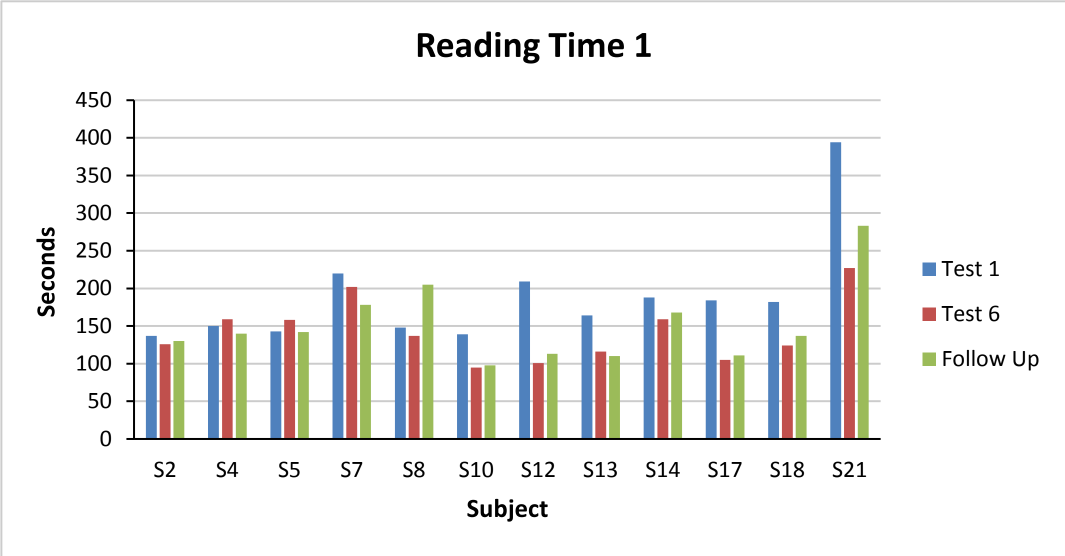
Total *Reading Time*

	Neurotypical	Dyslexic
T6	218	384
FU	200	513
Difference	-8%	+34%
***p*-value**	p = 0.1	p = 0.09*

Table 12. Results from statistical analysis on the variable *Total Reading Time* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

Graph 21 shows *Reading Time 1* scores of each participant collected during Test 1, Test 6 and follow-up.

From a first analysis of the data, it can be observed that 4 neurotypical readers out of 11 show a reduction in *Reading Time 1* in comparison to Test 6 (S4, S5, S7 and S13). The aim of the Follow Up was to verify if the improvement given by the daily exercise with Eye-Hop™ was still present after the end of the training and if explicit knowledge of at least one set of preview techniques would have brought a significant improvement not only in the already enhanced variables (such as *Reading Time* and *Reading Effectiveness*), but also – and most importantly - in *Comprehension*. For what concerns the remaining neurotypical readers, it can be observed that the average *Reading Time 1* underwent a worsening in comparison to Test 6, with an increase of reading time equal to 3% (from an average of 135 seconds in Test 6 to an average of 139 seconds in Follow Up). Moreover, analyzing *Graph 21*, it can be observed that *Reading Time 1* scores of the dyslexic reader underwent a worsening in the Follow Up, with an increase of 56 seconds compared to data collected during Test 6 (+25%).



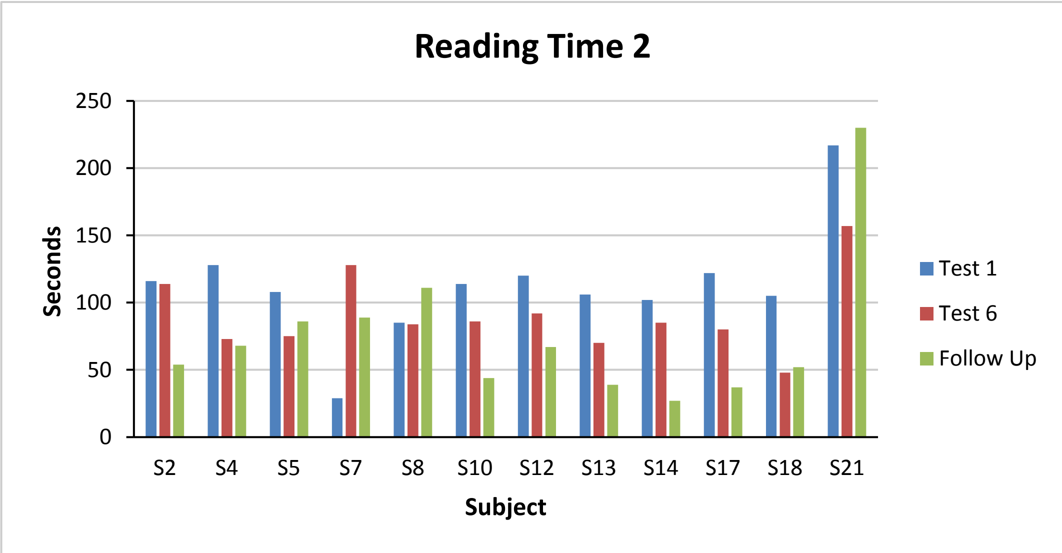
Graph 21. Average *Reading Time 1* (calculated in seconds) collected during Test 1, Test 6 and follow up for each participant. Only four participants out of twelve show a reduction in reading time during first reading after been instructed to use some *anteprima* techniques.

The experimenter ran the *Wilcoxon Signed Rank Test* to detect if any change was caused by the *anteprima* techniques. Results underlined that there was no significant change in average scores of *Reading Time 1* in Test 6 compared to Follow Up (Wilcoxon V = 30.5, p = 0.8588) in the group of neurotypical readers. The experimenter also ran the *Mellenbergh & van den Brink* (1998) *test* to compare *Reading Time 1* in Test 6 and in Follow Up, and - even in this case – no significant change was detected in the dyslexic reader's scores (z = 1.21, $p > .1$).

An interesting variable to analyze was certainly *Reading Time 2* (*Graph 22*). It can be highlighted that 8 participants out of 11 from the neurotypical readers' group showed an evident decreasing in reading time while reviewing the text. Average scores of *Reading Time 2* decreased from 85 seconds in Test 6 to 61 seconds in Follow Up, a reduction equal to 28%. Instead, the dyslexic reader's performance worsened during the second reading of the Follow Up, increasing time from 157 seconds in Test 6 to 230 seconds in the Follow Up (+ 46%). *Graph 22* shows the differences in *Reading Time 2* registered in Test 1, Test 6 and Follow Up from all participants.

Statistical analyses ran with the *Wilcoxon Signed Rank Test* revealed that there was a significant change in *Reading Time* during review in the group of neurotypical readers (Wilcoxon V = 57, *p* = 0.03223), hypothesizing that the *anteprima* techniques have influenced positively reading time in this variable.

It is also interesting the performance of the dyslexic reading during Follow Up, which was significantly worse in comparison to the one observed during Test 6, and this evidence was confirmed by the *Mellenbergh & van den Brink* (1998) *test* (z = 2.00, *p* < .05*).

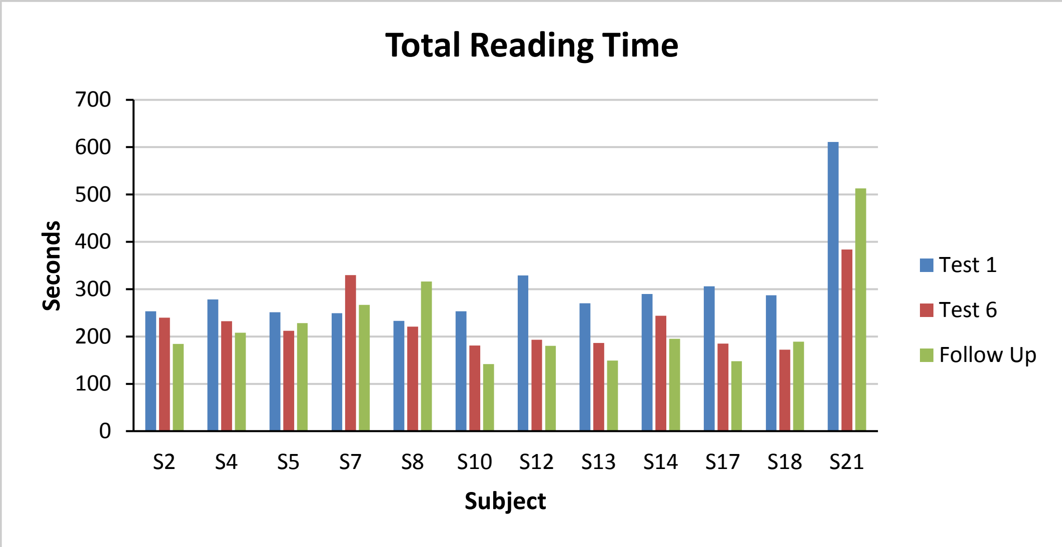


Graph 22. Average *Reading Time 2* (calculated in seconds) collected during Test 1, Test 6 and follow up for each participant.

Observing *Graph 23*, it is evident that 8 neurotypical readers out of 11 improved their performance for what concerns *Total Reading Time*. Average *Total Reading Time* diminished of 8%, from an average of 218 seconds in Test 6 to an average of 200 seconds in Follow Up; the dyslexic reader, instead, worsened the performance increasing *Total Reading Time* of 34%, from 384 seconds in Test 6 to 513 seconds in Follow Up.

Concerning the neurotypical readers, statistical analysis ran with the *Wilcoxon Signed Rank Test* showed that there was no significant change in *Total Reading Time* (Wilcoxon V = 50, *p* = 0.1422) from Test 6 to Follow Up. Moreover, the *Mellenbergh*

& van den Brink (1998) *test* showed that the dyslexic reader's performance overall did not change significantly from Test 6 to Follow Up (z = 1.72, p = 0.09*).



Graph 23. Average *Total Reading Time* (calculated in seconds) collected during Test 1, Test 6 and follow up for each participant.

3.1.5.3.2 Comprehension

One set of metacognitive strategies (the *anteprima* technique) was illustrated during the Follow Up meeting. The aim was to observe the presence of an increase in rates for what concerned comprehension during first and second reading. *Tables 13* and *14* underline how *Comprehension* variables did not undergo the expected improvement; moreover, the dyslexic reader worsened significantly the performance in *Comprehension* during first reading.

Comprehension 1

	Neurotypical	Dyslexic
T6	62	45
FU	55	15
Difference	-11%	-67%
***p*-value**	$p = 0.3$	$p < .05$*

Table 13. Results from statistical analysis on the variable *Comprehension 1* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

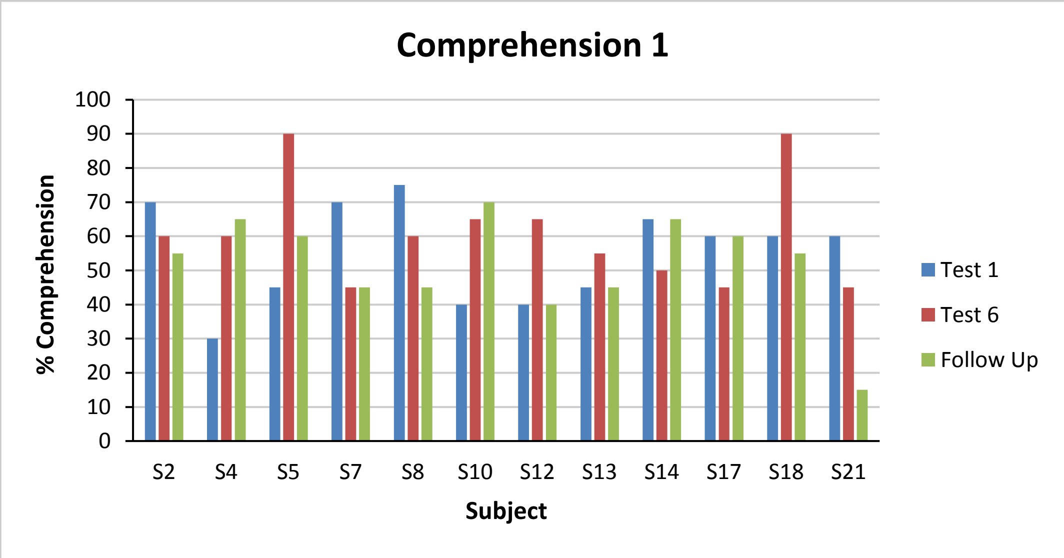
Comprehension 2

	Neurotypical	Dyslexic
T6	88	70
FU	93	80
Difference	6%	14%
***p*-value**	$p = 0.2$	$p > .1$

Table 14. Results from statistical analysis on the variable *Comprehension 2* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

Graph 24 shows that only 4 participants out of 11 improved comprehension rates during first reading. The remaining neurotypical readers did not improve average *Comprehension 1,* but rather decreased its rates from 62% (Test 6) to 55% (Follow Up) (-11%). S21 shows a clear worsening in *Comprehension 1* rates, with a reduction equal to 67% (from 45% in Test 6 to 15% in Follow Up).

