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DYSLEXIA, BILINGUALISM AND EDUCATION: INFLUENCE ON READING PROCESSING IN L1 AND L2

RIO DE JANEIRO

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Master's thesis presented to the Graduate Program in Linguistics at the Faculty of Letters of the Federal University of Rio de Janeiro as one of the requirements for obtaining a Master's degree in Linguistics.

Advisor: Marije Soto

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I dedicate this dissertation to my dear mother Márcia Reina for inspiring me to conquer my dreams, for identifying my vocation and helping me achieve this goal throughout my life. She taught me that it is never too late to do what you are meant to.

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"For everything comes from Him and exists by His power and is intended for His glory. All glory to Him forever! Amen."

(Romans 11:36)

ABSTRACT

REINA, Rebecca Christina Tomaz. **Dyslexia, bilingualism and education: influence on reading processing in L1 and L2.** Master's dissertation in Linguistics. 240f. Faculdade de Letras, Programa de Pós-Graduação em Linguística. Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2023.

Dyslexic people are often discouraged from learning a L2, however, this can be wrongly assumed once it can have beneficial effects as scientists and studies show this (SPARKS; GANSCHOW, 1993; WYDELL; BUTTERWORTH, 1999; AZEVEDO, 2016, among others). L1 and L2 reading difficulties are influenced by differences between language orthographic systems. Specific features can be the degree of transparency between sound and grapheme and the different dimensions of granularity in the sound-orthography relationship; we associate these features to a dual route reading model (ELLIS, 1995). That is, the dual route reading model proposes that reading can be processed through two distinct routes: the lexical route, which relies on whole word recognition, and the non-lexical route, which uses phonological decoding. Furthermore, reading and oral skills may not be consolidated simultaneously (LODEJ, 2016). The objective is to compare dyslexics participants of 8, 9 and 11 years old and their control pairs in a variety of cognitive tasks such as word dictation, repetition and reading aloud of words, and silent reading of sentences for comprehension in L1 [Brazilian Portuguese (BP)] and L2 [English (EN)], alongside tests such as IQ, digit span, RAN, Reading Speed of Sentences, English proficiency and language experience and proficiency questionnaire. The hypothesis is that if dyslexics of this study, through exposure to English, have consolidated reading strategies via the lexical route due to the opaque and relatively less fine grained nature of the English spelling system, this may be more compatible with their underlying cognitive issues and, therefore, be beneficial to their reading in both L1 and L2. In the reading aloud task for words and pseudowords task, the hypothesis that dyslexics would struggle with pseudowords in both languages was confirmed. The successful and rapid reading of sentences for comprehension shows students have managed to automatize their reading. When it comes to Reading Speed of Sentences, there are higher scores in English, a very small difference between BP and EN. Reading sentences is different from reading words. This result confirms the hypothesis that they are better in English reading and that there is a positive effect on Portuguese reading. The dictation data seem to confirm the difference between cognitive processes involved in reading and writing. In writing, the transparency of a language seems to help as we can see that the scores in BP were greater than in EN. In RAN tasks, dyslexics show difficulties, as expected. The experience and linguistic proficiency questionnaire showed that all the dyslexic participants prefer reading and writing in English with the exception of D1 who prefers writing in Portuguese. Although the digit span result was not relevant to the hypothesis, there was a surprising result in which the dyslexic group showed higher recall than the control group, which was not expected once dyslexics show impairment with working memory (SILVA; CRENITTE, 2014; SMITH-SPARK;FISK,2007; MENGHINI et al, 2011). In the BP pseudowords repetition task, results revealed that dyslexic participants do not struggle with their phonological loop once they achieve high marks in the smaller words and due to the fact that all words require a certain level of phonological analysis. Indeed, the dyslexic participants showed specific difficulties with pseudowords both for BP and EN compared to the control group, which suggest a weak engagement of the phonological route. However, sentence reading performance shows good and efficient performance closer to control groups, possibly as a result of direct lexical mapping. Herewith, the data of this study truly expand Azevedo's (2016) findings. Bilingual dyslexics that have a great exposure to English have better performance in reading measures in English than Portuguese, even at early age; but have also developed reading skills in BP despite receiving only 5 hours of weekly reading instruction in the language. The results partially show this idea that bilingual dyslexics "take advantage" of the English reading strategies to Portuguese, but it is difficult to state that because there are still differences between groups. However, the dyslexics were certainly better in English than Portuguese, showing that the exposure to a L2 is not a problem.

Keywords: dyslexia; bilingualism; education; reading; orthographic depth.

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LIST OF ABBREVIATIONS

BP - Brazilian Portuguese

EN - English language

D - dyslexic participants

C - control group participants

L1 - mother tongue

L2 - second language

FL - foreign language

ADHD - Attention Deficit Hyperactivity Disorder

WASI - Wechsler Abbreviated Intelligence Scale

QuExPLi - Language Experience and Proficiency Questionnaire

PVST - Picture Vocabulary Size Test

RAN - Rapid Automatized Naming

SD - Standard Deviation

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INTRODUCTION

Mastery of reading and writing introduces us to the literate community. However, difficulty in this domain (dyslexia) can exclude a person from this community. According to the International Educational Statistics (2008), there are a total of 654.9 million school-age children in the world and, if dyslexia affects 10 to 15% of these children (FLETCHER *et al*. 2007), this translates to 65 to 98 million students with this difficulty. This research proposes to investigate whether intensive learning of a second language can have a remedial effect on dyslexic children.

Dyslexia[1] is a disorder of neurobiological origin that presents itself as a severe difficulty in learning to read (SHAYWITZ, 2006) and is associated with a deficit in the association between phonemes and graphemes by learners (DEHAENE, 2012). Dehaene (2012) notes that virtually all brain imaging studies of dyslexia find hypoactivation in the left posterior temporal region. Another equally frequent anomaly is the hyperactivation of the left inferior frontal cortex during reading or in phonological tasks (see also BUCHWEITZ, 2014). This reference by Buchweitz (2014) goes beyond hypoactivation, it states a more diffuse activation – i.e., more areas activated with less force. In this sense, recent functional neuroimaging studies have shown that brain plasticity is associated with an effective intervention for dyslexia (GABRIELI, 2009). Remediation is associated with improvements (in the sense of becoming more typical) in activation patterns in the temporoparietal and left frontal regions, where usually less activation is observed in people with dyslexia compared to typically developed readers.

Brain imaging studies have indeed revealed hypo-activations in adult and children dyslexics in regions involved in phonetic computations, particularly the left temporo-parietal region, often accompanied by an increase in the inferior frontal regions which is interpreted as a compensatory response (CHANDRASEKARAN et al., 2009; DUFOR et al., 2007; HOEFT et al., 2011; MAISOG et al., 2008; PAULESU et al., 2001; RICHLAN et al., 2009; RUFF et al., 2003; SHAYWITZ et al., 2003).

Therefore, hypoactivation is associated with a lack of connectivity between frontoparietal/temporal areas/networks, while hyperactivation appears to be associated

[1] The DMS-5 (Diagnostic and Statistical Manual of Mental Disorders) includes dyslexia as a specific learning disorder, characterized by impairment in reading, in the speed of word recognition and in the decoding process, which may or may not be related to comprehension difficulties.

with more than typical effort to complete certain tasks (including a pattern of more diffuse activation of more areas, less focal – focal here it is associated with network effectiveness).

Activation of frontal-lobe networks, including right hemisphere areas, is a characteristic of dyslexic readers; it is hypothesized that dyslexics may activate more areas of the frontal lobe than normal readers to compensate for their decoding and reading fluency difficulties (BUCHWEITZ, 2014).

While the first signs of dyslexia occur with the child's first contact with literacy, the age for children to receive a dyslexia diagnosis in Brazil is generally similar to other countries, usually around 7-8 years old or later. However, it can vary depending on the child's access to healthcare, education, and diagnosis resources.

In Brazil, the diagnosis of dyslexia is usually made by a multidisciplinary team, which may include a neurologist, psychologist, speech therapist, and educator. The diagnosis process often involves cognitive and language assessments, as well as an evaluation of the child's reading and writing skills (SILVA;CARDOSO-MARTINS, 2015).

It's important to note that dyslexia can often go undiagnosed in Brazil and other countries, particularly among children from low-income families or those living in rural areas. This highlights the importance of improving access to diagnosis and treatment for dyslexia in Brazil and other countries around the world.

In Brazil, according to the Base Nacional Curricular Comum document (BRASIL, 2018), the English language subject is mandatory from 6th grade on (11-year-old children) for public schools. However, with the growth of bilingual programs in private schools, the insertion of English is getting earlier and more intensive/extensive.

In the past, the idea of dyslexics learning a L2 was seen as something undesirable, however, the hypothesis that learning an L2 would bring harm and/or confusion for the dyslexic student/pupil has been successfully contested by many scientists (SPARKS; GANSCHOW, 1993; WYDELL; BUTTERWORTH, 1999; AZEVEDO, 2016, among others).

Throughout my years as an English teacher, I have always had the inclination towards special education. I have passed through some experiences that made me realize that there is a lack of pedagogical preparation on how to insert a dyslexic student in a L2 (second language) environment. Much is said about having to include dyslexic students in the classroom, but less is the preparation. Based on that, I became each day more curious on how the exposure to a L2 would influence a dyslexic performance on reading.

At first, my wish was to compare various levels of bilingualism and how this may affect a dyslexic's reading performance. However, due to schools' lack of interest in the research and the taboo around dyslexia by both parents and schools, it was not possible to do so.

Therefore, it occurred to me that there is a common well-spread consensus that dyslexics would face lots of difficulties in acquiring a second language, based on my personal experiences. Thereby, there is room for investigation.

Azevedo (2016) concluded that bilingual dyslexic participants (learners of English as L2) still lacked automation in reading, but showed superior performance compared to a group of monolingual dyslexics in all reading and writing components of Brazilian Portuguese, for which bilingual dyslexics obtained results close to typical readers. An explanation for this phenomenon suggested by Azevedo (2016) is that the dyslexic language learners take advantage of the differences between languages in their grapheme to phonological and/or lexical mapping.

In a language learning context, L1 and L2 reading difficulties are influenced by differences between language orthographic systems. Specific features can be the degree of transparency between sound and grapheme symbol and the different dimensions of granularity in the sound-grapheme relationship. Furthermore, reading decoding skills and oral language comprehension in L2 may not consolidate simultaneously, for example a L2 learner may become first fluent in speaking than reading, which is an important variable in L2 learning. This may affect the selection of the cognitive strategy for mapping between sound and written form (LODEJ, 2016).

In this sense, Azevedo (2016) postulates that bilingual dyslexics made a change in reading strategy in relation to so-called monolingual dyslexics, something predicted by the dual route model (ELLIS, 1995). This model foresees the existence of two routes: the Phonological Route or Indirect Route (also called Non-lexical Route, see Coltheart *et al.,* 2001) and the Lexical or Direct Route. The Lexical Route is often referred to as the direct route, whereby sub lexical orthographic information makes direct contact with whole-word orthographic representations, which then provide access to whole-word phonology on the one hand, and higher-level semantic information on the other (COLTHEART *et al.,* 2001).