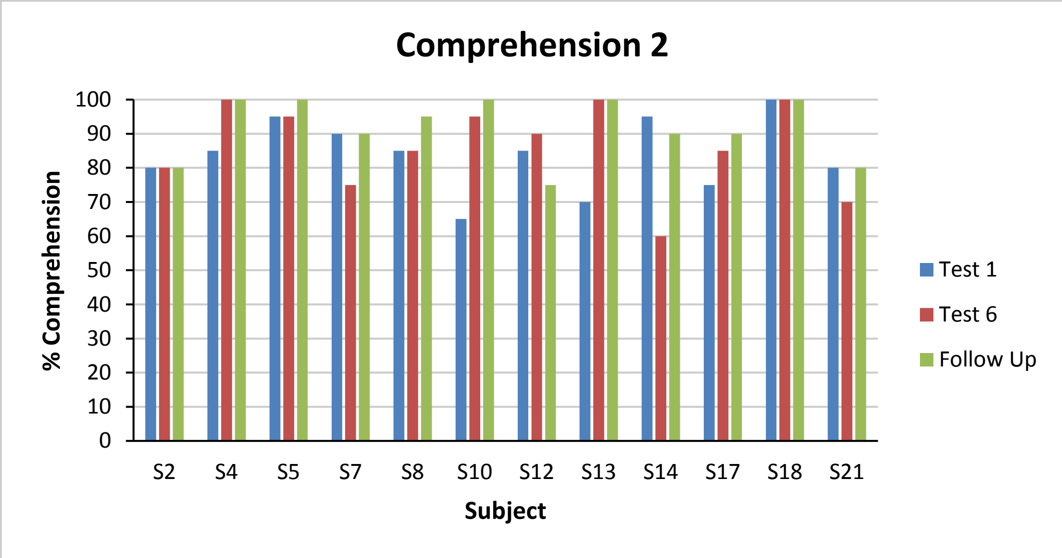
Statistical analyses confirmed for neurotypical readers that there was no significant change in comprehension during first reading (*Wilcoxon Signed Rank Test;* Wilcoxon V = 39, $p = 0.2597$). Instead, the performance of the dyslexic reader during Follow Up was considered by the *Mellenbergh & van den Brink* (1998) *test* significantly poorer than the one during Test 6 (z = -2.12, $p < .05$*).



Graph 24. Average *Comprehension 1* (calculated in percentage) collected during Test 1, Test 6 and follow up for each participant.

Graph 25 illustrates a different situation compared to the one seen in *Comprehension 1*: 9 readers out of 11 improved their accuracy in *Comprehension 2*, two participants maintained the same percentage in Follow Up compared to Test 6 (S2 and S4), and only one reader decreased the accuracy scores (S12). *Comprehension 2* rates of neurotypical readers increased from an average of 88% during Test 6 to an average of 93% during Follow Up (+6%), while *Comprehension 2* rates of the dyslexic reader increased from 70% in Test 6 to 80% in Follow Up (+14%).

Still, statistical analyses ran on data revealed no significant change in performance from Test 6 to Follow Up. Concerning the neurotypical readers, the *Wilcoxon Signed Rank Test* signaled any substantial change in rates (Wilcoxon V = 5.5, p = 0.1724), for the dyslexic reader the *Mellenbergh & van den Brink* (1998) *test* showed that the change that there was not significant change either (z = 0.81, $p > .1$).



Graph 25. Average *Comprehension 2* (calculated in percentage) collected during Test 1, Test 6 and follow up for each participant.

3.1.5.3.3 Reading Effectiveness

As we can see from *Tables 15*, *16* and *17*, the *anteprima* technique did not affect any of the *Reading Effectiveness* variables. Statistical analyses, in fact, underlined that there was no change in scores between Test 6 and follow-up in both populations.

Reading Effectiveness 1

	Neurotypical	Dyslexic
T6	119	47,5
FU	100	12,5
Difference	-16%	-74%
***p*-value**	$p = 0.3$	$p > .1$

Table 15. Results from statistical analysis on the variable *Reading Effectiveness 1* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

Reading Effectiveness 2

	Neurotypical	**Dyslexic**
T6	268	107
FU	428	83
Difference	60	-22,50%
***p*-value**	*p* = 0.054	*p* > .1

Table 16. Results from statistical analysis on the variable *Reading Effectiveness 2* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

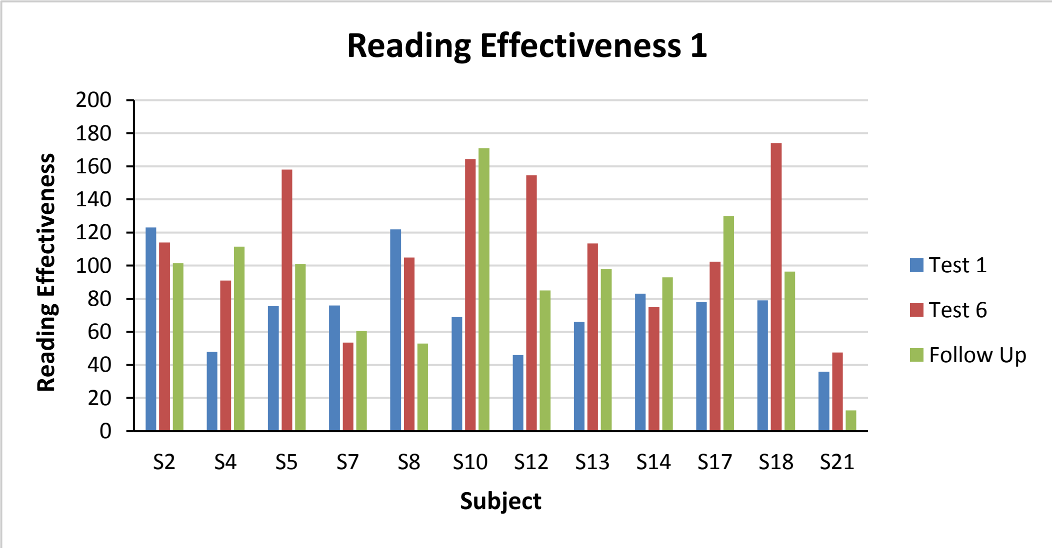
Total Reading Effectiveness

	Neurotypical	**Dyslexic**
T6	387	154,5
FU	528	95,5
Difference	36%	-38%
***p*-value**	*p* = 0.1	*p* > .1

Table 17. Results from statistical analysis on the variable *Total Reading Effectiveness* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

Reading Effectiveness 1 collected from remaining participants of both groups generally did not improve (*Graph 26*): an increase in *Reading Effectiveness* 1 is evident only in 5 readers out of 11. Generally, neurotypical readers showed a decrease equal to 16% in *Reading Effectiveness* points from an average of 119 points in Test 6 to an average of 100 points. The performance of S21 during Follow Up (12,5 points) was worse than the one during Test 6 (47,5 points), with a decrease equal to 74%.

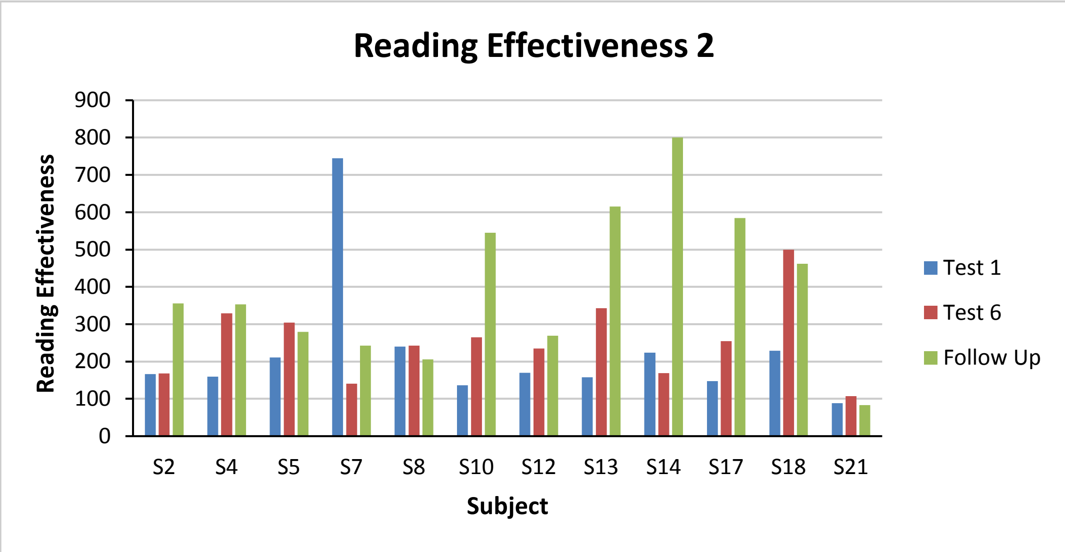
Statistical analyses confirmed that there was no improvement nor worsening in *Reading Effectiveness* 1, since the *Wilcoxon Signed Rank Test* reported no significant change in scores from Test 6 to Follow Up in neurotypical readers (Wilcoxon V = 45, p = 0.3203), as well the *Mellenbergh & van den Brink* (1998) *test* found no significant change in scores from Test 6 to Follow Up in the dyslexic reader's performance (z = -0.78, $p > .1$).



Graph 26. Average *Reading Effectiveness 1* (calculated in points) collected during Test 1, Test 6 and follow up for each participant.

The second variable in the *Reading Effectiveness* group was improved by 8 participants out of 11, starting from an average *Reading Effectiveness* during review of 268 points in Test 6 to an average 428 points in Follow Up, with an increment equal to 60%. Once again, the dyslexic reader shows a decrease in points collected during Follow Up (83 points), while during Test 6 were collected 107 points (-22,5%) (*Graph 27*).

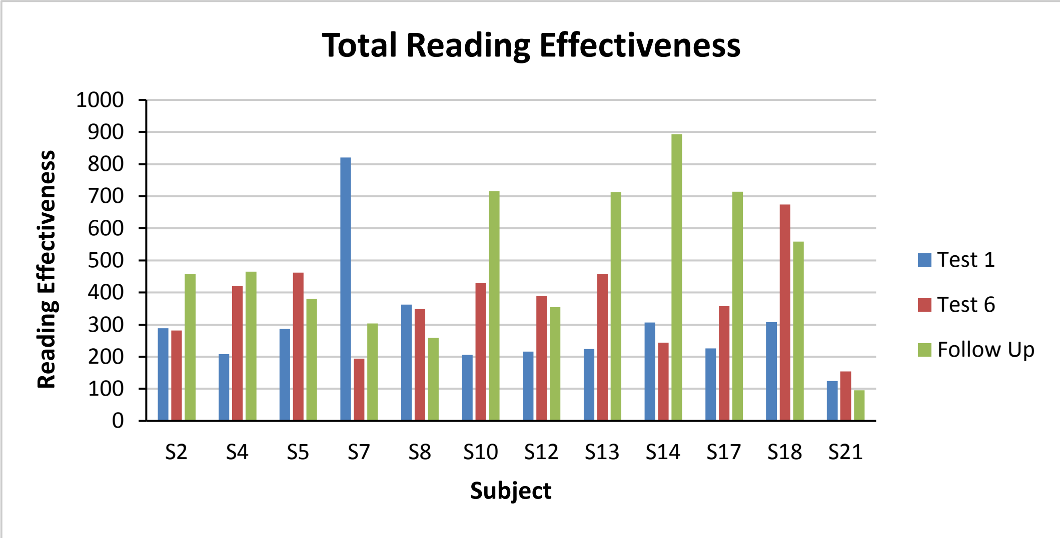
Results obtained running statistical analyses say that readers from both groups did not undergo an improvement in *Reading Effectiveness 2*: for what concerns the remaining neurotypical readers, *Wilcoxon Signed Rank Test* suggested that no significant change was made from Test 6 to Follow Up even if from the descriptive table an increment was more than evident (Wilcoxon V = 11, p = 0.05371). The *Mellenbergh & van den Brink* (1998) *test* signaled that there was not a significant change in scores (z = 0.090, $p > .1$) even in the dyslexic reader's *Reading Effectiveness 2*.



Graph 27. Average *Reading Effectiveness 2* (calculated in points) collected during Test 1, Test 6 and follow up for each participant.

Total Reading Effectiveness underwent an improvement in 7 participants out of 11 (*Graph 28*), with an increase in *Reading Effectiveness* points equal to 36% from Test 6 (average: 387 points) to Follow Up (average: 528 points) in the small group of neurotypical readers. The dyslexic reader – on the other hand – showed a decrease in *Total Reading Effectiveness* from Test 6 (154,5 points) to Follow Up (95,5 points) equal to 38%.

Statistically speaking, the *Wilcoxon Signed Rank Test* revealed that change in scores noticed in *Total Reading Effectiveness* from neurotypical readers was not significant (Wilcoxon V = 14, $p = 0.1016$). The *Mellenbergh & van den Brink* (1998) *test* explicitly underlined that the change in *Total Reading Effectiveness* scores was not significant (z = -0.20, $p > .1$) even for S21.



Graph 28. Average *Total Reading Effectiveness* (calculated in points) collected during Test 1, Test 6 and follow up for each participant.

3.1.5.3.4 Words Per Minute (WPM)

The last variable to be analyzed – linked to *Reading Time* – is Words Per Minute (*WPM*). Statistical analyses of data collected from the two reading sessions highlighted an improvement in words per minute during review only in neurotypical readers, consistent with the statistically significant improvement observed in the variable *Reading Time 2* (*Table 18* and *19*).