In the Phonological Route, the words are segmented into orthographic units that are mapped into sub lexical phonological units, that is, in the transformation of graphemes into phonemes, which subsequently map onto lexical entries.

Meanwhile, the Lexical Route or Direct Route consists of the visual analysis of written word in a more immediate and direct interpretation of the word making a simultaneous transfer of the orthographic analysis to the meaning that is stored in a kind mental orthographic lexicon, as a "mental dictionary" (ELLIS, 1995).

That is, the essential difference lies in how the result of visual perception maps onto mental representations: indirectly, from orthography to phonemes that go on to compose a complex phonological form, which then maps onto a lexical entry; as opposed to going from orthographic processing onto whole word phonological forms, or as some suggest onto orthographic forms, which map onto lexical entries directly.

The two routes engage different networks connecting different areas of the brain. According to Capovilla, Dias e Montiel (2007), the temporal parietal circuit is activated by the phonological route/indirect pathway; the occipital-temporal circuit is activated by the lexical route/direct pathway.

This pattern thus confirms the idea of a dual pathway model of reading, proposed by Ellis in 1995.

Ellis (1995) presented several pieces of evidence in support of the dual route model, including studies of patients with brain injuries, brain imaging studies, dyslexia studies and writing studies. Ellis and Young (1996) studied patients who suffered brain lesions in specific areas of the brain and observed that some patients had difficulties reading regular words (which follow letter-sound correspondence rules) and other patients had difficulties in reading irregular words (which do not follow letter-sound correspondence rules). This suggests that different areas of the brain are responsible for processing different types of words. Also, several brain imaging studies (e.g., using the functional magnetic resonance imaging technique (fMRI) have shown that different areas of the brain are activated during the processing of reading regular and irregular words, supporting the idea that different processing pathways are involved (ELLIS;YOUNG, 1996). Thus, Ellis *et al.* (1990) argues that dyslexia can be seen as a failure to process the phonological pathway of reading. People with dyslexia have difficulty converting letters into sounds and therefore have difficulty reading unfamiliar or unfamiliar words. However, they can succeed in reading familiar and frequent words using the lexical route. Finally, Ellis and Young (1996) also argue that the phonological route is important for writing, since writers need to convert sounds into letters in order to write words. People with dyslexia often have trouble spelling words, which can reflect problems establishing the relation between sounds and the letters and combination of letters that represent them.

Hence, Azevedo (2016) presented results from an fMRI study, which point to the fact that bilingual dyslexics showed a disengagement from the traditional areas of the phonological reading route (temporal parietal circuit), engaging the lexical route as well as the control group, while monolingual dyslexics seemed to engage the phonological route. Importantly, these activation patterns correlated with more success for bilingual dyslexics at a variety of reading tasks than their monolingual counterparts.

Azevedo’s (2016) research uses a broad set of data collected from a variety of tests including anamnesis, reading and writing in BP and EN, Language History Questionnaire for research with bilinguals, language proficiency and fMRI for all tests; however, it leaves open the question of how soon it is possible to see the effect of a high level of bilingualism in dyslexics' reading due to her study be with 13-18 year olds. Only one bilingual of her study received reading instruction in English and Portuguese and studied in a full English-immersive environment. The other bilingual participants were Brazilians, native speakers of Portuguese and students of English as a foreign language since the age of 6 (or younger), whether in their school, language courses or private teacher, having formal exposure to the language 4 to 5 times a week , have a certificate of proficiency from the University of Cambridge or another. Therefore, although there is no mention of this school's methodology, it seems that the school of her research is a more traditional school in terms of methodology and English teaching.

To address the matter of how early the effects of bilingualism can impact reading, I have decided to test younger participants (8-11 years old) once they have just finished their reading instruction process and due to the fact that the dyslexic participants had just been diagnosed. Also, the school's methodology is taken into consideration once it puts the student in the center of their learning (Montessorian method), different from more traditional teacher centered methods.

The Montessori method is an educational approach that emphasizes the importance of child-centered learning and self-directed exploration. This method is based on the belief that children have an innate desire to learn and explore their environment, and that they can develop their own learning strategies with appropriate guidance and support. Overall, the Montessori method can have a positive impact on children's psychological development by fostering independence, intrinsic motivation, problem-solving skills, and social and emotional skills (LILLARD, 2012).

Thus, the current research aims to investigate the reading of dyslexics with a high level of exposure to English, having as the hypothesis that this learning positively affects the reading performance of the dyslexic child both in L1 (Portuguese) and in L2 (English), since reading strategies different from those used in L1 will need to be developed to read the L2, correlating with direct/indirect pathways. That is, the objective is to investigate the reading performance of young dyslexics (8-11 years old) with a higher level of bilingualism (more exposure to English in their daily lives, high levels of proficiency, exposure and use) in reading tasks in English and Portuguese. Based on the dual-route model (ELLIS, 1995) which predicts that the Phonological Route consists of the grapheme to phoneme mapping of written words and the Lexical Route consists of processing whereby sub lexical orthographic information makes direct contact with whole-word orthographic representations, we propose a study in which we will investigate reading strategies in different aged-dyslexics with high bilingualism levels and typical bilingual readers measuring reading performance on reading tasks in both languages. If someone engages the lexical route rather than a phonological route, they might be bad at some tasks (e.g. those that involve mapping smaller and perhaps lexically non-existent phonological segments), but this may affect fewer tasks or stimuli that map onto whole-word phonological forms, or even via a direct link between visual forms and lexical entries. It should affect sentence reading less than word reading too and these differences affect Brazilian Portuguese more pronouncedly than English, since in English the tendency would be more direct mapping.

In this study, we expect to replicate and complement the effects of Azevedo (2016) but in immersive teaching, postulating that a high level of English exposure has an influence on reading performance in Brazilian Portuguese even for young bilingual pupils. The difference between our studies is the immersive teaching, importance of school methodology and participants' age as well as the tests used. It is also important to mention that this is an after-pandemic study.

The analyzed group is composed of 6 participants, 3 dyslexic and 3 non-dyslexics, students of an international school in Rio de Janeiro. Participants are matched by age and school grade, with 2 3rd grade participants aged 8/9 years old, 2 4th grade participants aged 9/10 years old, and 2 5th grade participants aged 11 years old. The tests carried out were applied by me, by a team of psychologists and by a speech therapist. All participants from the dyslexic group had previous diagnosis for both dyslexia and ADHD. There is a need for a previous diagnosis that involves the participation of a speech therapist and anamnesis, since this rules out other possible underlying cognitive problems that may be the cause for reading difficulties. However, in the study, to better understand participants' backgrounds, an updated anamnesis is important. Also, a trained speech therapist can apply additional diagnostic test to get a broader picture of the extent and nature of participants' dyslexia. In this study, the speech therapist applied a rapid naming test (RAN) (DENCKLA, 1974), dictation in Portuguese (CAPOVILLA, 2000 – based on PINHEIRO, 1994), and repetition of pseudowords in Portuguese (KESSLER, 1997), Furthermore, it is important to assess participants' proficiency, IQ, attention, working memory, reading and writing for both languages and Reading Speed of Sentences for both languages.

Rapid Automatized Naming (RAN) tasks involve naming sets of visually presented items as quickly as possible, and deficits in RAN have been linked to reading difficulties. The Double Deficit Hypothesis suggests that there are two distinct subtypes of dyslexia, one characterized by phonological deficits and the other by naming speed deficits, and that individuals with both deficits have a more severe form of dyslexia (WOLF; BOWERS, 1999).

Dyslexia is dissociated from general intelligence, so it is important to investigate this aspect, if not for control, for the possible explanation of certain cognitive aspects and behaviors of the participants (i.e., in this study, participants have ADHD that can have consequences for other cognitive domains captured among others by IQ testing). Therefore, it is of great importance and value the fact that this research counted on a multidisciplinary team once research of this nature requires multidisciplinary work. In this study, a psychologist applied an IQ test (WISC-III: Wechsler Intelligence Scale for Children), and the experimenter applied a digit span test in Portuguese (ITPA) to verify memory functioning.

Bilingualism is here understood as the use of two or more languages or dialects in daily life, according to need and with different levels of proficiency (GROSJEAN, 2013). This is relevant in the sense that there are levels of bilingualism and that bilingualism, depending on a series of factors, can present an advantage for cognition more generally, including for reading processes (BIALYSTOK *et al*., 2004). There is an importance of showing that these dyslexic children can reach comparable levels of bilingualism, and this will be measured by qualitative tests (such as questionnaires) and quantitative tests (such as proficiency tests). I have developed two tests for this research: reading aloud of words and pseudowords in Portuguese and English and Reading Speed of Sentences in Portuguese and English due to the lack of tests of this kind aiming at bilingual pupils. To complement proficiency measures I have also used an English proficiency (Picture Vocabulary Size Test) and a Language Experience and Proficiency Questionnaire based on Scholl and Finger (2013).

In order to probe specific difficulties with pseudowords vs. words, reading words vs. writing words, and reading words in isolation vs. reading words in sentential context, I applied a dictation in English (SIQUEIRA, 2018) of words and pseudowords, reading aloud of words and pseudowords in Portuguese and English (developed for this study), and a Reading Speed of Sentences with sentences in Portuguese and English (developed for this study).

This study may bring contributions within the field of neurolinguistics and psycholinguistics. One of the benefits of working directly with students in their educational context is that it may bring the university and school closer, which will allow an expansion of the cultural repertoire and world knowledge of the students, who will have contact with such study and with the researcher. Not only the students themselves, but also their caregivers will be actively involved in the data collecting, as well as receiving a full report on the test results of their children. This in turn may foster awareness among parents (and teachers) on their true cognitive potential.

Likewise, it is our objective that the research carried out at the university improves practices and teaching methods in schools, brings awareness to teachers and facilitates the students' learning process, since the results will reveal how much an English language methodology (English immersive environment with Montessorian method) can influence reading. Another possibility is that, if the research results point to a positive effect of bilingual education for children with dyslexia, this study may also contribute to a broader offer of bilingual education. More specifically, it intends to endorse the many voices that for some time have been trying to include students with dyslexia in the English language classroom. Thus, we will try to add to evidence found in the literature that it is beneficial to dyslexic students to achieve higher levels of bilingualism (high levels of proficiency, exposure and use), especially when the L2 presents mostly opaque grapheme-phoneme correspondence compared to L1, as is the case with English (L2) and Portuguese (L1). Although there is a growing interest in this topic, more studies are needed to solidify the scientific underpinnings of the inclusion of dyslexic students in the L2 classroom. This will enable educators, parents, and speech therapists to understand the cognitive impact of L2 exposure on dyslexic reading development and contribute to the demystification of supposed difficulties in L2 learning. The study also expands the science of reading to other populations (bilingual dyslexics). In a broader sense, the study may also support a better understanding of the dyslexia framework as a whole.

Herewith I finish this introduction chapter and, from now on, I will address important theoretical background themes such as bilingualism (section 1), science of reading (section 2), granularity and transparency hypothesis (section 3), different reading strategies for Portuguese and English (section 4), dyslexia (section 5), ADHD and dyslexia (section 6), dyslexia and bilingualism (section 7), as well as objectives of this research (section 8) and hypothesis (section 9), explain the experiment (section 10), the results in detail (section 11), comparative results between languages (section 12), finishing with discussion (section 13) and final considerations (section 14). You may find a listing of all abbreviations, a list of all images, a list of all tables and a list of all graphs before the introduction.

1 BILINGUALISM

To understand bilingualism, we first need to accept and assimilate it as a complex, multiform, and extremely heterogeneous phenomenon.

For a long time, the hypothesis was defended that a bilingual being would be composed of 'two monolinguals inside the same head', so it was expected, therefore, that the same person should have the same resourcefulness in the two spoken languages (SAER, 1922 apud ZIMMER, FINGER; SCHERER, 2008). The aforementioned hypothesis was called the Monolingual Dual Hypothesis and, today, is considered outdated.

Here, bilingualism is taken as the use of two or more languages or dialects in daily life, according to need and with different levels of proficiency (GROSJEAN; LI, 2013) once. They note that bilingualism is a complex and multidimensional phenomenon that encompasses a range of language abilities, including language proficiency, language use, and language acquisition. They also emphasize that bilingualism is not a fixed or static state, but rather a dynamic and evolving process that can change over time and in response to different social and environmental factors. Overall, their definition of bilingualism reflects the idea that bilingualism involves the active and ongoing use of multiple languages in everyday life. This is relevant in the sense that there are levels of bilingualism and that bilingualism, depending on a series of factors, can present an advantage for cognition more generally, including for reading processes (BIALYSTOK *et al*., 2004).

Regarding child development and learning an L2, research investigating the effects of bilingualism on child development has shown that bilingualism seems to accelerate children's linguistic and metalinguistic development. Research suggests that bilingualism can have a positive effect on children's linguistic and metalinguistic development. Specifically, bilingual children have been found to have more advanced metalinguistic skills, such as the ability to think about language and understand its rules, than monolingual children (BIALYSTOK, 2001, 2006 and 2007). Bilingualism can be seen as one of many factors that may influence the development and expression of dyslexia (WANG *et al*., 2019).

The findings from Fleury and Avila (2015) indicate that the learning of a second language can have a beneficial impact on rapid naming skills, reading speed, and accuracy. Bilingual students from Brazil demonstrated enhanced phonological memory abilities in both English and Brazilian Portuguese, leading to improved reading fluency. Notably, distinct correlation patterns were observed in the bilingual group analysis regarding rapid naming, accuracy, and reading speed in both languages.

Another factor that cannot be ignored is the possible influence of improved executive functions (EF) as a result of learning a foreign language. Bialystok (2012) postulates the possible beneficial effects of bilingualism, which translate, roughly, into an improvement in executive functions (EFs), due to exposure to a second language. Bialystok (2012) argues that bilingualism may have a positive impact on executive functions (EFs), which are cognitive processes responsible for regulating thought and behavior, such as attention, working memory, and inhibition. She suggests that the use of two languages on a regular basis requires bilingual individuals to constantly switch between and monitor both languages, which may result in the development of more efficient and flexible EFs.

Regarding the context of exposure, Bialystok (2012) notes that the beneficial effects of bilingualism on EFs are most likely to be observed in individuals who have been exposed to both languages from an early age and who continue to use both languages on a regular basis. This means that the more exposure and practice an individual has with both languages, the more likely they are to develop stronger EFs.

Furthermore, Bialystok (2012) notes that the positive effects of bilingualism on EFs may be greater for some types of tasks than for others. For example, tasks that require inhibitory control, such as the Stroop task, may show larger benefits from bilingualism than tasks that rely more heavily on working memory, such as digit span tasks.

Overall, Bialystok (2012) suggests that bilingualism can have a positive impact on EFs, but the degree of benefit is likely to depend on factors such as the age of language exposure, the amount of language use, and the specific types of EFs being measured.

The EFs, which interfere in almost all spheres of cognition, involve reasoning, working memory, planning, attention and inhibitory control, among others (STUSS; LEVINE, 2002 apud TONIETTO *et al*.). In this sense, it is not impossible to imagine that EFs impact reading, both in learning new spelling systems and in controlling the processing of decoding and reading itself. That is why it is important to investigate influences of a more general cognitive nature, such as attention, working memory, IQ, in addition to investigating factors more directly related to linguistic aspects, such as reading and writing measures, proficiency tests.

Therefore, we aim to understand how age, level of bilingualism (BIALYSTOK, 2019) and educational methodology affect the reading performance of dyslexics in L1 and L2, depending on factors such as transparency, approximation of languages, granularity and reading strategy used.

1.1 BILINGUALISM IN EDUCATIONAL CONTEXTS

It is important to mention that in Brazil,

> (...) the reality of the bilingual individual is more due to the formal learning environment than to geopolitical or sociocultural factors. Fully bilingual schools offering total immersion in the language are still restricted to a very specific public, with high purchasing power, and, when we analyze the context of bilingual education in Brazil, there is a high number of language courses and schools that offer English only during a certain time of the day. [2]
> (OTERO, 2022, p. 23, translated)

[2] Original: "(...) a realidade do indivíduo bilíngue se dá mais pelo ambiente formal de aprendizagem do que por fatores geopolíticos ou socioculturais. Escolas totalmente bilíngues, que oferecem total imersão no idioma, ainda são restritas a um público muito específico, com alto poder aquisitivo, e, ao analisarmos o contexto da educação bilíngue no Brasil, nota-se um número alto de cursos de idiomas e de escolas que oferecem língua inglesa apenas durante um determinado horário do dia" (OTERO, 2022, p. 23).

This is important because it shows that the phenomenon of bilingualism in Brazil, specifically with English as L2, is mostly restricted to students learning the language in a formal setting, who vary greatly and the degree of exposure and usage of the English language. This is especially relevant to this study, because if a high level of bilingualism is proven to improve Brazilian dyslexics' reading, this scenario must change.

Bilingualism is becoming more popular in Brazilian schools as the country seeks to increase its competitiveness in the global economy. Many private schools in Brazil offer bilingual programs, and some public schools have also begun to offer bilingual education as well. In bilingual programs, students receive instruction in both Portuguese and a second language, usually English. The aim is to develop their proficiency in both languages, allowing them to communicate with people from different parts of the world and providing them with more opportunities for higher education and employment (LOPES, 2017).

However, the implementation of bilingual education in Brazil is not without its challenges. One of the main issues is the shortage of bilingual teachers and the lack of adequate training programs for teachers. Another challenge is the lack of materials and resources in the second language, especially in public schools. Despite these challenges, many schools are investing in bilingual education in Brazil, recognizing the benefits that bilingualism can bring to their students in terms of academic and professional opportunities (DE CARVALHO, 2019).

An immersive English environment is an environment in which children are surrounded by the English language and culture. This could include living in an English-speaking country, attending an English-speaking school or daycare, or participating in a language immersion program. A so called “bilingual” school in Brazil is a school in which there is a bilingual program that usually means more time of English classes per week, this type of school is different from an international school, that is immersive. The goal of an immersive English environment is for children to develop their language skills through natural exposure to the language.

On the other hand, English classes for kids typically involve formal instruction in a classroom setting. The focus of these classes is often on building the four language skills (reading, writing, speaking, and listening) through structured lessons, exercises, and activities.

There are several studies that support the benefits of an immersive English environment for learning English. A study published in the journal Language Learning found that adults who were immersed in an English-speaking environment made greater gains in English vocabulary and grammar than children who received English instruction in a classroom setting (DEKEYSER *et al*., 2002).

Another study, published in the journal Applied Psycholinguistics, found that French-speaking children (5-12 years old) who were exposed to English through immersion programs developed stronger English proficiency and had better academic outcomes than children who received English instruction in their native language (GENESEE, 1987).

A review of research studies on language immersion programs published in the International Journal of Multilingualism concluded that immersion programs are effective at developing language proficiency, and that they can have additional benefits for cognitive and academic development (LINDHOLM-LEARY; BORSATO, 2016).

A study published in the Journal of Educational Psychology found that language immersion programs can help students develop a positive attitude towards the target language and culture, which can contribute to their overall motivation and engagement in language learning (THOMPSON, 2009).

In general, these studies suggest that an immersive English environment can be an effective way for children to learn English, and that it may have additional benefits for their cognitive and academic development. The studies mentioned above provide evidence that an immersive English environment can be an effective way for children to learn English. Specifically, the studies suggest that children who are immersed in an English-speaking environment make greater gains in English vocabulary and grammar than children who receive English instruction in a classroom setting. Also, children who are exposed to English through immersion programs develop stronger English proficiency and have better academic outcomes than children who receive only English instruction. In the same way, immersion programs are effective at developing language proficiency and may have additional benefits for cognitive and academic development. Language immersion programs can help students develop a positive attitude towards the target language and culture, which can contribute to their overall motivation and engagement in language learning. Overall, the studies suggest that an immersive English environment can be an effective and engaging way for children to learn English.

Similarly, the cognitive effects of being in an English immersive school as a kid in Brazil can be significant, with potential benefits for cognitive flexibility, problem-solving skills, academic achievement, and cultural awareness. However, it is important to note that these effects may vary depending on individual factors such as the child's age, language proficiency, and cultural background, as well as the specific features of the immersion program (BIALYSTOK, 2017).

As a non-native speaker dyslexic student, studying in an immersive English school may have benefits such as improved spoken language skills, increased cognitive demands, potential social and emotional benefits: research has shown that immersion programs can promote social and emotional development, particularly in areas such as intercultural competence, empathy, and self-esteem (HOWARD; SUGARMAN; CHRISTIAN, 2003). These benefits may be particularly important for non-native speaker dyslexic students, who may face additional challenges in social and emotional domains. Overall, the effects of studying in an immersive English school as a non-native speaker dyslexic student may be complex and multifaceted. While dyslexia can present challenges for reading and writing in English, immersion programs may provide opportunities to develop spoken language skills and promote social and emotional growth. It is important to consider individual factors such as language proficiency, dyslexia severity, and personal preferences when evaluating the potential effects of immersion programs for non-native speaker dyslexic students (ECHEVARIA; NATION, 2017).

Another important topic is the overall educational philosophy and methods that are adopted by the school. The immersive school in this study uses a Montessorian method of education. The Montessori method of education can provide several benefits to dyslexic students, such as multisensory approach, individualized instruction, emphasis on creativity and problem-solving, focus on social and emotional development (GUTEK, 2003).