WPM 1

	Neurotypical	**Dyslexic**
T6	189	106
FU	180,5	85
Difference	-4,50%	-20%
***p*-value**	$p = 0.3$	$p > .1$

Table 18. Results from statistical analysis on the variable *WPM 1* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

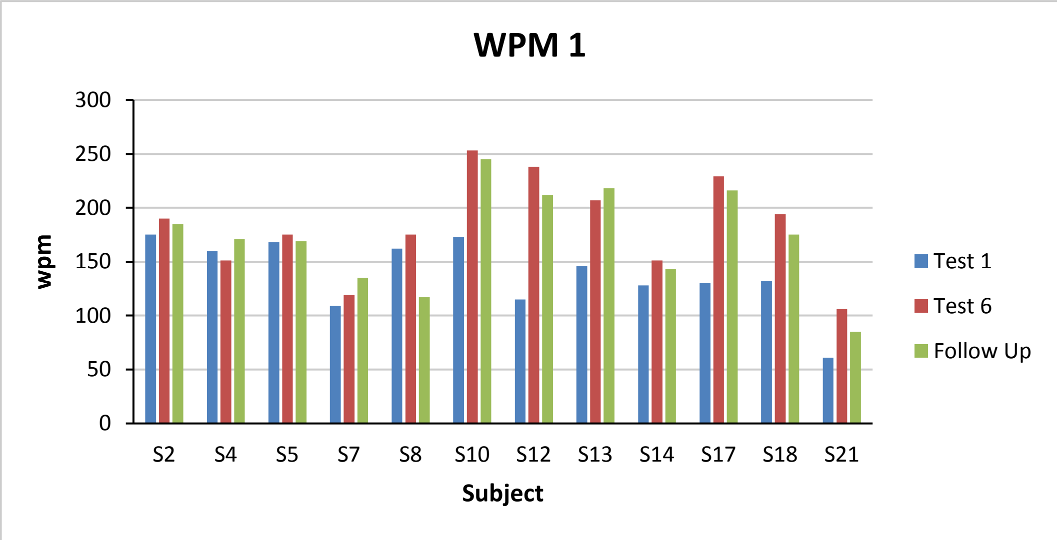
WPM 2

	Neurotypical	**Dyslexic**
T6	300	153
FU	462	104
Difference	54%	-32%
***p*-value**	p = 0.03	p > .1

Table 19. Results from statistical analysis on the variable *WPM 2* from data collected during Test 6 and follow-up in neurotypical and dyslexic readers.

During first reading of Follow Up, neurotypical readers scored an average of 180,5 words per minute, showing a decrease equal to 4,5% in comparison to the average number of words measured during Test 6 (189 words per minute). More generally, only three participants (S4, S7, S13) out of 11 showed an increase in words per minute during Follow Up. The *WPM* score during first reading of the dyslexic reader decreased during Follow Up (85 wpm) from Test 6 (106 wpm, -20%) (*Graph 29*).

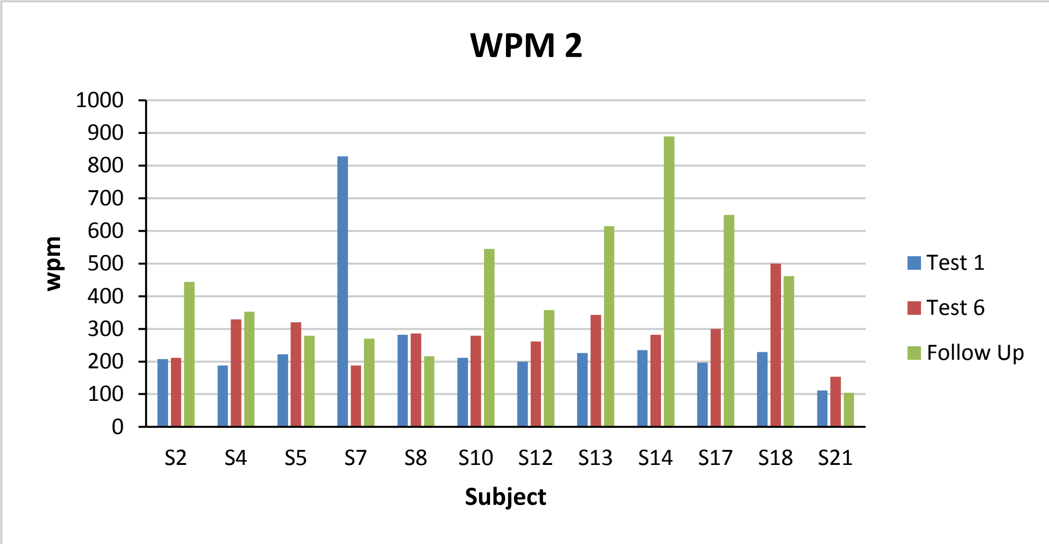
Statistical analyses confirmed the absence of significant change in both groups of readers. The *Wilcoxon Signed Rank Test* (Wilcoxon V = 45, p = 0.3063) confirmed the absence of significant changes in words per minute during first reading in the group of neurotypical readers, while the *Mellenbergh & van den Brink* (1998) *test* suggested that there was no significant change in words per minute in Follow Up compared to Test 6 (z = -0.38, p > .1) in the dyslexic reader's performance.



Graph 29. Average *Words Per Minute 1* collected during Test 1, Test 6 and follow up for each participant.

WPM 2 scores of neurotypical participants underwent a significant improvement from Test 6 to Follow Up, and an evident increase in words per minute during review is showed in *Graph 30*. Eight participants out of 11 showed an increase of words per minute during second reading: the group of neurotypical readers increased its average score from 300 words per minute during Test 6 to 462 words per minute during Follow Up (+54%), while the dyslexic reader diminished the number of *WPM* from 153 during Test 6 to 104 during Follow Up (-32%) (*Graph 30*).

Confirming the improvement for the neurotypical readers in *Reading Time 2*, the *Wilcoxon Signed Rank Test* signaled a significant improvement in *WPM 2* for the aforementioned group (Wilcoxon V = 9, p = 0.03223). On the other hand, the *Mellenbergh & van den Brink* (1998) *test* shows that there is no significant change between the two tests (z = - 0.17, p > .1) in the dyslexic reader's performance.



Graph 30. Average *Words Per Minute 2* collected during Test 1, Test 6 and follow up for each participant.

3.1.6 Discussion

In this paragraph will be discussed previous findings and analyses of the data of the current study. Answers will be given to research questions and predictions.

1. Statistical analyses of data collected from neurotypical readers have revealed that there is a statistically significant improvement in *Reading Time*, in *Reading Effectiveness* and *WPM*. *Reading Time* diminished for first reading, review and total reading time (which is composed by the sum of the first two variables – first reading and review), *words per minute* in first and second reading increased throughout the six tests, and all the three variables of *Reading Effectiveness* increased from Test 1 to Test 6. This means that the group of neurotypical readers benefitted of the time spent exercising with Eye-Hop™, confirming previous results from Italian research (Scagnelli, Oppo, Santulli, 2014; Santulli, Scagnelli, Oppo, 2016; Santulli & Scagnelli, 2017; Scagnelli *et al.*, 2018) about the positive influence of Eye-Hop™ on all these variables and confirming predictions made. The dyslexic reader showed a significant improvement only in the three variables of *Reading Time*, confirming the efficacy of Eye-Hop™ even for the dyslexic population for what concerns reading speed. Interestingly, the *WPM* variables did not undergo a statistically significant improvement and because a lack of data from eye tracker, it cannot be adequately discussed. The eye tracker could have confirmed or rejected the change in ocular pattern with the gathering of data during baseline and post-training tests, giving also an explanation to the statistical results from the variables. Because of the lack of data collected from eye tracking, this research needs to be considered just a starting point to prove the efficacy of the Eye-Hop™ exercise. Previous studies (Scagnelli, Oppo, Santulli, 2014; Santulli, Scagnelli, Oppo, 2016) have already shown that practicing with Eye-Hop™ for 40 minutes every day for the entire duration of the course (10 weeks) brings benefits to *Reading Effectiveness* and a change in the ocular pattern of the participants, both neurotypical readers and dyslexic reader. In this research, for control group *Reading Time* diminished an average of 19,75% from baseline, words per minute increased of an average of

18,12% and *Reading Effectiveness* increased of an average of 38,12% from Test 1 to Test 6. For the dyslexic reader, *Reading Time* diminished of an average of 41,56%. It was predicted that – with the current organization of this study – *Reading Time*, *WPM* and *Reading Effectiveness* improvement should have been attested around 20-25%: following statistical analyses, it can be confirmed that predictions were correct at least for two groups of variables in control group *(Reading Time* and *WPM*), and improvement was even greater in *Reading Effectiveness* for control group and in *Reading Time* for the dyslexic reader. Interesting is the improvement of the dyslexic reader's values in relation to average scores from control group in single tests. Many variables were significantly different from the average score of control group, underlining the difficulty in reading speed (*Reading Time 1* in Test 1, *Reading Time 2* in Test 1 and in Test 6, *Total Reading Time* in Test 1 and in Test 6, and *WPM 2* in Test 6). Other variables, instead, were not statistically different from the average scores of the other individuals, showing that there was no difference in performance between the dyslexic reader and the group of neurotypical readers (*Comprehension 1* and *2* in Test 1, all three variables of *Reading Effectiveness* in Test 1, *WPM 2* in Test 1). Moreover, it is worth noting that the dyslexic reader's scores of some variables (*Reading Time 1* in Test 6, all three variables of *Reading Effectiveness* in Test 6) underwent an improvement that can be directly linked to the training. Once again, these analyses confirm the efficacy of Eye-Hop™ if adequately exercised.

2. The principal aim of SuperReading™ is to "reduce reading time and improve comprehension at the same time" (Santulli & Scagnelli, 2017). From the analyses discussed in the previous paragraph, both groups of readers showed an improvement in the *Reading Time* variables, but for what concerns comprehension only the group of neurotypical readers showed a small increment in the percentage of correct answer - still statistically not significant –, while the dyslexic subject showed a worsening in comprehension percentage. *Appendix E* includes Graphs from A to J which summarize the performances of both groups in all tests (Follow Up included) and compare the two groups in all variables. What can be seen is that the group of neurotypical readers underwent a gradual improvement in all variables, and this is evident from baseline to post-training tests. It can be hypothesized that this improvement of neurotypical readers could

be correlated with the gradual change in type of Eye-Hop™ (which encourages readers to absorb increasingly numerous groups of words saving time after type of exercise) and minutes of daily practice. This could be accounted as true also for the dyslexic reader, whose improvement was not as linear as the one detected in the group of neurotypical readers. This fluctuating rate evident in the dyslexic reader's improvement is probably due to the lack of objective techniques that guide readers throughout all kind of texts: of course, what we are referring to are the metacognitive strategies that are taught during the SuperReading™ course. These techniques are extremely important especially for dyslexic readers, because they constitute a way to counterbalance the effects of the practice with Eye-Hop™ on silent reading speed. This reduction of comprehension rates of the dyslexic reader could be due to the excessive concentration on the decoding the written material of the text along with a lack of knowledge of metacognitive or memorization strategies. For this reason, we can conclude that the lack of metacognitive or memorization strategies in the training could be the reason why neurotypical readers did not improve significantly comprehension during first and second reading, and why the dyslexic reader even showed a worsening in comprehension rates both during first reading and review, with the training concentrating only on the practice of Eye-Hop™.

3. Follow Up was characterized by teaching a set of preview strategies that can be found in the SuperReading™ course – the *anteprima* techniques. Observing the graphs in *Appendix D*, it is evident that the neurotypical group of readers benefitted partially of knowledge of the strategies: *Reading Time 1* diminished but not significantly, however, *Reading Time 2* improved significantly, with an evident decrease of seconds in reading time during review. Linked to this enhancement, words per minute in the variable *WPM 2* calculated during Follow Up show an increase compared to Test 6. All other variables were not influenced significantly by the *anteprima* techniques. For what concerns the dyslexic reader, scores from *Reading Time 2* and *Comprehension 1* collected during the Follow Up meeting were found significantly lower compared to the scores collected during Test 6, while all other variables did not differ from Test 6. The reason behind this partial benefit - limited to *Reading Time 2* and *WPM 2* in neurotypical readers - could be related to the fact that the first time that participants used the *anteprima* techniques coincided with the first time they

could experience the mode of operation of these techniques. Probably the newness of the strategies, along with anxiety for the test, did not bring any significant improvement especially in *Reading Time 1* and in *WPM 1* in both groups. Once participants had experienced the mechanisms of *anteprima* they could approach the follow up test with less anxiety and stress, improving significantly *Reading Time 2* and *WPM 2*, at least neurotypical readers. Note that this step in this research was programmed to observe an eventual further improvement in performance, this time including also the comprehension variables left out from the improvement given by practicing with Eye-Hop™. Unfortunately, the fact that the experimenter did not give the right amount of time to start practicing with this set of techniques influenced the general performances of both groups. For this reason, the prediction made was not confirmed, at least for most variables. Further research should consider keeping this last step in a model of study similar to the current one, or to focalize the attention only on Eye-Hop™ training and data collected from eye tracker to study in details the ocular pattern developed through the practice with the Eye-Hop™ technique.

4. This study shows evident limitations: first of all, the fact that there is only one dyslexic reader in the research. For this reason, it is important to keep in mind that results cannot be generalized to a greater population but can be considered as a starting point for future research. The behavior of one participant during these seven tests cannot be applied to other dyslexic readers, and it is highly recommended to design other studies with Eye-Hop™ as the only exercise in the training gathering a larger group of dyslexic readers to collect more grounded data and to be able - successively - to generalize them. The dyslexic reader who participated at this study showed a significant improvement in all three variables of *Reading Time*, confirming that Eye-Hop™ affects reading speed also of people with a diagnosis of dyslexia. The reader showed difficulties more for the nature of the text, telling the experimenter that certain texts were more difficult compared to others since they contained information that were hard for the reader to remember, such as numbers and dates. Difficulty with texts with certain characteristics or topics was also reported by the neurotypical readers. The difficulties with some tests are visible in the Tables in the following page: Tests C and D were the most complicated for all participants, and this is evident

from the low percentage of correct answers both during first reading and review (respectively 51% and 43,5% in comprehension during first reading, 79% and 72,5% in comprehension during second reading). On the contrary, Test A and Test B were considered easier by participants, with information that could be memorized and retrieved with less difficulty when answering the questions of the test (respectively 66% and 72% in comprehension during first reading, 85% and 88% in comprehension during review). This irregularity in performances is visible in this research probably due to the lack of metacognitive strategies in the training: the knowledge of certain techniques and how to move across every type of text, sure about where to search relevant information it is the first motor in improve comprehension. Standardized methods to approach texts are fundamental especially for academic purposes. For these reasons, it is highly recommended to continue researching on SuperReading™ eventually organizing studies in which are taught only metacognitive strategies, to observe which among the variables improve more, and how metacognitive strategies affect the *SuperReader* in training.

Compr1	**A**	**B**	**C**	**D**	**E**	**F**	**H**	**MEAN**
1	66,25	66,67	45	45	40	50		52,38
2	73,33	75	77,5	36,67	47	43,75		56
3	62,5	66,25	42,5	41,67	66,67	45		55,79
4	71,25	73,75	57,5	41,25	57,5	52,5		60
5	67,5	81,25	38,33	45	50	67,5		59,72
6	52,5	65	55	55	65	81,67		63,06
FU							51,67	51,67
	66,31	72,37	50,83	43,5	56,31	56,84	51,67	57,06

Table 20. Average percentage of comprehension (correct answers) during first reading in each test by all participants from both groups. Test C and D were reportedly the most difficult for participants of both groups, while Test B was considered easier for information to be remembered and the type of text.

Compr2	A	B	C	D	E	F	H	MEAN
1	76,25	76,67	80	78,75	92,5	86,67		80,71
2	93,33	86,67	97,5	65	91	82,5		85,75
3	86,25	88,75	60	56,67	98,33	91,67		82,1
4	90	87,5	75	73,75	90	90		84,17
5	75	93,75	68,33	82,5	80	95		84,44
6	85	95	86,25	72,5	92,5	96,67		88,89
FU							91,67	91,67
	84,74	87,63	78,61	72,5	92,1	90,26	91,67	84,96

Table 21. Average percentage of comprehension (correct answers) during second reading in each test by all participants from both groups. Test C and D were reportedly the most difficult for participants of both groups, while Test B was considered easier for information to be remembered and the type of text. Also, Test E and Test F show high scores in accuracy during review.

5. Another limitation for this research is the fact that there are no data collected with the eye tracker. As it was previously mentioned, tools were not available to observe the ocular patterns of participants during the baseline test and throughout the experimentation. For further research, it is suggested to organize a new study with a training similar to the one of this study (exercising only with Eye-Hop™) but implementing also a collection of data from readers who carry out comprehension tests while equipped with eye trackers. In this way, the new ocular pattern induced with *eye-hopping* will be revealed, movements which are not influenced by the knowledge of preview strategies such as the one explained during the Follow Up meeting in this study. Knowing how Eye-Hop™ works will be extremely important in determining a new method of rehabilitation that will focus on the strongest abilities of people with a diagnosis of dyslexia.
6. It could be important to analyze the correlation between the quantity and the quality of practice and time employed in reading. By analyzing the descriptive analysis (*Table 4*), we can see that less practice during the weeks of training could cause a delay – or a complete stop – in the improvement of reading speed. This can be observed especially in Test 5 and in Test 6: *Reading Time* overall (all three variables) and *WPM* in both reading sessions underwent a worsening. This means that *Reading Time* increased and words per minute diminished (11

participants out of 18 did not respect the schedule during last week of training, 2 out of 11 did not practice Eye-Hop™ at all the previous week). A statistical analysis using Pearson's correlation was conducted comparing the average seconds employed in reading (all three variables) and the average time spent exercising weekly with *eye-hopping* by both groups of readers. Results however underlined no statistically significant correlation between the variables in neurotypical readers (*Reading Time 1*: $t(4) = -1.9944$, $p = 0.1169$; *Reading Time 2*: $t(4) = -0.30347$, $p = 0.7767$; *Total Reading Time*: $t(4) = -1.1146$, $p = 0.3275$) nor in the dyslexic reader (*Reading Time 1*: $t(4) = -2.2411$, $p = 0.08851$; *Reading Time 2*: $t(4) = -0.28076$, $p = 0.7928$; *Total Reading Time*: $t(4) = -1.1706$, $p = 0.3068$).

Subject	Week 1 (max 70 min)	Week 2 (max 84 min)	Week 3 (max 98 min)	Week 4 (max 112 min)	Week 5 (max 140 min)	TOT
S2	70	84	98	64	40	356
S4	70	84	98	112	80	444
S5	70	84	98	96	120	468
S6	70	84	98	80	140	472
S7	71,5	84	98	72	90	415,5
S8	70	84	98	112	118	482
S9	70	84	98	80	20	352
S10	70	84	98	80	20	352
S11	70	84	42	0	20	216
S12	70	84	56	0	20	230
S13	70	84	98	80	60	392
S14	70	84	98	96	60	408
S15	70	84	98	112	120	484
S17	70	84	98	96	80	428
S18	70	60	56	112	120	418
S19	75	72	84	112	120	463
S20	70	84	98	112	120	484
S21	84	84	105	126	80	479
	1280,5	1476	1617	1542	1428	7343,5

Table 22. Time spent by single participants (both neurotypical and dyslexic readers) exercising with Eye-Hop™ during the training.

3.2 Conclusion

This study was designed to observe the effects of one of the many components of the SuperReading™ course, that is the Eye-Hop™. The exercise was designed to help readers to absorb more information through single fixations, increasing reading speed and diminishing time employed in reading a text.

A five-week training was organized to observe the effects of *eye-hopping* practice on a group of participants which included neurotypical readers and one dyslexic reader. An additional test was planned the week after the end of the training. This follow up test was included in the study to observe if the effects of *eye-hopping* practice were still present even if participants did not exercise with Eye-Hop™. Moreover, in this follow up meeting a preview technique was introduced to participants. This technique was added to observe if comprehension rates of readers were higher in comparison to the one collected during the training.

With the limitations of the case, statistical results underlined that *eye-hopping* practice influenced reading time and speed in neurotypical and dyslexic readers. For this reason, it can be hypothesized that the exercise modified the pattern in eye movements, presumably reinforcing the elaboration of information in the parafoveal region, especially in the dyslexic reader. However, it is worth noting that statistical correlation did not find any relationship between the minutes of practice of the exercise and the time employed to read the texts presented during the weekly tests. With the data collected in this research, it can be confirmed previous conclusions regarding Eye-Hop™ made by researchers saying that this exercise influences speed during silent reading (e.g., Scagnelli, Oppo, Santulli, 2014; Santulli & Scagnelli, 2017). This affirmation could have been further examined through data acquired with the eye tracker - explaining also a probable alternative eye movement pattern - but unfortunately, no such data was collected. Future research should consider implementing this type of data comparing it with the patterns found in precedent studies (Scagnelli, Oppo, Santulli, 2014; Santulli, Scagnelli, Oppo, 2016; Santulli & Scagnelli, 2017; Scagnelli *et al.*, 2018) and monitoring if there is an actual difference of eye movements in the first, third and sixth weekly test. In particular, it needs to be observed any detectable change in the preview effect in the parafoveal region, both in neurotypical and dyslexic readers, including also experimental designs aimed at eliciting that particular effect. One point in favor of Eye-Hop™ is that this exercise can be easily practiced at home: once it has been explained, everyone can practice daily using materials handed by a SuperReading™ coach or alternatively, readers can even use self-made material (with the help of a website). The fact that this exercise works on improving reading speed by promoting a new visual approach to texts, it can be taken in consideration to be adopted as an exercise during rehabilitation by dyslexic readers who speak languages with regular orthographies such as Italian (Hawelka *et al*., 2009). This research confirmed the efficacy even for neurotypical readers, who can benefit equally to dyslexic participants from this exercise in scholastic and academic environments. It requires great motivation to keep exercising with regularity, but improvement is evident, and researchers are confirming it study after study. Another important conclusion can be done by observing the comprehension rates. They did not undergo a significant change throughout the period of collection of data in both populations. This could be linked to the fact that any metacognitive strategy was included in the training, depriving participants of tools which help them at managing and memorizing information more easily.

Conclusion

It takes many years to master a complex and elaborated process such as reading. Research have underlined how the brain and its neuronal connections need to adjust their structure to create an intricate network which guarantee the functioning of all subprocesses included in the main reading process. It takes time, exercise and energies to acquire the steps that lead individuals to reach the ultimate goal of the reading process and become skilled readers: understanding the message of a written string of graphic symbols. Comprehension of written information is the goal of reading, and to be effective, many cognitive processes need to be well-preserved to cooperate successfully. However, there are cases in which some components of the reading network are impaired, causing deficits in the process and ultimately affecting comprehension. Dyslexia is caused by the deficit of a component of the model which describes how single words are read. It is included in the group of *Specific Learning Disabilities*, a definition which includes other deficits regarding abilities developed in formal education, such as writing and calculus. Since they are children, dyslexic readers encounter many difficulties, not only from dyslexia itself, but also from what concerns the emotional sphere, that could be – in their case - very fragile. An essential component in reading is certainly the elaboration of visual stimuli and the patterns in eye movements. In fact, research underlined how neurotypical and dyslexic individuals show different pattern of movements while reading. Moreover, it has been demonstrated that this difference can have repercussions also on text comprehension in dyslexic readers. Chapter One introduced and described three major topics: the mechanisms behind the reading process and text comprehension in neurotypical individuals, a description of dyslexia and its effects on reading, and ultimately, eye movement patterns in both populations.

The theoretical framework was discussed to further understand the elements included in the SuperReading™ course (and in the study). This innovative course was developed by Ron Cole in the US in 1990s to improve speed in silent reading and comprehension in its participants. Chapter Two of this dissertation described the course and its components in detail: metacognition, the emotional sphere of readers and *eye-hopping*, which is the most peculiar exercise developed particularly for this course.

SuperReading™ was designed to help employees who worked in Californian offices and needed to save time with paperwork, at the same time keeping high efficiency in their work. SuperReading™ revealed itself to be an interesting course not only for its structure, but also for the results collected from readers after the end of the training. This because Cole observed that not only a general improvement in reading speed and comprehension was evident in participants at the course, but also that especially dyslexic readers benefitted more from the exercises and techniques in comparison to neurotypical readers. It is made up of many components such as the metacognitive one – which teaches readers to think about their approach to texts and gives tools to be used to maximize comprehension – and the emotional one – which aims at bringing benefits to the psychological sphere of the readers (especially to dyslexic participants, who are usually insecure of their abilities, and this insecurity can cause stress and discomfort) giving encouragement through positive affirmations. Last, but not least, the Eye-Hop™ exercise consists in jumping between groups of words while reading as fast as possible, still preserving comprehension. Increasing difficulty by gradually incrementing the number of words inside the groups, Eye-Hop™ was designed to help readers to improve silent reading speed (e.g., Cooper, 2009, 2012; Scagnelli, Oppo & Santulli, 2014). Chapter Two included also a brief overview on existent literature on SuperReading™ and its effects.

Considering all studies previously conducted on SuperReading™ and the theory presented in the first two chapter of this thesis, the study reported in Chapter Three was programmed to start a more in-depth analysis of the single components of the course. The Eye-Hop™ exercise was taught to a group of 21 university students, who practiced with it for five weeks (before the end of the training, 3 participants left the research; statistical analysis were conducted on the data collected from the remaining 18 participants). This training was programmed to observe if the single practice of the Eye-Hop™ would have generated changes in the pattern of silent reading in the group of participants, both neurotypical and dyslexic individuals. Since Eye-Hop™ was designed to save time and absorb visually as much information as possible while reading, it was predicted that all participants would have been affected positively in terms of reading speed if they practiced regularly. Moreover, it was hypothesized that the Eye-Hop™ with its peculiar layout would have strengthened the preview effect in both populations. Preview effect is essential when it comes to the automatization of the reading process, accelerating speed with a global analysis of the written stimuli at the right of the fixation point (see paragraph 1.3.3). Any other component, technique and exercise present in the course were voluntarily kept out from the training. The changes in the silent reading pattern were monitored by weekly administering a test, which consisted in reading a 400-words text and answering 10 questions in two reading sessions. A follow-up meeting was scheduled to observe if any change in comprehension rates after having included a metacognitive strategy, the *anteprima* technique.

At the end of the five-week training, results highlighted an improvement in reading speed and a consequent reduction of seconds employed in reading in all participants, both neurotypical and dyslexic readers. Neurotypical readers' performance was also characterized by improvements in other two variables, namely *Reading Effectiveness* and *Word Per Minute*. These results can support the hypothesis on the working mechanisms of the Eye-Hop™, suggesting that it aims at strengthening the parafoveal region in the area of vision and the preview effect, which are weaker in dyslexic readers in comparison to neurotypical readers. However, it needs to be reminded that the group of participants is relatively small, and to confirm this hypothesis, it is recommended to continue researching on Eye-Hop™ and the effect of the other components of the course. On the other hand, comprehension rates of participants from both populations did not undergo a significant change after the end of the training. Data collected during the follow-up meeting highlighted a partial benefit for neurotypical readers from the effect of the *anteprima* technique (scores of *Reading Time 2* and *WPM 2* were found statistically improved in comparison to Test 6). Keeping in mind that the current study possesses evident limitations (for example, the unbalanced number of dyslexic and neurotypical readers to be compared), it could be concluded that *eye-hopping* with a certain regularity can affect positively silent reading speed in both neurotypical and dyslexic readers, decreasing seconds employed in reading.