The Montessori method emphasizes a hands-on, multisensory approach to learning. This approach can be particularly beneficial for dyslexic students, who may struggle with traditional reading and writing activities. By engaging multiple senses, such as touch and movement, Montessori activities can help dyslexic students develop stronger neural connections and improve their ability to process information. Montessori classrooms are designed to provide individualized instruction based on each student's needs and interests. This can be particularly helpful for dyslexic students, who may require different instructional strategies or pacing than their peers. By allowing dyslexic students to work at their own pace and providing support as needed, Montessori classrooms can help to promote a positive learning experience and improve academic outcomes. The Montessori method emphasizes creativity and problem-solving skills. Dyslexic students may struggle with traditional academic tasks, but may excel in areas such as art, music, or hands-on activities. Montessori classrooms provide opportunities for dyslexic students to engage in these types of activities, which can help to build confidence and promote a positive self-concept. It also places a strong emphasis on social and emotional development. Dyslexic students may face challenges in these areas, such as difficulties with peer relationships or self-esteem. By promoting a supportive and collaborative classroom environment, Montessori classrooms can help dyslexic students build social and emotional skills and feel more confident in their abilities, when early diagnosis and intervention is partnered with an attentive guide and appropriate accommodations, the dyslexic learner can become a successful reader and learner through life (AWES, 2014). It is important to note that each dyslexic student is unique, and the effectiveness of the Montessori method may vary depending on individual needs and preferences (AWES, 2014).

Likewise, the Montessori method has been successfully combined with second language teaching in various settings. As the Montessori method emphasizes a hands-on, multisensory approach to learning, it can be particularly beneficial for second language learners. By engaging multiple senses, such as touch, sight, and sound, Montessori activities can help students develop stronger neural connections and improve their ability to process information in a new language. Along with that, Montessori classrooms are designed to provide individualized instruction based on each student's needs and interests. This approach can be particularly helpful for second language learners, who may require different instructional strategies or pacing than their peers. By allowing students to work at their own pace and providing support as needed, Montessori classrooms can help to promote a positive learning experience and improve language acquisition outcomes (LILLARD; ELSE-QUEST, 2006).

Additionally, the Montessori method emphasizes natural language acquisition through immersion in the target language. Montessori teachers speak to students in the target language throughout the day, providing opportunities for students to listen, speak, and interact in the new language in a natural, meaningful context. It also emphasizes the integration of language and culture. Second language learners in Montessori classrooms have the opportunity to learn about the culture and traditions associated with the target language, which can help to promote a deeper understanding and appreciation of the language (FARYADI, 2009). Results from Faryadi (2009) indicated that Montessori instruction statistically increased students' motivation and most noticeably their final grade in the exam.

All in all, Montessori bilingual schools are educational institutions that use the Montessori method to teach a bilingual curriculum. These schools typically offer a program that instructs students in both the Montessori method and in a second language, with an emphasis on natural language acquisition and cultural integration. In a Montessorian bilingual school, students are typically immersed in the target language for a significant portion of the day, with instruction in both languages provided by trained Montessori teachers. The Montessori approach is often used to teach foundational skills in the primary language, while the second language is integrated into daily activities and lessons. One advantage of Montessorian bilingual schools is that they provide students with the opportunity to learn a second language in a natural and meaningful context, which can lead to more effective language acquisition. Additionally, the Montessori method provides a solid foundation for learning by emphasizing individualized instruction, hands-on activities, and a multisensory approach to learning (LILLARD; ELSE-QUEST, 2006). It is important to note that Montessorian bilingual schools may have different language models, such as immersion or bilingual education. Each school may also have a different approach to how the Montessori method is integrated with the second language instruction.

Studies have shown that dyslexic students may have a preference for visual learning and may struggle with phonological processing, which is essential for learning a new language (NICOLSON;FAWCETT, 2008). Therefore, it is not surprising that research has suggested that dyslexic students may benefit from multisensory and hands-on learning activities, which may be less common in a traditional classroom setting (GUIMARÃES;SILVA, 2013).

The emerging bilingualism in immersive educational context must be addressed in this study once it is the bilingual educational context of the participants. They study in a full-immersive English environment, staying at school 8 hours per day, having 50 minutes of Portuguese class every day. The participants must have had a minimum 3 years of enrollment and their proficiency will be assessed as well through different tests. These groups of participants are limited in social-cultural aspects once it is a very specific reality but is extraordinarily rich in cognitive terms.

Evidently, there are many benefits of an immersive environment not only to reading strategy but for other cognitive effects. We expect to find evidence for those in this study.

To better understand why those factors, have influence on reading, I will address this topic in the next section.

2 SCIENCE OF READING

Reading is an overly complex process that involves highly dynamic cognitive processes, interacting with knowledge of the world, textual and discursive knowledge, ability to make inferences, vocabulary knowledge, and others, involving psychological, social, emotional natures (LODEJ, 2016). Despite this, I am focusing more on those cognitive processes that underlie basic reading abilities that have to do with the specific difficulty of the dyslexic person, which is the bridge between visual and phonological-lexical processing (LODEJ, 2016).

Reading words involves several processes, including visual perception, phonological processing, semantic processing, working memory and attention. The visual perception process involves the ability to recognize and distinguish letters and words based on their visual appearance. When reading, our eyes scan the text and send signals to the brain, which processes the information and converts it into meaningful words (PELI, 2008). Likewise, phonological processing involves the ability to recognize the sounds of letters and words. When we read, we use our knowledge of phonics to decode unfamiliar words and recognize the sounds of familiar words (SNOWLING; HULME, 2012). Semantic processing involves the ability to understand the meaning of words and comprehend the message being conveyed by the text. When we read, we use our knowledge of vocabulary, syntax, and context to understand the meaning of the words and sentences (NATION; SNOWLING, 1998). The working memory process involves the ability to hold and manipulate information in our minds while we read. When we read, we use our working memory to keep track of the meaning of the text, make connections between ideas, and remember vital details (JUST;CARPENTER, 1992). Attention refers to the ability to focus our attention on the text and ignore distractions. When we read, we use our attention to stay focused on the words and comprehend the message being conveyed (RAYNER, 1998).

Learning how to read also involves learning that different shapes may map onto one phonological value. For instance, in the alphabet, the letters ‘a,’ ‘a’, and ‘A’, all refer to the same sound. This characteristic is called invariance.

> Grapheme decoding is not only special due to the intimate relation with phonological and lexical processing, but also due to the specific visual characteristics of the alphabetical representation. Different forms of letters may all refer to one phonological representation, such that, for example, mesa, MESA and mesa, all refer to the same phonological representation of /‘meza/, meaning <chair>, in Portuguese. The cognitive gymnastics of linking variant forms to one symbolic representation is a striking feature of grapheme processing. On the other hand, there is no variance allowed in other graphemic aspects; for example, b and d, mirror images of the same form, correspond to a different phonological value. With reading acquisition, familiarity of graphemic context is also a factor: it is easier to recognize a "d" embedded in the word "admirer" than it is in the illicit sequence "dmreai", for example (DEHAENE *et al.*, 2010).
> (SOTO *et al.,* 2018, p. 407).

It is also interesting to note that the child needs to learn regularities (orthographic-phonological 'rules'): eg. b=[b], but a <s> is not always a [s], it can be a [z] too, e.g., in the word "casa" that is /kaza/. That is, in Portuguese they are regularities, with a certain predictability, but in English much less so (LODEJ, 2016).

That being said, it is known that learning to read is a different process from learning to speak. All languages have a spoken modality, but not all have a written version (LENT, 2010). Speech and listening comprehension develop from a strong innate neurobiological foundation that enables language acquisition right after the first few months of life. Writing and reading are cultural constructions that depend on instruction to be developed. In learning this invention that is writing, some children fail to develop reading fluently and accurately, unexpectedly (RAMUS, 2004). Goswami (2002) states that the better the performance of children in reading, the greater the sensitivity they have regarding the sound constituents of words.

According to Snowling and Hulme (2013) when entering elementary school, usually at the age of six, the child already demonstrates oral competence in their mother tongue, and reading competence will develop from this base. Likewise, according to Morais (2014), the decoding of written words comprises three processes ordered in time:

the decomposition of the written word into a sequence of graphemes, the pairing of these with the corresponding phonemes and, finally, the integration or fusion of the successive phonemes of each syllable in order to get the pronunciation of the word.

For the total constitution of the orthographic mental lexicon, the individual must have the written form of the words memorized, which frees up linguistic and cognitive resources for the operations of syntactic analysis and semantic integration that are part of the process of understanding the texts. However, to acquire the orthographic mental lexicon, it is necessary to go through the decoding stage (MORAIS, 2014).

Morais (2014) does not specifically discuss the concept of reading routes, such as the lexical and phonological routes. Rather, the article focuses on the development of the orthographic lexicon from a memory perspective, emphasizing the role of different memory systems in the acquisition and use of orthographic representations. However, the concept of decoding, which is mentioned in the statement you provided, is related to the phonological route in reading, as it refers to the process of mapping graphemes onto phonemes to read unfamiliar words. So, while Morais (2014) does not explicitly refer to the lexical and phonological routes, the concept of decoding is indeed related to the phonological route.

With regard to reading processes, Coltheart (2013) proposes that there are two different routes on the reading system. He bases his proposal on the Dual-Route Cognitive Model (ELLIS, 1995), which states that reading takes place at two levels: lexical and phonological. Both reading routes start with the visual analysis system, which has the functions of identifying the letters of the alphabet, the position of each letter in the word, and grouping them.

Image 1 - Dual Route reading of words model (ELLIS, 1995)

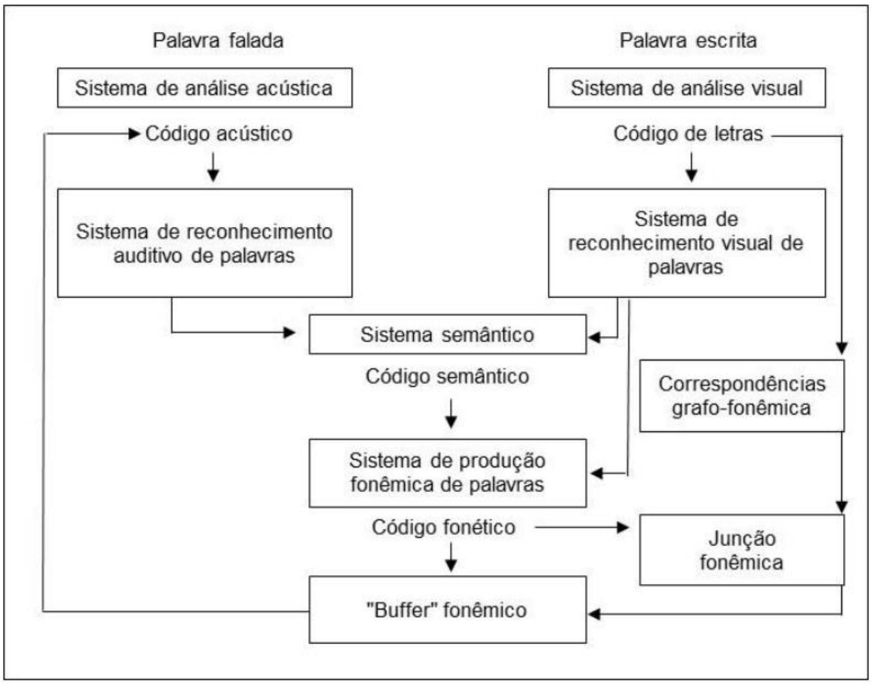

Image 1

The phonological route and the lexical route are two different ways that the brain can process written language during reading. The phonological route involves mapping individual letters or combinations of letters onto phonological units and blending them together to form phonological word forms based on their phonetic sounds. This route is often used when encountering unfamiliar or irregular words and requires a strong understanding of phonics and phonological awareness. In contrast, the lexical route involves recognizing whole words as units of meaning, without necessarily sounding them out. This route is used for words that are familiar and have been stored in the brain's mental lexicon and relies on visual recognition of word shapes and patterns. The lexical route is faster and more efficient than the phonological route but is less effective for unfamiliar or irregular words. Both routes can be used simultaneously during reading, and the relative balance between them may vary depending on factors such as a reader's language background and reading proficiency (COLTHEART *et al*., 2001; ELLIS, 1999).