In conclusion, this study could be considered a starting point for further research on Eye-Hop™ and its effects on the eye movement patterns in neurotypical and dyslexic readers. Due to many limitations, we can affirm with caution that results collected in the study head towards the hypothesis on effects of the Eye-Hop™ practice on the parafoveal region and the preview effect of both populations of readers, speeding up the reading process. For this reason, in further research, it is essential to include data collected from eye-trackers, which are tools that permit researchers to directly observe eye movement patterns in readers.

SuperReading™ can be considered one of the most innovative and inclusive proposal for what concerns the improvement of the reading process in neurotypical and dyslexic readers. It gives the possibility to all readers to become more aware and strengthen their already present knowledge through exercises and techniques designed to be effective in a relaxed environment, in which nobody feels judged by others, where everyone is at the same level. What is remarkably innovative in the SuperReading™ course if the fact that it promotes cohesion, active interaction between participants and – finally – it promotes inclusion for dyslexic readers, which is extremely important especially in the scholastic environment. The organization of the course could be also considered a basis for exercises in classrooms, giving new tools to all students and permitting them to reflect upon texts more accurately, with a new approach directly aimed at understanding, acquiring and elaborating all the important information in a text. In this sense, these tools will help all students, independently from the fact that they are affected by developmental dyslexia or not (Santulli and Scagnelli introduced some examples of exercises shaped upon the SuperReading™ structure in their book published in 2019). Finally, it is important to continue researching on SuperReading™ and the effects of its components on the reading process, to further understand the mechanisms behind the success of this training.

References

Akturk, A. O. & Sahin, I. (2011). “Literature Review on Metacognition and its Measurement”, *Procedia – Social and Behavioral Sciences*, volume 15, pp. 3731-3736;

Alexander-Passe, N. (April 2006). “How Dyslexic Teenagers Cope: An Investigation of Self-esteem, Coping and Depression”, *Dyslexia*, volume 12, pp. 256-275;

Ashby, J., Yang, J., Evans, K. H. C., Rayner, K. (2012). “Eye movements and the perceptual span in silent and oral reading”, *Attention, Perception & Psychophysics*, volume 74, pp. 634-640;

Barca, L., Burani, C., Di Filippo, G., Zoccolotti, P. (2006). “Italian developmental dyslexic and proficient readers: Where are the differences?”, *Brain and Language*, volume 98, pp. 347-351;

Bellocchi, S., Muneaux, M., Bastian-Toniazzo, M., Ducrot, S. (2013). “I can read it in your eyes: What eye movements tell us about visuo-attentional processes in developmental dyslexia”, *Research in Developmental Disabilities*, volume 34, pp. 452-460;

Bender, W. N. & Wall, M. E. (Autumn 1994). “Social-Emotional Development of Students with Learning Disabilities”, *Learning Disability Quarterly*, volume 17, n° 4, pp. 323-341;

Bishop, D. V. M., Snowling, M. J. (2004). “Developmental Dyslexia and Specific Language Impairment: Same or Different?”, *Psychological Bulletin*, volume 130, n° 6, pp. 858-886;

Boulware-Gooden, R., Carreker, S., Thornhill, A., Malatesha Joshi, R. (2007). “Instruction of Metacognitive Strategies Enhances Reading Comprehension and Vocabulary Achievement of Third-Grade Students”, *The Reading Teacher*, volume 61, n° 1, pp. 70-77;

Castles, A., Coltheart, M. (1993). “Varieties of developmental dyslexia”, volume 47, pp. 149-180;

Cooper, R. (Spring 2009). “Evaluation of a ‘Super Reading’ Course with Dyslexic Adults”, *The Journal of Inclusive Practice in Further and Higher Education*, volume 1, n° 2, pp. 1-17;

Cooper, R. (October 2012). “Updating the evidence of the impact of SuperReading on dyslexic students”, *The Journal of Inclusive Practice in Further and Higher Education*, volume 4, n° 1, pp. 26-41;

Cubukcu, F. (2008). “Enhancing vocabulary development and reading comprehension through metacognitive strategies”, *Issues in Educational Research*, volume 18, n° 1, pp. 1-11;

De Luca, M., Di Pace, E., Judica, A., Spinelli, D., Zoccolotti, P. (1999). “Eye movement patterns in linguistic and non-linguistic tasks in developmental surface dyslexia”, *Neuropsychologia*, volume 37, pp. 1407-1420;

De Luca, M., Borrelli, M., Judica, A., Spinelli, D., Zoccolotti, P. (2002). “Reading Words and Pseudowords: An Eye Movement Study of Developmental Dyslexia”, *Brain and Language*, volume 80, pp. 617-626;

Devine, M., Meyers, R., Houssemand, C. (2013). “How can coaching make a positive impact within educational settings?”, *Procedia – Social and Behavioral Sciences*, volume 93, pp. 1382-1389;

Elliott, J. G. & Grigorenko, E. L. (2014). “The Dyslexia Debate”. New York: *Cambridge University Press*;

Facoetti, A., Paganoni, P., Turatto, M., Marzola, V., Mascetti, G. G. (2000). “Visual-spatial attention in developmental dyslexia”, *Cortex*, volume 36, pp. 109-123;

Fanari, R., Scalisi, G., Orsolini, M. (2013). “La lingua scritta”, Chapter 9, pp. 231-256 in D’Amico, S. & De Vescovi, A., *Psicologia dello Sviluppo del Linguaggio.* Bologna: Il Mulino;

Flavell, J. H. (1979). “Metacognition and Cognitive Monitoring – A New Area of Cognitive-Developmental Inquiry”, *American Psychologist*, volume 34, n°10, pp. 906-911;

Fletcher, S. J. (2012). “Coaching: an overview”, in *The SAGE Handbook of Mentoring and Coaching in Education*, edited by Fletcher, S. J. & Mullen, C. A.; Chapter 2, pp. 24-40;

Friedmann, N. & Coltheart, M. (2016). “Types of developmental dyslexia” in Baron, A. & Ravid, D., *Handbook of communication disorders: Theoretical, empirical and applied linguistics perspectives*. Berlin, Boston: De Gruyter Mouton;

Furnes, B. & Norman, E. (2015). “Metacognition and Reading: Comparing Three Forms of Metacognition in Normally Developing Readers and Readers with Dyslexia”, *Dyslexia*, volume 21, pp. 273-284;

Gersten, R., Fuchs, L. S., Williams, J. P., Baker, S. (Summer, 2001). “Teaching Reading Comprehension Strategies to Students with Learning Disabilities: A Review of Research”, *Review of Educational Research*, volume 71, n° 2, pp. 279-320;

Goodman, K. S. (1967). “Reading: A Psycholinguistic Guessing Game”, *Journal of the Reading Specialist*, volume 6, pp. 126-135;

Grabe, W. (2004). “Research on Teaching Reading”, *Annual Review of Applied Linguistics*; Cambridge University Press, volume 24, pp. 44-69;

Grigorenko, E. L. (2001). “Developmental Dyslexia: An Update on Genes, Brains, and Environments”, *Journal of Child Psychology and Psychiatry*, volume 42, n° 1, pp. 91-125;

Hawelka, S., Gagl, B., Wimmer, H. (June 2009). “A dual-route perspective on eye movements of dyslexic readers”, *Cognition,* volume 115, n° 3, pp. 367-379;

Hofmann, W., Schmeichel, B. J., Baddeley, A. D. (March 2012). “Executive functions and self-regulation”, *Trends in Cognitive Sciences,* volume 16, n° 3, pp. 174-180;

Horton Bowden, J. (September 1991). “Learning to Read”, *The Elementary School Teacher*, volume 12, n° 1, pp. 21-33;

Humphrey, N. (2002). “Self-Concept and Self-Esteem in Developmental Dyslexia: Implications for Theory and Practice”, *Self-Concept Research: Driving International Research Agendas*, pp. 1-11;

Hutzler, F. & Wimmer, H. (2004). “Eye movements of dyslexic children when reading in a regular orthography”, *Brain and Language*, volume 89, pp. 235-242;

Ingesson, S. G. (2007). “Growing Up with Dyslexia”, *School Psychology International*, volume 28, n° 5, pp. 574-591;

Irsch, K. & Guyton, D. L. (January 2009). “Anatomy of Eyes”, *Encyclopedia of Biometrics*;

Jones, M. W., Branigan, H. P. & Kelly, M. L. (2009). “Dyslexic and nondyslexic reading fluency: Rapid automatized naming and the importance of continuous lists”, *Psychonomic Bulletin & Review*, volume 16, n° 3, pp. 567-572;

Judica, A., De Luca, M., Spinelli, D., Zoccolotti, P. (2002). “Training of developmental surface dyslexia improves reading performance and shortens eye fixation duration in reading”, *Neuropsychological Rehabilitation*, volume 12, n° 3, pp. 177-197;

Kim, Y. S., Wagner, R. K., Foster, E. (July 2011). “Relations Among Oral Reading Fluency, Silent Reading Fluency, and Reading Comprehension: A Latent Variable Study of First-Grade Readers”, *Scientific Studies of Reading*, volume 15, n° 4, pp. 338-362;

Kirby, J. R., Silvestri, R., Allingham, B. H., Parrila, R., La Fave, C. B. (January/February 2008). “Learning Strategies and Study Approaches of Postsecondary Students with Dyslexia”, *Journal of Learning Disabilities*, volume 41, n° 1, pp. 85-96;

Knoepe, J. & Richter, T. (in press). “Reading comprehension: Individual differences, disorders, and underlying cognitive processes” in Bar On, A. & Ravid, D., *Handbook of communication disorders: Theoretical, empirical and applied linguistics perspectives*. Berlin, Boston: De Gruyter Mouton;

Kuhn, D. (October 2000). “Metacognitive Development”, *Current Directions in Psychological Science,* volume 9, n° 5, pp. 178-181;

Livingston, J. A. (2003). “Metacognition: an overview”, ERIC, pp. 2-7;

Livingston, E. M., Siegel, L. S., Ribary, U. (June 2018). “Developmental dyslexia: emotional impact and consequences”, *Australian Journal of Learning Difficulties*, pp. 1-30;

Long, L., MacBlain, S., MacBlain, M. (October 2007). “Supporting Students with Dyslexia at the Secondary Level: An Emotional Model of Literacy”, *Journal of Adolescent & Adult Literacy*, volume 51, n° 2, pp. 124-134;

Luzzatti, C. & Serino, A. (2012). “Il Linguaggio Scritto”, Chapter 10, pp. 251-276, in Ladavas, E., *La Riabilitazione Neuropsicologica*. Bologna: Il Mulino;

Makowski, (2018). *The psycho Package: An Efficient and Publishing-Oriented Workflow for Psychological Science*. Journal of Open Source Software, volume 3, n° 22, 470;

McCallum, R. S., Sharp, S., Mee Bell, S., George, T. (2004). “Silent versus oral reading comprehension and efficiency”, *Psychology in the Schools*, volume 41, n° 2, pp. 241-246;

Mokhtari, K. & Reichard, C. A. (2002). "Assessing Students' Metacognitive Awareness of Reading Strategies", *Journal of Educational Psychology,* volume 94, n° 2, pp. 249-259;

Newby, R. F., Caldwell, J., Recht, D. R. (June/July 1989). "Improving the Reading Comprehension of Children with Dysphonetic and Dyseidetic Dyslexia Using Story Grammar", *Journal of Learning Disabilities*, volume 22, n° 6, pp. 373-380;

Rayner, K. (1977). "Visual attention in reading: Eye movements reflect cognitive process", *Memory & Cognition*, volume 5, n° 4, pp. 443-448;

Rayner, K. (1998). "Eye Movements in Reading and Information Processing: 20 Years of Research", *Psychological Bulletin*, volume 124, n° 3, pp. 372-422;

Rayner, K., Chace, K. H., Slattery, T. J., Ashby, J. (2006). "Eye Movements as Reflections of Comprehension Processes in Reading", *Scientific Studies of Reading*, volume 10, n° 3, pp. 241-255;

Rayner, K. (April 2009). "Eye Movements in Reading: Models and Data", *Journal of Eye Movement Research*, volume 2, n° 5, pp. 1-10;

Rayner, K. (2009b). "Eye movements and attention in reading, scene perception, and visual search", *The Quarterly Journal of Experimental Psychology*, volume 62, n° 8, pp. 1457-1506;

Reichle, E. D., Pollatsek, A., Fisher, D. L., Rayner, K. (1998). "Toward a Model of Eye Movement Control in Reading", *Psychological Review*, volume 105, n° 1, pp. 125-157;

Reichle, E. D., Rayner, K. & Pollatsek, A. (2003). "The E-Z Reader model of eye-movement control in reading: Comparisons to other models", *Behavioral and Brain Sciences*, volume 26, pp. 445-526;

Riddick, B. (1996). "Living with dyslexia", Chapter 1, pp. 1-48; *Taylor & Francis*;

Santulli, F., Scagnelli, M., Oppo, A. (2016). “Super Reading: corso di lettura veloce per studenti con DSA” in *Genetica e ambiente nella dislessia*, edited by Guaraldi, G., Ghidoni, E., Genovese, E.; Trento: *Erickson*, pp. 91-110;

Santulli, F. & Scagnelli, M. (Winter 2017). “The Improvement of Silent Reading Strategies through SuperReading”, *The Journal of Inclusive Practice in Further and Higher Education*, volume 9, n° 1, pp. 88-100;

Santulli, F. & Scagnelli, M. (2019). “Leggere per comprendere: Un intervento inclusivo nei contesti formativi”. Milano: *FrancoAngeli*.

Scagnelli, M., Oppo, A., Santulli, F. (2014). “Potenziare la lettura all’università in studenti con dislessia e normolettori. La sperimentazione italiana di SuperReading™”, in *Dislessia e apprendimento delle lingue*, edited by Cardinaletti, A., Santulli, F., Genovese, E., Guaraldi, G., Ghidoni, E.; *Erickson*, Trento, pp. 181-198;

Scagnelli, M., Ciuffo, M., Baradello, A., Santulli, F. (January 2018). “SuperReading: ulteriori prove di efficacia rilevate con i test di valutazione per l’adulto”, *Dislessia*, volume 15, n° 1, pp. 35-51;

Schraw, G. (1998). “Promoting general metacognitive awareness”, *Instructional Science*, volume 26, pp. 113-125;

Sereno, S. C. & Rayner, K. (November 2003). “Measuring word recognition in reading: eye movements and event-related potentials”, *Trends in Cognitive Sciences*, volume 7, n° 11, pp. 489-493;

Simmons, F. & Singleton, C. (2000). “The Reading Comprehension Abilities of Dyslexic Students in Higher Education”, *Dyslexia*, volume 6, pp. 178-192;

Sperling, R. A., Howard, B. C., Miller, L. A., Murphy, C. (2001). “Measures of Children’s Knowledge and Regulation of Cognition”, *Contemporary Educational Psychology*, pp. 51-79;

Stella, G. & Savelli, E. (2011). "Dislessia oggi. Prospettive di diagnosi e intervento in Italia dopo la Legge 170". Trento: *Erickson.*

Trainin, G. & Lee Swanson, H. (Fall 2005). "Cognition, Metacognition, and Achievement of College Students with Learning Disabilities", *Learning Disability Quarterly*, volume 28, pp. 261-272;

Tressoldi, P. E., Stella, G., Faggella, M. (September/October 2001). "The Development of Reading Speed in Italians with Dyslexia", *Journal of Learning Disabilities*, volume 34, n° 5, pp. 414-417;

Tressoldi, P. E., Vio, C., Iozzino, R. (May/June 2007). "Efficacy of an Intervention to Improve Fluency in Children with Developmental Dyslexia in a Regular Orthography", *Journal of Learning Disabilities*, volume 40, n° 3, pp. 203-209;

Veenman, M. V. J., Wilhelm, P., Beishuizen, J. J. (2004). "The relation between intellectual and metacognitive skills from a developmental perspective", *Learning and Instruction*, volume 14, pp. 89-109;

Veenman, M. V. J., Van Hout-Wolters, B. H. A. M. & Afflerbach, P. (April 2006). "Metacognition and learning: Conceptual and methodological considerations", *Metacognition and Learning*, volume 1, pp. 3-14;

Warren, P. (2013). "Introducing Psycholinguistics", Chapters 7, 9, 10, 11, 12, 13. Cambridge University Press;

Wimmer, H. (1993). "Characteristics of developmental dyslexia in a regular writing system", *Applied Psycholinguistics*, volume 14, pp. 1-33;

Ziegler, J. C., Perry, C., Ma-Wyatt, A., Ladner, D., Schulte-Körne, G. (2003). "Developmental dyslexia in different languages: Language-specific or universal?", *Journal of Experimental Children Psychology*, volume 86, pp. 169-193;

Ziegler, J. C. & Goswami, U. (2005). “Reading Acquisition, Developmental Dyslexia, and Skilled Reading Across Languages: A Psycholinguistic Grain Size Theory”, *Psychological Bulletin*, volume 131, n° 1, pp. 3-29;

Zimmerman, B. J. (2008). “Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects”, *American Educational Research Journal*, volume 45, n° 1, pp. 166-183;

Zoccolotti, P., De Luca, M., Di Pace, E., Judica, A., Orlandi, M., Spinelli, D. (1999). “Markers of developmental surface dyslexia in a language (Italian) with high grapheme-phoneme correspondence”, *Applied Psycholinguistics*, volume 20, pp. 191-216;

Zoccolotti, P., Angelelli, P., Judica, A., Luzzatti, C. (2005). “Disturbi evolutivi di lettura e scrittura: metodiche per la valutazione”, in *I disturbi evolutivi di lettura e scrittura – manuale per la valutazione*. Roma: Carocci Faber. Chapter 2: pp. 45-78.

Appendix

Appendix A. Different varieties of developmental dyslexia (Friedmann & Coltheart, 2016).

Name	Type	Deficient component	Characteristics	Symptoms
Letter position dyslexia	Peripheral	Orthographic visual analyzer (letter position encoding)	Problems in encoding the position and the order of letters inside a word, but intact faculty of recognizing and naming the letters	Migrations of letters - both vowels and consonants - inside the word, with the first and final letters that usually keep their position; omission of double letters
Attentional dyslexia	Peripheral	Between-word position encoding	Correct identification of words, but letters migrate between words maintaining the original position in the word	Omission of double letters; addition of letters
Letter identity dyslexia	Peripheral	Orthographic visual analyzer (creation of abstract letter identity)	Difficulties in naming, identifying or matching the graphic form of letters with their abstract identities	Incorrect identification of isolated letters; substitution or omission of letters within words and nonwords
Neglect dyslexia	Peripheral	Orthographic visual analyzer	Difficulty in elaborating and reporting a written stimulus in the left side of the visual field	Omission, substitution or addition of letters on the left side of the written stimulus - words, sentences, text
Visual dyslexia	Peripheral	Output of the orthographic visual analyzer	Reading of the target word in another visually similar word	Errors in the identification of words by migration of letters
Surface dyslexia	Central	Lexical route	Difficulty in reading irregular words and words with uncommon pronunciation	Regularization errors of phonologically ambiguous words (e.g., non-homograph homophones)
Phonological dyslexia	Central	Sublexical route	Difficulties in reading unknown words and nonwords; correct reading of words already stored in the mental lexicon	Different types of errors during reading
Vowel letter dyslexia	Central	Sublexical route	Difficulties in reading unknown words and nonwords; correct reading of words already stored in the mental lexicon	Omission, substitution, transposition or addition of vowels. The phenomenon appears more frequently in words in which a changed vowel result in another existing word
Deep dyslexia	Central	Both lexical and sublexical routes, between the orthographic input lexicon and the phonological output lexicon	Reading of nonwords and morphologically complex words is severely impaired	Production of semantic, morphological and visual errors

Appendix B. Demographic data of neurotypical and dyslexic readers.

Participant	Initials	Sex	Age	Education	Occupation	Group
S1	AS	F	19	Secondary School Degree	Student	Control
S2	BV	F	21	Secondary School Degree	Student	Control
S3	BM	F	19	Secondary School Degree	Student	Control
S4	BG	F	23	Secondary School Degree	Student	Control
S5	BE	F	19	Secondary School Degree	Student	Control
S6	CA	F	19	Secondary School Degree	Student	Control
S7	FD	M	27	Secondary School Degree	Student	Control
S8	FV	F	19	Secondary School Degree	Student	Control
S9	GA	F	19	Secondary School Degree	Student	Control
S10	GV	M	20	Secondary School Degree	Student	Control
S11	MM	F	19	Secondary School Degree	Student	Control
S12	NB	F	20	Secondary School Degree	Student	Control
S13	NM	F	23	Bachelor's Degree (BA)	Student	Control
S14	RR	F	21	Secondary School Degree	Student	Control
S15	RM	F	20	Secondary School Degree	Student	Control
S16	RN	F	22	Secondary School Degree	Student	Control
S17	RF	F	30	Bachelor's Degree (BA)	Student	Control
S18	SR	F	22	Secondary School Degree	Student	Control
S19	SC	F	21	Secondary School Degree	Student	Control
S20	TL	M	20	Secondary School Degree	Student	Control
S21	ZM	F	19	Secondary School Degree	Student	SLD

Appendix C. Copy of informed consent for the study "SuperReading™: where does the improvement come from? The effects of the *Eye-hop*™ training on a group of university students".

SuperReading™ è un corso rivolto a studenti universitari e soggetti adulti, che si propone di valutare l'efficacia di alcune tecniche specifiche nell'incremento delle abilità di lettura (intese come velocità nella lettura, comprensione e memorizzazione delle informazioni) in studenti universitari e soggetti adulti.

Il corso prevede di esercitarsi quotidianamente con una tecnica specifica - l'*Eye-Hop* - il cui contributo al successo del verrà indagato nel corso di questa indagine. Trattandosi di un corso in fase di sperimentazione, con questo modulo Le chiediamo di esprimere il Suo consenso in merito alla partecipazione a questo progetto di ricerca e in merito all'utilizzo dei dati riguardanti la Sua prestazione ai test di valutazione delle abilità di lettura. Nello specifico, Le chiediamo di avere accesso alle prove di lettura da Lei fornite, ai Suoi dati anagrafici e alla eventuale certificazione di disturbo dell'apprendimento. Tali dati verranno utilizzati in forma anonima ai fini di analisi statistiche e qualitative e ai fini della standardizzazione del corso. Tali dati verranno altresì presentati a convegni e corsi di formazione e potrebbero essere pubblicati in articoli di carattere scientifico.

Viene tutelata la privacy dei partecipanti a tale progetto di ricerca. Non verranno in alcun modo forniti i nominativi dei partecipanti al progetto di ricerca.

Io sottoscritto ………………………………………… nato a ………………… Il……………… residente……………………………………………… dichiarando di avere ben compreso gli obiettivi della ricerca così come qui sopra delineati e spiegati da __________________________________esprimo il mio consenso in merito all'utilizzo dei dati raccolti nel corso degli incontri di esercizio su *Eye-Hop* ai fini di analisi statistiche. Esprimo altresì il mio consenso all'utilizzo dei dati raccolti a convegni corsi di formazione e alla pubblicazione di tali dati in articoli scientifici.

Milano, lì -----/-----/-------- In fede

Firma………………………

Appendix D. Research Project for the study "SuperReading™: where does the improvement come from? The effects of the Eye-hop™ training on a group of university students".

Introduzione:

SuperReading™ è un corso di dieci settimane ideato da Ron Cole negli Stati Uniti che mira ad aumentare la velocità della lettura e a migliorare la comprensione del testo promuovendo un approccio visivo. Avendo osservato miglioramenti significativi sia nei partecipanti lettori esperti sia nei partecipanti con dislessia nei suoi corsi negli USA (si parla di una diminuzione del tempo impiegato nella lettura ed un miglioramento generale delle abilità di comprensione, con un risultato ancora migliore nei soggetti con diagnosi di dislessia), Ron Cole ha avviato collaborazioni con università in Inghilterra (LLU+, Londra) e in Italia (IULM, Milano) per avviare nuove sperimentazioni e verificare se anche nei partecipanti inglesi e italiani si riscontrasse che "l'efficacia di lettura dei soggetti (…) raddoppiasse nell'arco delle dieci settimane del corso[143]".

Il corso prevede sei incontri della durata di tre ore ciascuno in cui vengono insegnate tecniche di lettura (come la lettura globale) e di memorizzazione (come la stanza della memoria) con un approccio metacognitivo, allo stesso tempo lavorando anche sull'autostima con l'uso di affermazioni positive. Nello specifico, la tecnica dell'Eye-Hop – che consiste nel saltare con il dito (e con lo sguardo) tra gruppi di parole in un testo impaginato su colonne – è quella che viene allenata maggiormente dal momento che è richiesta come esercizio quotidiano (30-40 minuti al giorno, anche dilazionati nell'arco di tutta la giornata) e che quindi è possibile ipotizzare che sia una delle cause principali del miglioramento generale della lettura e della comprensione.

Poiché al momento sono sconosciute l'origine e il motivo alla base dei miglioramenti dell'efficacia di lettura sia nei lettori esperti, sia nei soggetti con dislessia, questo progetto di ricerca in collaborazione con l'università IULM di Milano mira ad isolare la variabile Eye-Hop programmando un training di cinque settimane con esercizio giornaliero ed osservando gli eventuali miglioramenti di partecipanti attraverso test di comprensione a cadenza settimanale.

[143] Scagnelli, M., Oppo, A., Santulli, F. (2014). "Potenziare la lettura all'università in studenti con dislessia e lettori esperti. La sperimentazione italiana di SuperReading™", riferimento completo in bibliografia.

Obiettivi, Benefici e Rischi:

Lo scopo della ricerca è di indagare l'evoluzione del miglioramento della competenza della lettura silente e della comprensione in un gruppo di studenti universitari sottoposto ad un training di sei settimane basato sull'esercizio Eye-Hop, di porre le basi per un'osservazione dettagliata di questo specifico esercizio e se esso possa essere considerato il fattore principale del miglioramento riscontrato nei lettori esperti e nei soggetti con dislessia. Questa è ricerca di base.

È possibile che la partecipazione dei soggetti allo studio porti benefici graduali nella loro competenza di lettura e comprensione; in ogni caso, potrà aiutare i ricercatori a capire meglio i meccanismi di funzionamento dell'esercizio Eye-Hop ed eventualmente a sviluppare protocolli sperimentali di valutazione basati sull'esercizio studiato. Non si anticipano rischi.