Dehaene's model for the cortical networks for reading mirrors these ideas in that it offers how the brain is engaged in these routes. A brief synthesis of this network is that occipital regions (in blue) process primary visual information which maps onto visual representations of graphemes or full orthographic word forms in what Dehaene has dubbed the visual word form area in the ventral occipital-temporal region (in red). These representations then link to regions associated to (not print specific) language processing (in green), such as the middle temporal region, anterior temporal region (associated to lexical processing and to meaning processing more general), superior temporal regions (in orange) (associated to phonological processing and phonological awareness, among other things), as well as to areas engaged in pronunciation and articulation, such as the anterior insula, precentral region (in orange) and the inferior frontal region (in green), which is also engaged with control and working memory processes (DEHAENE, 2009). Most of these processes engage the left hemisphere predominantly, but also involve bilateral activation of homologue regions in the right hemisphere.

Image 2 – Cortical networks for reading (DEHAENE, 2009).

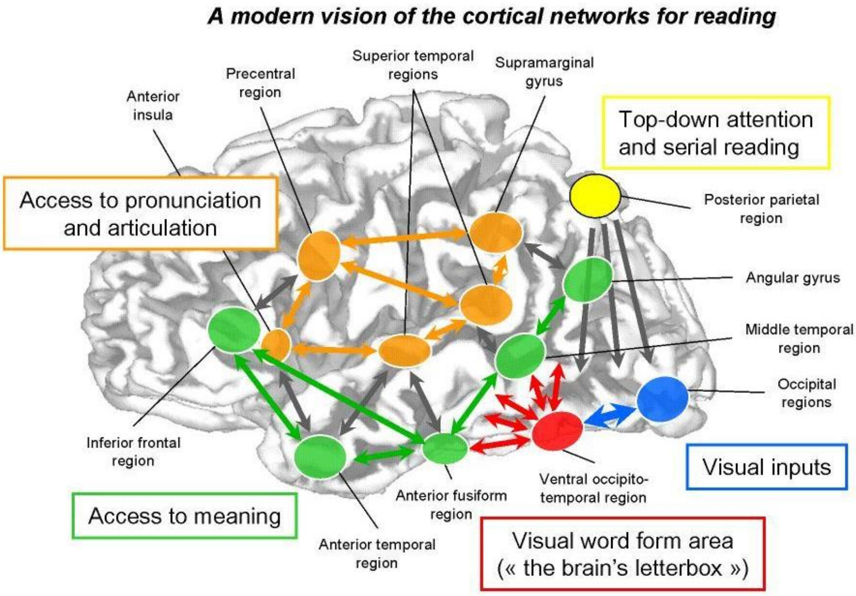

Image 2

How different languages may affect this basic reading network might be influenced by the characteristics of the orthographic representation of phonemes. Therefore, in the next section, an important aspect that affects one's reading, especially dyslexics' reading, will be addressed.

3 GRANULARITY AND TRANSPARENCY

Wydell and Butterworth (1999, p. 273) postulate that, “a language where orthography-to-phonology mapping is transparent, or even opaque, or any language whose orthographic unit representing sound is coarse (i.e., at a whole character or word level) should not produce a high incidence of developmental phonological dyslexia.”

The Granularity and Transparency Hypothesis (WYDELL AND BUTTERWORTH 1999; WYDELL; AND KONDO 2003) postulates that spellings can be described in two dimensions: transparency and granularity. As Wydell and Butterworth (1999) note:

> "(1) any orthography, where the print-to-sound translation is transparent (i.e., one-to-one) will not produce a high incidence of phonological dyslexia regardless of the level of translation (phoneme/syllable/character/word). This is the 'transparency' dimension, and (2) even when this relationship is opaque and not one-to-one, any orthography whose smallest orthographic unit representing sound is coarse (whole character/word), will not produce a high incidence of phonological dyslexia. This is the 'granularity' dimension. "
> (WYDELL;BUTTERWOTH, 1999, p. 1)

Wydell argues for this hypothesis based on the observation that developmental dyslexia is relatively rarely diagnosed in Japan, in his view due to coarse granularity of the Japanese Kana (representing syllable level) and the Kanji (representing word level). He also presents a case study of an English Japanese bilingual, who showed relatively bigger difficulty for English (boasting more fine-grained grapheme to phoneme correspondence compared to Japanese) than for Japanese. Thus, he concludes the bilingual is dyslexic in English but not in Japanese (WYDELL, 2005).

Likewise, Wydell and Butterworth (1999) examine reading acquisition in order to identify differences in the acquisition of different languages. They apply the theories of reading development proposed by Frith (1985) and claim that reading development takes place in three successive stages: "visual logographic", where a reader focuses on salient features of words and allows for instantaneous recognition of a known word; “alphabetical”, where the reader applies knowledge of a correspondence of sound letters to decode unknown words; and finally, “visual spelling”, where instantaneous word recognition occurs This is based on the division of words into orthographic units. For skilled reading in English, the student needs to acquire both strategies: logographic, or whole-word recognition, and alphabetic matching, or word-grapheme. The deficit in the acquisition of one of these strategies leads to developmental phonological dyslexia. Students do not develop the ability to make quick and automatic connections between letters and their sounds, and they are stuck in the logographic stage.

In this sense, reading in scripts with unpredictable spelling, such as English (e.g. the word "knight" in which "k" is silent, the word "enough" in which the "gh" is pronounced like an "f" in this word, making the pronunciation different from the spelling, "choir" in which "ch" is pronounced like "kw", among others), encourages the development of a lexical route, which reading in transparent languages may not allow, as the direct connection between letters and sounds means that words can be easily and quickly decoded using a phonological route as Portuguese, for example, the word "tatu" is read as "tatu" with the exact representation of phoneme and grapheme (LODEJ, 2016). In languages like English a separate lexical route is necessary for quickly recognizing words that do not follow regular spelling-sound correspondences.

The Granularity and Transparency Hypothesis suggests that reading acquisition is influenced by the transparency of the orthography, as well as the grain size of the phonological units used in the orthography. In Ziegler and Goswami (2005), the authors argue that orthographies that use smaller phonological units (i.e., those that are more granular) are easier to learn, and that the transparency of the orthography also affects reading acquisition. They review evidence from studies of reading acquisition and developmental dyslexia across different languages, including English, French, and Italian, and argue that the Granularity and Transparency Hypothesis can account for many of the findings.

In Seymour *et al*'s study (2003), they compared reading acquisition in different European languages with varying degrees of orthographic transparency, including English, French, German, and Finnish. The researchers found that the transparency of the orthography was a strong predictor of reading achievement, and that this relationship was mediated by the grain size of the phonological units used in the orthography. Specifically, they found that languages with smaller, more granular phonological units were easier to learn to read, and that this effect was stronger in more transparent orthographies.

In Ziegler and Ferrand (1998), the authors investigated the relationship between orthography and speech perception in French, which has a relatively transparent orthography. The researchers found that the consistency between the spelling and pronunciation of words affected the speed and accuracy of auditory word recognition. Specifically, words that were consistent with the orthography were recognized more quickly and accurately than words that were inconsistent. This suggests that the transparency of the orthography can affect the processing of spoken language, which supports the Granularity and Transparency Hypothesis.

According to the Hypothesis of Granularity and Transparency, a dyslexic student's success or failure in first and foreign language learning can be attributed to the spelling systems to which each language belongs, not to a direct cross-language transfer of difficulties as postulated by the Linguistic Coding Difference Hypothesis.

The Linguistic Coding Difference Hypothesis was proposed by Jorm and Share in 1983 in their paper "Orthographic and phonemic coding for word recognition in English". Since then, the hypothesis has been developed and expanded upon by many researchers in the field of reading development and disabilities, suggests that dyslexia may be caused by differences in the way that individuals process and code language. Specifically, it proposes that individuals with dyslexia may have difficulty with the phonological coding of language, which refers to the ability to associate sounds with symbols or letters. According to the hypothesis, individuals with dyslexia may have weaker phonological awareness and a less developed phonological memory than non-dyslexic individuals. This can lead to difficulties with phonological decoding and recognition of printed words, which are key components of reading ability (JORM; SHARE, 1983).

The Linguistic Coding Difference Hypothesis, proposed by Jorm and Share (1983), suggests that differences in the phonological and orthographic coding skills between different languages can impact reading acquisition. According to this hypothesis, languages with more complex and inconsistent orthographies, such as English, require more advanced phonological coding skills for successful reading acquisition, whereas languages with more consistent orthographies, such as Italian, rely more on visual-orthographic coding skills. The hypothesis suggests that this difference in coding skills can help explain why some children may struggle with reading acquisition in one language but not in another and highlights the importance of considering language-specific factors in developing effective reading interventions. Jorm and Share's hypothesis contrasts with Wydell's, as it postulates that the person takes difficulties from L1 to L2. In this case, if a dyslexic has difficulties (for example in orthographic-phonological mapping, or in processing (as evidenced by RAN for example), these difficulties are transferred to L2 learning. In this study, I intend to argue the opposite.

In this study, the Granularity and Transparency hypothesis is entertained. This is relevant because the second language in this study is an opaquer one (BUTTERWORTH, 1980; 1992) than the first language. In addition to that, the languages which this study focuses on are Brazilian Portuguese and English that force different reading strategies.

4 PORTUGUESE x ENGLISH: READING STRATEGIES

Studies show that the ease of learning an L2 is associated with the transparency and granularity of that language and its distance or approximation to the L1 (WYDELL and BUTTERWORTH, 1999). We can analyze the different characteristics of the orthographic systems of languages according to the level of transparency they present, which is also called the level of orthographic depth. Wydell and Butterworth's Granularity and Transparency theory (1999) proposes that the way that written language is processed during reading depends on the granularity (i.e., the degree of complexity) and transparency (i.e. the consistency of sound-symbol mappings) of the orthography. They argue that languages with complex, irregular orthographies (e.g., English) require the use of both the phonological and lexical routes in reading, as readers need to rely on both phonetic decoding and whole-word recognition. In contrast, languages with simpler, more regular orthographies (e.g., Finnish) may not require the development of a separate lexical route, as the phonological route alone is sufficient for reading. This theory suggests that the way that individuals learn to read and the strategies they use may be influenced by the properties of the language they are learning to read. Wydell and Butterworth (1999) propose that L1 and L2 reading difficulties are influenced mainly by differences between languages along two dimensions: transparency between sound and symbol and different dimensions of granularity.