Procedura:

Il giorno precedente all'inizio della procedura verranno spiegate le finalità della ricerca in questione, le modalità di svolgimento dei test settimanali e – in generale - del training che durerà sei settimane (dal 8/05/2018 al 13/06/2018) e che consisterà nel dedicare dai dieci ai venti minuti al giorno all'esercizio con la tecnica dell'Eye-Hop, escludendo tutte le altre tecniche presenti nel corso SuperReading™. Durante il primo incontro verranno anche raccolti i consensi informati e verranno determinate le modalità e le tempistiche dell'incontro giornaliero in base anche alle esigenze dei singoli partecipanti: l'obiettivo è quello di fare esercizio quotidiano in gruppo, in modo tale da osservare il modo in cui l'esercizio dell'Eye-Hop viene eseguito e fare in modo che tutti i partecipanti rispettino i minuti di esercizio quotidiano stabiliti. Il tempo dedicato all'esercizio inizialmente sarà di dieci minuti (cinque + cinque minuti, con una breve pausa), per poi aumentare fino ad arrivare a venti minuti (dieci + dieci minuti, con una breve pausa) alla fine delle sei settimane di training. Gli esercizi di Eye-Hop saranno a due, tre e quattro parole (eventualmente cinque parole): il passaggio da una tipologia all'altra sarà graduale e verrà suggerita dall'esaminatrice ai singoli partecipanti tenendo di conto dei loro progressi.

Verrà somministrato un pre-test di comprensione del testo per determinare il tempo impiegato nelle due sessioni di lettura e il tempo totale impiegato nella lettura per ciascun test, la percentuale di comprensione del testo nelle due sessioni di lettura, ed il livello di Efficacia di Lettura di base dei partecipanti, per poi continuare a somministrare i test una volta alla settimana fino al termine delle sei settimane di training. La durata del test settimanale (prima lettura del brano – domande volte a testare la comprensione – seconda lettura del brano – domande volte a testare la comprensione) è di venti-trenta minuti incluse le eventuali pause.

Popolazione dello studio e partecipazione:

I partecipanti allo studio sono 21 studenti universitari immatricolati a Ca' Foscari di entrambi i sessi e di età compresa tra i 19 e i 30 anni reclutati all'interno di una residenza studentesca a Venezia: ciò è stato programmato in modo tale da facilitare il training, fare esercizio quotidiano regolare in gruppo e somministrare i test con cadenza settimanale. Essi inizieranno il training dopo essere stati informati del progetto di ricerca e previa firma del consenso informato. La partecipazione al progetto di ricerca è assolutamente volontaria: ciascun partecipante può decidere in qualsiasi momento di non terminare il training e i test o di abbandonare il progetto comunicandolo tempestivamente.

Anonimato e confidenzialità:

Dopo aver raccolto il consenso informato, verrà associata una sigla (ad esempio, S1) a ciascun partecipante, in modo tale da garantire l'anonimato del soggetto stesso. Ai partecipanti è garantita la tutela dei dati e l'anonimato secondo il Decreto Legislativo 30 giugno 2003, n. 196 – Codice in materia di protezione dei dati personali. Inoltre, il progetto di ricerca e i ricercatori si atterranno al "Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi scientifici e statistici - G.U. n. 190 del 14 agosto 2004". In nessun momento i dati raccolti saranno collegati alle informazioni personali.

Trattamento dei dati:

I dati raccolti saranno registrati, elaborati ed archiviati in forma cartacea e informatizzata per le esclusive finalità connesse con la ricerca, in forma assolutamente anonima. I dati, collettivamente raccolti, saranno soggetti ad elaborazione statistica e in questa forma, sempre assolutamente anonima, saranno inseriti in pubblicazioni e/o congressi, convegni e seminari scientifici. Infine, i dati raccolti in questo studio potranno essere usati in una ricerca futura.

Codice Etico:

Lo studio sarà condotto in piena conformità con i principi della condotta etica nella ricerca umana (World Medical Association Declaration Of Helsinki – Ethical Principles for Medical Research Involving Human Participants), nel rispetto di tutti gli altri documenti di orientamento pertinenti (Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi scientifici e statistici - G.U. n. 190 del 14 agosto 2004) e nel rispetto delle leggi e dei regolamenti dello Stato Italiano (Decreto Legislativo 30 giugno 2003, n. 196 – Codice in materia di protezione dei dati personali).

Riferimenti bibliografici:

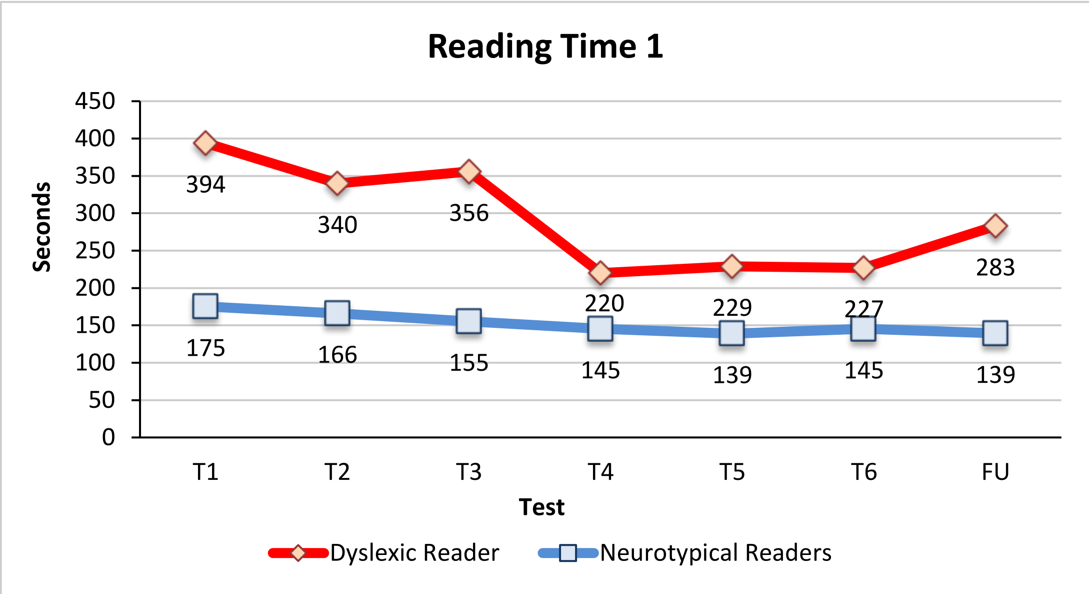
"World Medical Association Declaration Of Helsinki – Ethical Principles for Medical Research Involving Human Participants", <https://www.wma.net/wp-content/uploads/2016/11/DoH-Oct2013-JAMA.pdf>;

"Codice di deontologia e di buona condotta per i trattamenti di dati personali per scopi scientifici e statistici - G.U. n. 190 del 14 agosto 2004", < http://www.privacy.it/archivio/garanteprovv20040616.html>;

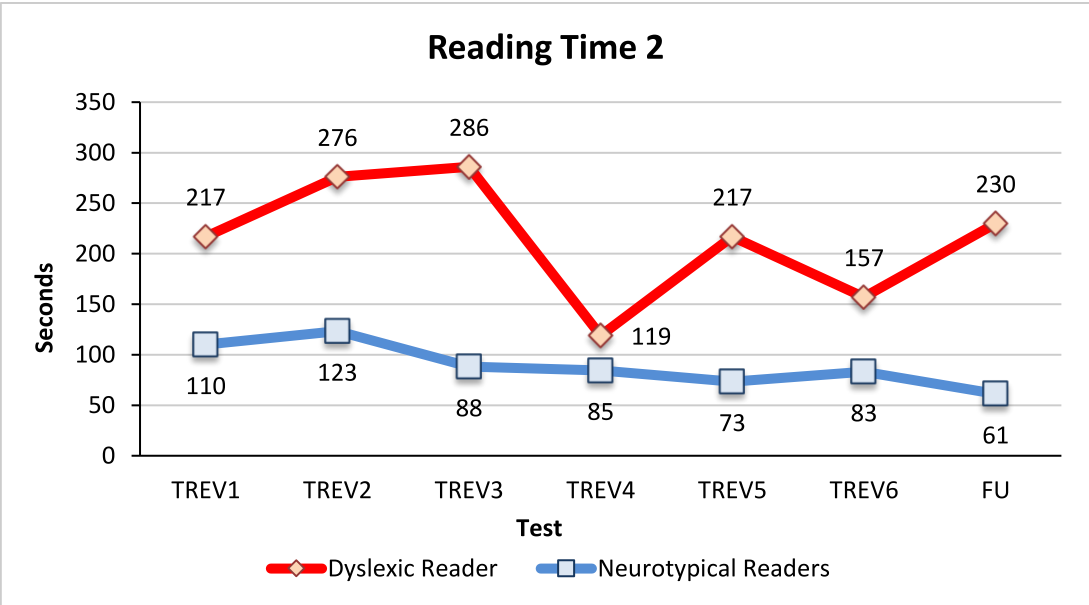
"Decreto Legislativo 30 giugno 2003, n. 196 – Codice in materia di protezione dei dati personali", < http://www.garanteprivacy.it/web/guest/home/docweb/-/docweb-display/docweb/1311248 >;

Scagnelli, M., Oppo, A., Santulli, F. (2014). "Potenziare la lettura all'università in studenti con dislessia e lettori esperti. La sperimentazione italiana di SuperReading™" in Cardinaletti, Santulli, Genovese Guaraldi & Ghidoni (eds.), Dislessia e apprendimento delle Lingue. Trento: Erickson.

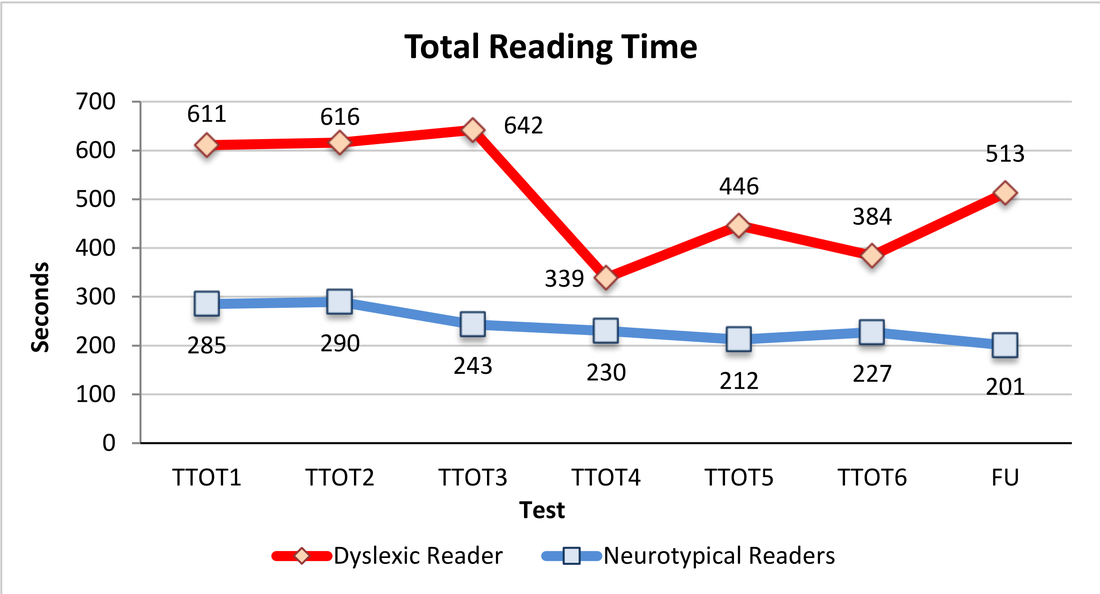
Appendix E. Graphics showing all participants' performances from Test 1 to Test 6.



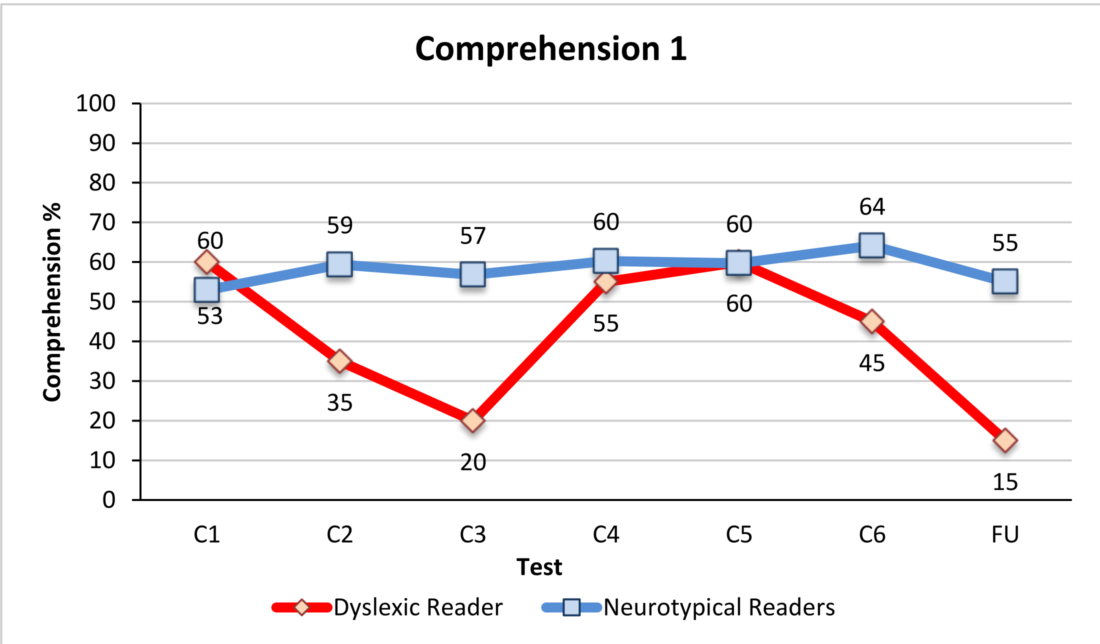
Graph A. Average *Reading Time 1* throughout all six tests and follow up collected from both populations.