According to Dehaene (2012), languages whose correspondence between grapheme and phoneme, for the most part, have relations of biunivocity are called “transparent” or “shallow”, that is, a certain grapheme corresponds to a phoneme and, consequently, this phoneme matches only that grapheme; and “opaque” or “deep” languages, those whose writing system carries many exceptions and ambiguities in relation to the rules of correspondence between letter and sound. A typical example of an opaque language is English, where the relationship between grapheme and phoneme is notoriously irregular (as in the word "thought", in which 7 letters map onto [θɔt], or "choir", in which there is a digraph that in the context of an “o” is pronounced [kw] and not as a [k] as in “character , an “o” is pronounced as an [a], and a schwa sound is not represented by any grapheme [kwaɪər]).

In that sense, reading in English involves many things, as phonological awareness develops more slowly with inconsistent spelling, whereas it develops faster with learning to read consistent spellings.

The English language orthographic system has 26 letters, 577 grapheme-phoneme correspondences and is considered inconsistent and opaque, while presenting fine granularity (LODEJ, 2016). In that sense, learning to spell, read and pronounce words in English is a challenging endeavor for any student. Nonetheless, it is a challenge overcome by millions of language learners worldwide. The English language is considered a lingua franca and we can relate the role of the English language today, with the notability that the British Empire had in the 19th and 20th centuries, and the economic hegemony exercised by the United States to from the Second World War (MOITA LOPES, 2008).

According to Lodej (2016), the English language has one-to-many mapping between letters and sounds at the sub syllabic level. An example of the one-to-many mapping between letters and sounds at the sub syllabic level in English can be seen in the letter sequence "ough". This sequence can be pronounced in multiple ways, depending on the word and context. For example, "enough" is pronounced with a long "o" sound, while "rough" is pronounced with a short "u" sound. In "thought", "ought" is pronounced with an "aw" sound, but in "through", it is pronounced with an "oo" sound. Recoding spelling symbols to sounds takes longer in languages with inconsistent spellings like English, so children learning to read English need to develop strategies for whole word recognition, rhyme analogies, and grapheme-phoneme recoding. Rhyme awareness is a very important aspect of phonological awareness in English, and density in English is deeply connected to rhyme (LODEJ, 2016).

An example of the English language's deep connection to rhyme is the use of nursery rhymes and children's songs to teach language skills. Many nursery rhymes in English are based on rhyme and alliteration, and often feature words with irregular spellings and pronunciations. For example, the nursery rhyme "Jack and Jill" includes the words "crown" and "down", which do not follow typical phonetic rules. Teaching children these rhymes help them develop phonological awareness and whole-word recognition skills. Goswami (2000) argues that phonological awareness, particularly the ability to manipulate phonemes at the syllable level, is crucial for reading acquisition in English. The author suggests that English has a "strong syllabic structure" that emphasizes the phonological reading of the whole word, rather than breaking words down into individual phonemes. This contrasts with languages such as Spanish, which have a more consistent one-to-one correspondence between letters and sounds at the phoneme level, and where syllables are less salient in spoken language.

In English, whole word reading is preferred, focusing on the phonological reading of the whole word while BP focuses on the phonological reading of the syllable (LODEJ, 2016).

Moreover, inconsistent spellings like English seem to force the reader to develop small and large unit reading strategies in parallel. The development of multiple granular sizing strategies is an efficient response to spelling (WYDELL; IJUIN, 2017). In contrast, Portuguese is considered a relatively transparent language, the word "tatu" has a direct correlation between grapheme and phoneme, /tatu/, as the word "banana", /banana/.

It is understood, then, that the reading processing of written words and texts as well as reading process acquisition in Portuguese differs considerably from the reading process in English. Alphabetic more transparent languages facilitate phonological registration (sound-based strategy), while opaque orthographies trigger the activation of a reading strategy based on a direct relationship between word form and lexical meaning (LODEJ, 2016).

Importantly, L2 reading decoding skills and oral language comprehension may not happen simultaneously among L2 learners (depending on the teaching method), which is an important variable in learning an L2. This may affect the selection of the strategy of the relationship between sound and written form (LODEJ, 2016). This is relevant because this study highlights the importance of a teaching method that is more open and flexible, as a Montessorian method, as well as the high exposure to English in immersive environments, claiming that it is an effective method in acquiring a L2, influencing dyslexics' reading strategies for both languages.

In general, the most transparent languages can use the phonological route both for reading words and pseudowords, while the opaquest languages favor the lexical route for reading words (KATZ and FROST, 1992). This is expected to be evidenced by the results of this study.

Katz and Frost (1992) conducted a study comparing reading in Hebrew and English, two languages with different degrees of orthographic transparency. In the study, participants were native Hebrew speakers who were also proficient in English as a second language. The participants were balanced bilinguals who lived in Israel and had started learning English at an early age (around 7-8 years old). The study compared reading performance in Hebrew and English among these bilingual participants. Participants were presented with both words and pseudowords and asked to perform a lexical decision task. The results showed that in Hebrew, a more transparent language, participants were faster and more accurate at both reading words and pseudowords using the phonological route. In contrast, in English, an opaquer language, participants were faster and more accurate at reading words using the lexical route, while pseudowords were processed similarly to Hebrew.

Ziegler *et al*. (2003) conducted a similar study comparing reading in French and German, two languages with different degrees of orthographic transparency. The study conducted by Ziegler *et al*. (2003) did not involve bilingual participants or participants living in the US. The study compared reading performance in French and German among monolingual children with French as their first language in France and German as their first language in Germany. Therefore, there were two groups of participants with different L1s. Participants were presented with both words and pseudowords and asked to perform a lexical decision task. The results showed that in French, a more transparent language, participants were faster and more accurate at reading both words and pseudowords using the phonological route. In contrast, in German, an opaquer language, participants were faster and more accurate at reading words using the lexical route, while pseudowords were processed similarly to French.

Notably, all those things impact dyslexia in different ways. To better understand how, I will entertain the dyslexia topic in the next section.

5 DYSLEXIA

Dyslexia is a topic researched by several areas such as neuroscience (e.g. HOEF *et al*., 2007), psychology (e.g. VELLUTINO *et al*., 2004), education (e.g. TORGENSEN;HUDSON, 2006), linguistics (e.g. RAMUS *et al*., 2013), genetics (e.g. GALABURDA *et al* 2006), computer science (e.g. KUTLU *et al*., 2018) and has recently received more attention from scholars. Research has shown that dyslexia has a genetic basis: if either one of the parents has dyslexia, the child is also likely to develop the condition (50% chance in case the father has dyslexia, 40% chance in case the mother has it) (SNOWLING, 2006). Studies already point to a connection between reading difficulty and chromosome 15 (IBID., 9), chromosome 2 (FAGERHEIM *et al*. 1999) and chromosome 15 (FISHER *et al*. 2002). More recent studies have stated that dyslexia is a highly polygenic neurodevelopmental disorder with a complex genetic architecture, that dyslexia categories share a large proportion of genetics with continuously distributed measures of reading skills, with shared genetic risks also seen across development and that dyslexia genetic risks are shared with those implicated in many other neurodevelopmental disorders (e.g., developmental language disorder and dyscalculia), that is to say that although there are certain correlations, it is always a polygenetic phenomenon and little is understood about why a certain gene, or combination of genes affect certain conditions, precisely because it is polygenetic (ERBELI; PARACCHINI, 2022). In addition, the prevalence is higher in males (LODEJ, 2016).

That being said, dyslexia is a disorder of neurobiological origin that presents itself as a severe difficulty in learning to read (SHAYWITZ, 2006) and is associated with a deficit in the association between phonemes and graphemes on the part of learners, who tend to hesitate at each syllable, mix up letters and end up trying to guess the words (DEHAENE, 2012). Also, dyslexics are less sensitive to rhyme (LODEJ, 2016). It is generally agreed upon by researchers that dyslexic individuals have difficulties with phonological awareness, which includes the ability to identify and manipulate sounds in spoken language. Rhyme sensitivity is one aspect of phonological awareness, which involves identifying and generating words that have the same ending sounds. Several studies have reported that dyslexic individuals have less sensitivity to rhyme compared to typically developing individuals, particularly when tasks involve explicit phonological awareness tasks or when the task is difficult (e.g., DUFF *et al*., 2015; WIMMER *et al*., 2016). However, other studies have found mixed or inconsistent results (e.g., SNOWLING *et al.*, 2003). It is important to note that the relationship between dyslexia and rhyme sensitivity is complex and likely influenced by various factors, such as language experience, age, and task demands. Therefore, it is difficult to make a general statement about the rhyme sensitivity of dyslexic individuals, and further research is needed to better understand this relationship.

Dyslexic children often present problems with performing fine motor skills and gross motor skills (DOYLE, 2002). Up to 60% of children with dyslexia show deficiency in motor skills (REID; FAWCETT, 2004) and this deficit results in poor balance, tendency of bumping or falling into objects, slow and untidy handwriting, poor judgment of distance (MOODY, 2002). Also, there is a consensus that visual and auditory perceptions deficits are causally related to reading problems in dyslexia (ELEVELD, 2005).

Dyslexic individuals can learn strategies and develop compensatory skills to circumvent their difficulties with reading and writing. While these compensatory strategies do not necessarily "cure" dyslexia, they can help individuals with dyslexia to become more successful in their academic and professional pursuits. Some of the compensatory strategies that dyslexic individuals may use include using assistive technology, visual aids, developing strong oral communication skills, breaking tasks into smaller steps and using mnemonic devices (FAWCETT *et al*., 2010). Overall, while dyslexia presents challenges to reading and writing, dyslexic individuals can learn to work around these challenges and develop compensatory strategies that help them to succeed in their academic and professional pursuits.

Dyslexia is associated with a persistent reading difficulty, unlike a momentaneous reading difficulty (during reading instruction process). Furthermore, non-dyslexics make use of an internal monologue while reading whereas dyslexics have little or no internal monologue, which means that they make use of subvocalization while reading (DAVIS, 2004).

The sooner the diagnosis is made, and the intervention is carried out, the greater the chances of making some advances and avoiding school dropout. As noted by Bogdanowicz (2002), the diagnosis should be made when the child begins reading instruction, to clearly identify dyslexia or identify lack of readiness to read and write or risk for dyslexia, e.g. the pupil can face typical difficulties during the reading instruction process (mirroring, slowly reading, among others). In this context, several studies already point to early signs of dyslexia, in order to identify and intervene as soon as possible (REID, 2004; BRUNSWICK, 2011). However, in Brazil, diagnosis and intervention are strongly associated with socioeconomic factors.

There is no accurate data on the percentage of children with dyslexia in Brazil, since there is no national tracking system to identify children with dyslexia. However, dyslexia is estimated to be a significant problem in the country, as well as in other parts of the world. Some regional studies suggest that the prevalence of dyslexia in Brazil may be between 5% and 10% of school-age children. However, the lack of awareness about dyslexia and the scarcity of resources and trained professionals to assess and treat dyslexia may limit the ability to identify and treat children with dyslexia in the country (CAPOVILLA; CAPOVILLA, 2011; MARTINS; CAPELLINI, 2016).

In Brazil, diagnosis and intervention are strongly associated with socioeconomic factors. As noted by Bogdanowicz (2002), the diagnosis should be made when the child begins reading instruction, to clearly identify dyslexia or identify lack of readiness to read and write or risk for dyslexia. In this context, several studies already point to early signs of dyslexia, in order to identify and intervene as soon as possible (REID, 2004; BRUNSWICK, 2011).

In addition, access to health and education is unequal in different parts of Brazil, which can affect children's ability to receive proper diagnosis and treatment for dyslexia. Therefore, it is important that the health and education system in Brazil raise awareness about dyslexia and make diagnosis and treatment services available to children in need.

According to the International Dyslexia Association (2002), dyslexia is a disorder specific reading in which there is no change in intelligence, characterized as a differentiated form of language processing, in which deficits are found on phonological awareness, phonological working memory and lexical access (SHARE, 1995), that is, a change in the tripod of temporal processing.

Working memory is a type of short-term memory whose function is to hold, for a restricted period, information needed to perform a cognitive task. Furthermore, it is fundamental in the process of composing long-term memory, as in addition to allowing use, it manages and organizes this information (MALLOY-DINIZ *et al.*, 2010, p. 81). Among the working memory components, the phonological loop was researched in both tests involving analysis of this ability, as it is responsible for provisionally store the data of a phonological code coming from a draft visuospatial (BADDELEY, 1986), making it primordial in the decoding and in the comprehension of a written text (GUARESI; OLIVEIRA, 2017; PIPER, 2015). The phonological loop is responsible for the temporary storage and manipulation of verbal information. It is made up of two subcomponents: the phonological store, which holds auditory information in a phonological code, and the articulatory rehearsal process, which is used to maintain information in the phonological store through subvocal repetition. The phonological loop is important for a wide range of cognitive tasks, including language processing, reading, and problem-solving (BADDELEY;HITCH, 1974).

Kibby *et al* (2014) found that, when using Baddeley’s model of working memory, it appears that the phonological loop contributes to basic reading ability, whereas the central executive contributes to fluency and comprehension, along with decoding and also that attention control predicts reading fluency is consistent with prior research which showed sustained attention plays a role in fluency.

Nilssen and Hulme (2014) found that weaknesses in phoneme awareness, rapid automatized naming and working memory are strong and persistent correlates of literacy problems even in adults learning a relatively transparent orthography.

In terms of working memory, Jeffries and Everatt (2004) found that dyslexics performed as well as controls on working memory visuo-spatial scratch pad measures and one of two additional visual–motor coordination tasks. However, according to Smith-Spark and Fisk (2007), it seems clear that working memory difficulties in dyslexia extend into adulthood, also, it can affect performance in both the phonological and visuospatial modalities, and implicate central executive dysfunction, in addition to problems with storage. Results from Menghini *et al* (2011) show deficits on span tasks tapping verbal, visual-spatial, and visual-object working memory in dyslexic children and indicate that the working memory deficit in developmental dyslexia is not limited to dysfunction of phonological components but also involves visual-object and visual-spatial information. The current literature states that working memory, being a component of temporal processing or phonological, is part of the central difficulty found in developmental dyslexia (SILVA; CRENITTE, 2014). Depending on how working memory is assessed and on which task type is being used, dyslexics show impairment with it. Also, working memory capacity has been found to be low in bilinguals' L2 and working memory processes are more efficient in L1 (ARDILA, 2003).

There is a difference between developmental dyslexia and acquired dyslexia (alexia). The first is associated with disturbances in neuronal migration that lead to the appearance of ectopias and micro-furrows and has a leading to selective cognitive difficulties with reading, without affecting cognitive functioning (or 'intelligence') as a whole. The second attributes the reading difficulty to some brain injury and occurs after the person has learned to read, the destruction of the brain tissue produces an interruption in the circuit, which prevents reading.

The brain of a dyslexic lacks symmetry in the right and left hemispheres. Furthermore, both brain activity and anatomy are distinct from non-dyslexics (ECKER *et al*., 2003). In this study, the researchers used magnetic resonance imaging (MRI) to compare the brain structures of dyslexic and non-dyslexic individuals. They found that the left-right symmetry of the brain was significantly reduced in dyslexic individuals, particularly in the planum temporale area of the brain, which is involved in language processing. The study also showed that the gray matter volume and brain activity in certain areas of the dyslexic brain were different from those of non-dyslexic individuals. Recent functional neuroimaging studies (GABRIELI, 2009) have shown that brain plasticity is associated with an effective intervention for dyslexia. While there is evidence that dyslexia is associated with differences in brain activation patterns in various regions, the relationship between these differences and remediation is complex and not fully understood. Some studies have suggested that effective remediation is associated with changes in brain activation patterns in regions such as the left inferior frontal gyrus and left temporoparietal regions, but the findings are not consistent across all studies (HOEFT *et al*., 2006; DHAYWITZ;SHAYWITZ, 2008; TEMPLE *et al*., 2003.

In general, dyslexics show hypoactivation in the left posterior temporal region, hyperactivation of the left inferior frontal cortex (Broca's region) during reading or phonological tasks, are less sensitive to rhyme, can also search for incorrect phonemes in their memory, can circumvent their difficulties (DEHAENE, 2012; BUCHWEITZ, 2014).

As previously mentioned, dyslexic individuals engage in little to no internal monologue (hearing your own voice in your head while you read). To compensate for the difficulties, they subvocalize, that is, they pronounce the words in a low tone while reading. This strategy is evidenced during brain studies with reading tasks by compensatory activation in Broca's region, responsible for articulating the words that are verbalized. The image below retrieved from Buchweitz (2014) shows circled in blue the Broca's contralateral counterpart in the right hemisphere and circled in orange Broca's area in the left hemisphere (the axial brain slice is seen from above). The image on the left is the typical reader scan whereas the image on the right is the dyslexic reader scan.

Image 3 - Typical reader vs dyslexic reader: compared brain map (BUCHWEITZ, 2014)

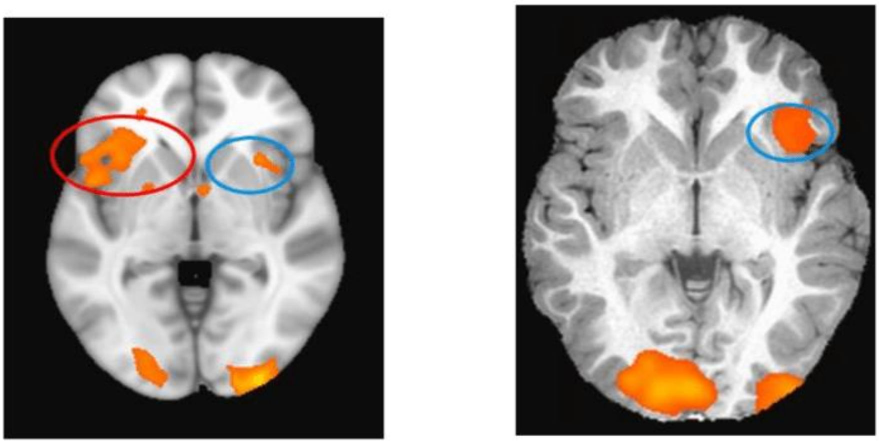

Image 3

Left hemisphere	Right hemisphere	Left hemisphere	Right hemisphere

Furthermore, the hypoactivation of the Visual Word Form Area (VWFA) is associated with low reading fluency and the risk of dyslexia (DEHAENE, 2012). The visual word form area (VWFA) is a region of the brain that is involved in the recognition of written words. It is located in the left hemisphere of the brain, typically in the left occipital-temporal cortex, near the junction of the occipital and temporal lobes. The VWFA is specialized for processing the visual features of written language, and it is activated when people read words or recognize letters. Research has shown that the VWFA is a critical part of the neural network that supports reading, and that it is particularly sensitive to the visual features of words, such as their shape, size, and orientation. The VWFA is also thought to play a role in connecting visual information about written language with language processing areas in the brain, allowing people to understand the meaning of what they read. Although the VWFA is primarily associated with reading and language processing, recent research suggests that it may also be involved in other visual recognition tasks, such as face recognition and object recognition (DEHANE;COHEN, 2011).

Image 4 - Visual Word Form Area in orange (VWFA) adapted from ZHOU *et al*., 2019, p. 1, view through two coronal sections showing involvement of the lateralized ventral occipital-temporal cortex (left vOT). Activation recorded by fMRI during word reading (ZHOU *et al*., 2019).

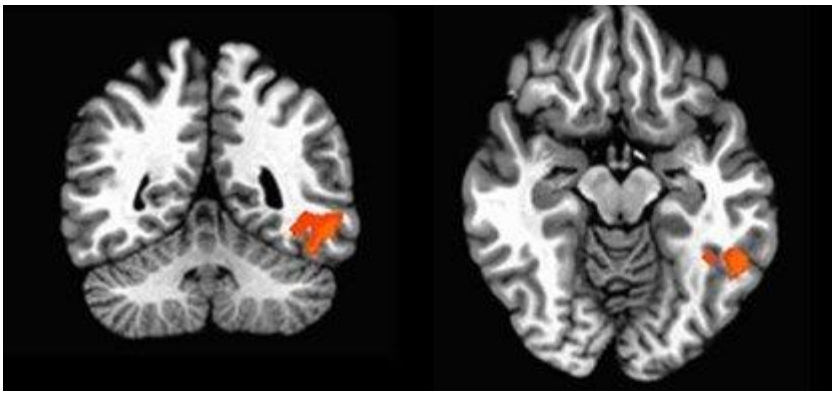

Image 4

With regard to cognitive symptoms, dyslexics have impaired short-term memory, phonological skills, sequencing and structuring of information, perception and movement, and have a slow exchange of response to stimuli (MOODY 2004; 2007; FAWCETT and RODERICK 1993; SNOWLING 2006). Dyslexia is often a condition that does not exist alone in the individual. Depression, anxiety, dyscalculia and ADHD are syndromes commonly identified in dyslexics (LODEJ, 2016). Dyslexia is a neurological condition dependent on biological, cognitive and educational factors and this complexity can, therefore, manifest through varying underlying cognitive deficits which have led scientists to propose distinct categories of dyslexia.

According to Ciasca, Capezzini and Tonelotto (2008) based on data from Border (1973), apud Pinheiro (1994), there are three types of dyslexia:

1-Dysphonetic Dyslexia or Phonology: characterized by a difficulty in oral reading of unfamiliar words. The difficulty lies in the letter-sound conversion. Usually associated with temporal lobe dysfunction.