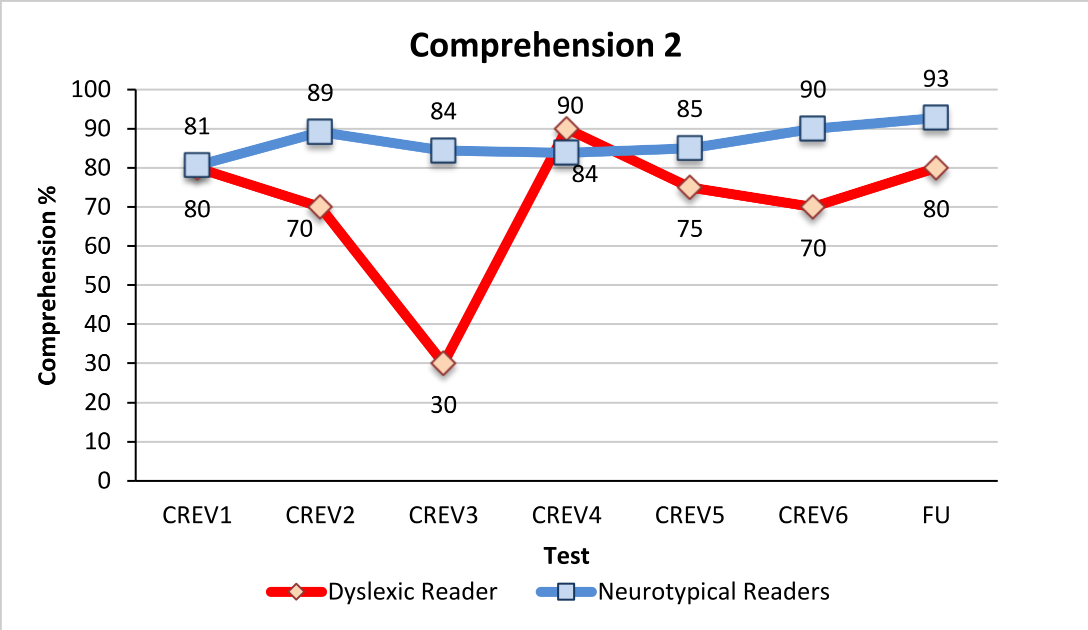
Graph B. Average *Reading Time 2* throughout all six tests and follow up collected from both populations.



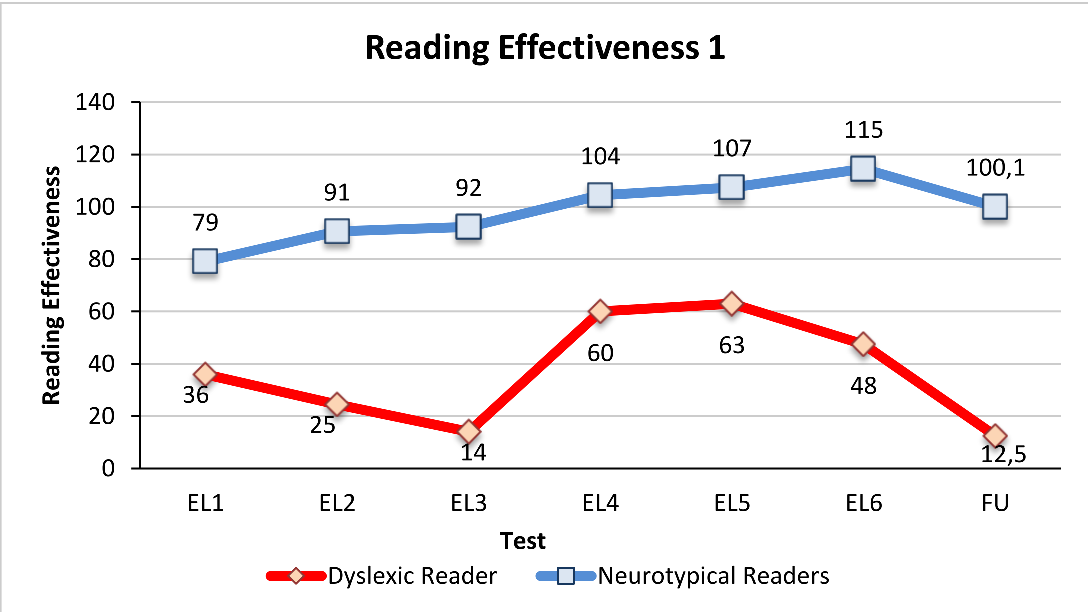
Graph C. Average *Total Reading Time* throughout all six tests and follow up collected from both populations.



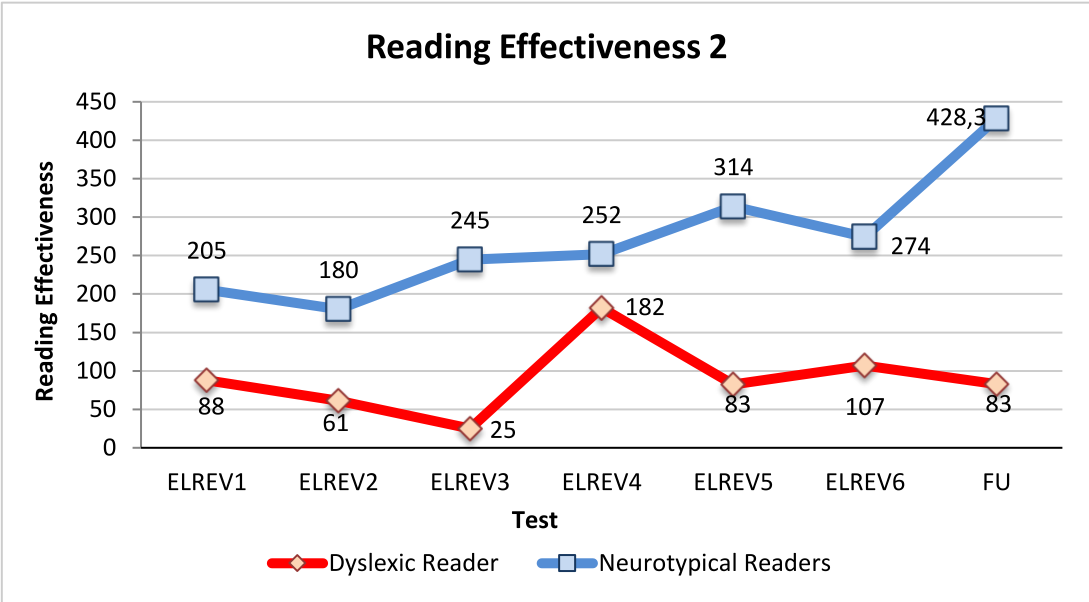
Graph D. Average *Comprehension 1* throughout all six tests and follow up collected from both populations.



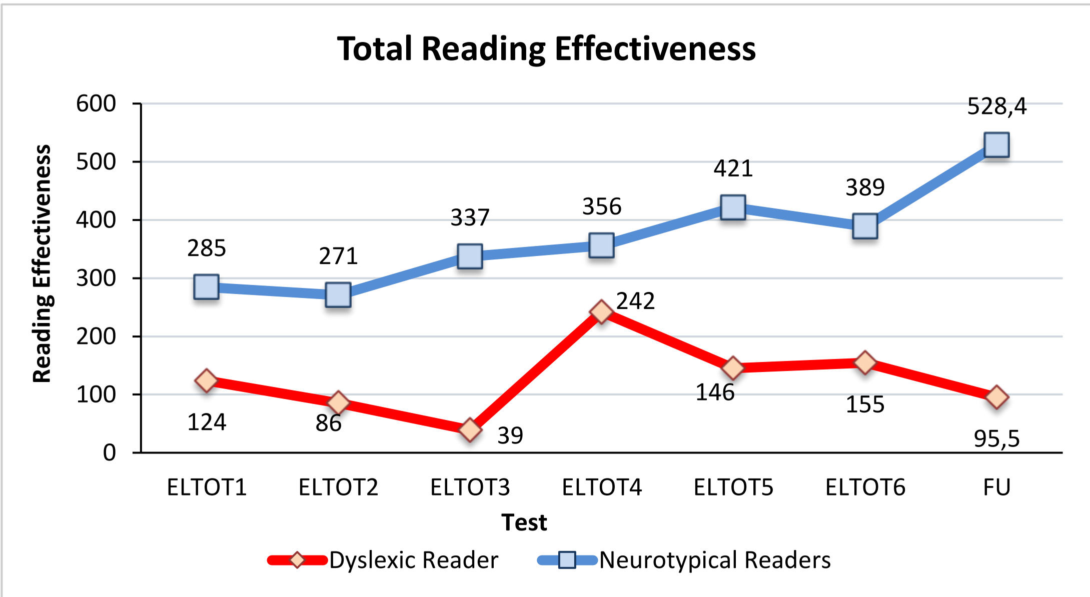
Graph E. Average *Comprehension 2* throughout all six tests and follow up collected from both populations.



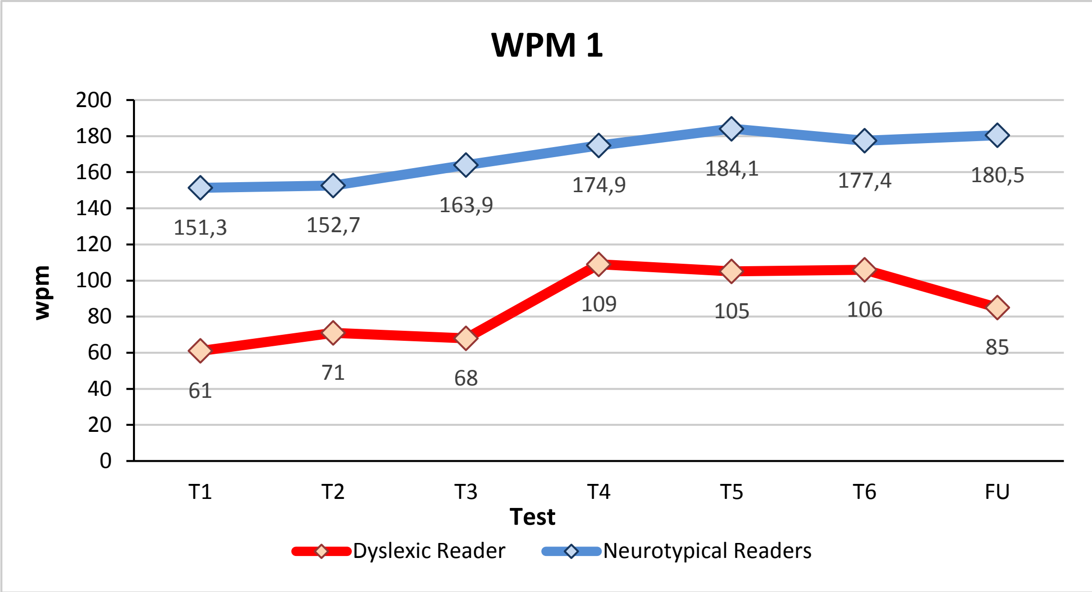
Graph F. Average *Reading Effectiveness 1* throughout all six tests and follow up collected from both populations.



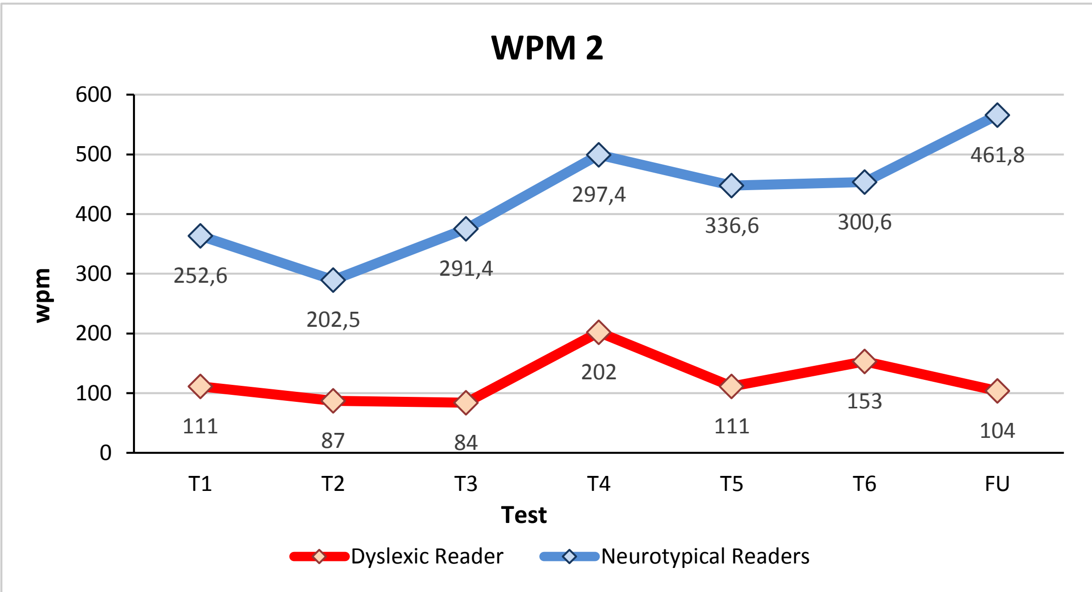
Graph G. Average *Reading Effectiveness 2* throughout all six tests and follow up collected from both populations.



Graph H. Average *Total Reading Effectiveness* throughout all six tests and follow up collected from both populations.



Graph I. Average *WPM 1* throughout all six tests and follow up collected from both groups.



Graph J. Average *WPM 2* throughout all six tests and follow up collected from both groups.