2- Dyseidetic Dyslexia: it is a difficulty in reading characterized by a visual problem, that is, the visual process is deficient. For Ellis (1995), this reader reads through an extremely elaborate process of analysis and phonetic synthesis that is associated with dysfunctions of the occipital lobe.

3- Mixed Dyslexia: characterized by readers who present problems of both dysphonetic and dyseidetic subtypes, being associated with dysfunctions of the prefrontal, frontal, occipital and temporal lobes (CIASCA, 2000).

Furthermore, according to Dehaene (2012), there are two types of dyslexia: phonological/deep dyslexia and surface dyslexia. The first one has an affected reading phonological route. This type of dyslexic faces problems reading rare but regular words, neologisms and pseudowords, however, frequent and irregular words are a no-trouble. Differently, the second one refers to an affected reading lexical route. This type of dyslexic faces problems reading irregular words, but regular words and pseudowords are a no-trouble.

Wolf and Bowers (1999) developed the Double-deficit Hypothesis. It posits that phonological deficits and the processes underlying naming speed (such as attention, visual recognition, access to phonological codes, temporal processing, and articulation) are separable sources of reading dysfunction, and their combined presence leads to severe impairment of reading ability. reading. The double deficit hypothesis proposed the classification of four groups of readers: typical readers having no deficits in phonological processing or naming speed, phonological deficit readers having deficits in phonological processing but normal naming speed, naming speed deficit having deficits in naming speed but normal phonological processing and double deficit readers having deficits in both phonological processing and naming speed. As the authors noted, the most important implication of the dual deficit hypothesis relates to diagnosis and intervention. Individuals with a unique naming rate deficit require adequate intervention, not based solely on phonological skills training. Phonological skills training is a type of intervention that aims to improve a child's ability to perceive, manipulate, and use speech sounds. Here are some examples of phonological skills training: phonemic awareness training, phonics instruction, word-level decoding training, rhyme and alliteration training and auditory discrimination training (TORGENSEN, 2005).

For the double deficit group, interventions that focus solely on phonological processing or fluency may not be sufficient to address all their reading difficulties. Instead, interventions that target other underlying cognitive processes, such as attention, memory, and executive functioning, may be more effective for improving reading outcomes in this group.

Therefore, while both the phonological impairment group and the double deficit group should receive treatment, the type of treatment should be tailored to their specific patterns of reading difficulties. For the phonological impairment group, phonological-based interventions may be most effective, while for the double deficit group, interventions that target multiple cognitive processes may be more effective.

Both the phonological impairment group and the double deficit group would receive treatment, but not treatment related to phonological impairment or fluency. Furthermore, phonological skills training may not be as effective for languages with opaque spelling, where phonological processing skills play a less significant role, such that naming speed becomes a powerful predictor of reading performance. In this sense, an intervention of the type of RAN (Rapid Automatized Naming) such as naming images, for example, would be more effective in these cases.

Rapid Automatized Naming (RAN) has been found to be related to dyslexia and is often used as a screening tool for dyslexia. Dyslexic readers typically perform more poorly on RAN tasks than non-dyslexic readers, although the exact nature of this relationship is still a topic of debate. Some researchers suggest that the relationship between RAN and dyslexia may be due to underlying deficits in phonological processing. According to this view, dyslexic readers have difficulty processing and manipulating the sounds of language, which can affect their ability to quickly and accurately name visual stimuli in a serial fashion, as required by RAN tasks (WOLF;BOWERS, 1999).

Norton *et al.* (2014) identified the types of dyslexia of their participants by applying Letters and the Numbers subtests of RAN-RAS Tests (Wolf; Denckla, 2005) to determine the presence or absence of RAN deficits and Elision and Blending Words subtests of the Comprehensive Test of Phonological Processing to determine the presence or absence of phonological deficits.

Other researchers have suggested that the relationship between RAN and dyslexia may be due to broader cognitive deficits, such as working memory, attention, or processing speed. For example, dyslexic readers may have difficulty holding information in working memory or shifting attention quickly, which can affect their ability to perform well on RAN tasks (KIRBY *et al*., 2010).

Despite these debates, there is evidence to suggest that RAN tasks can be a useful tool for identifying children at risk for dyslexia. RAN tasks that use letters or digits have been found to be particularly predictive of dyslexia, as these tasks may tap into the underlying phonological processing deficits that are characteristic of dyslexia.

Overall, while the exact nature of the relationship between RAN and dyslexia is still a topic of debate, there is evidence to suggest that RAN tasks can be a useful tool for identifying children at risk for dyslexia and for understanding the cognitive processes underlying dyslexia.

Double-deficit hypothesis is the theory that I have chosen to underlie this study, once multiple studies have shown the importance of RAN skills in dyslexics' reading. Multiple studies provide evidence that RAN skills, which involve quickly and accurately naming familiar visual stimuli, are intricately linked to reading fluency and overall reading ability. Deficits in RAN have been found to be a strong predictor of dyslexia, and interventions that target RAN skills have been shown to improve reading outcomes for individuals with dyslexia (DENCKA;RUDEL, 1976; WOLF;BOWERS,1999; NORTON;WOLF,2012; ARAÚJO *et al*., 2015; MOLL *et al*., 2014).

Wolf and Bower's double-deficit theory (1999) corroborates with Ellis' Dual-Route Cognitive Model (1995). Also, there is a Functional Neuroanatomical Evidence for the Double-Deficit Hypothesis of Developmental Dyslexia by Norton *et al* (2014).

Image 5 - Brain activation differences between groups in Norton *et al* (2014).

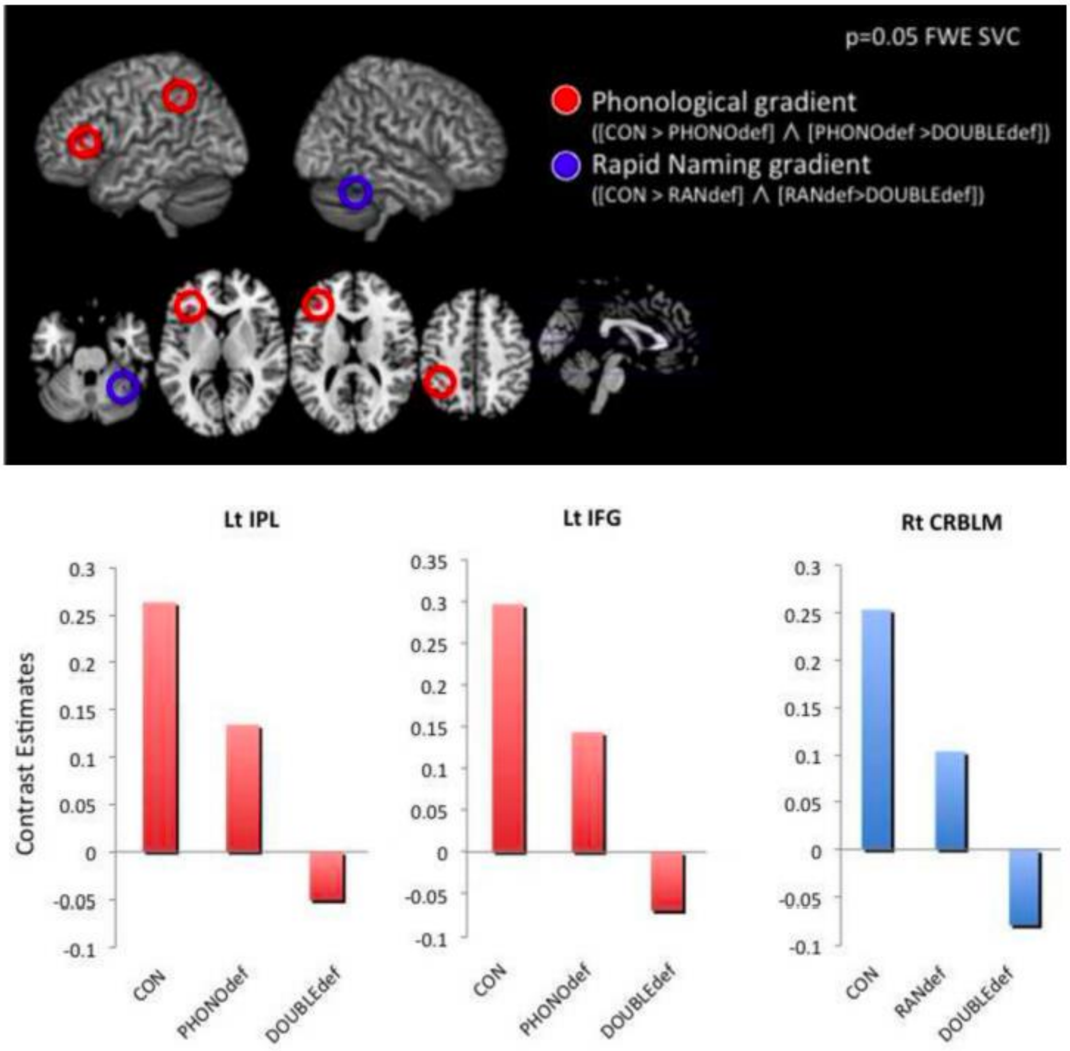

Image 5

a. Brain regions in red show reduced activation in both children with deficits in phonological awareness (PA, PHONOdef) compared to controls (CON) and children with double deficit (DOUBLEdef) compared to PHONOdef (Controls > PHONOdef > DOUBLEdef). Statistical threshold was set at $p = 0.05$ family-wise error (FWE) corrected after small volume correction (SVC). Brain regions in blue show reduced activation in both children with deficits in rapid naming (RANdef) compared to controls (CON) and children with double deficit (DOUBLEdef) compared to RANdef.

b. Mean average contrast estimates of each cluster in Figure 1a were extracted for each child and plotted (left inferior parietal lobule = Lt IPL, left inferior frontal gyrus = Lt IFG, right cerebellum= Rt CRBLM).

The Linguistic Coding Difference Hypothesis is supported by evidence from studies that have found differences in brain activation patterns between dyslexic and non-dyslexic individuals during reading tasks. For example, functional magnetic resonance imaging (fMRI) studies have shown that individuals with dyslexia tend to show less activation in the left hemisphere of the brain, which is typically associated with language processing, during reading tasks (SHAYWITZ *et al*., 2002; SNOWLING;HULME, 2012).

Overall, the Linguistic Coding Difference Hypothesis suggests that dyslexia may be caused by differences in the way that individuals process and code language, particularly regarding phonological processing. This theory has important implications for the development of effective interventions for individuals with dyslexia, which may focus on improving phonological awareness and memory skills.

Nevertheless, the dyslexic participants of this study have diagnoses for both dyslexia and ADHD. To better understand this marriage, read the next section.

6 ADHD AND DYSLEXIA

According to the American Psychiatric Association (2013), Attention Deficit Hyperactivity Disorder (ADHD) is the most common neuropsychiatric disorder in childhood and is included among the most prevalent chronic diseases among schoolchildren. Attention deficit hyperactivity disorder (ADHD) is a condition that affects people's behavior. Symptoms include inattention and hyperactivity. People with ADHD can seem restless, may have trouble concentrating and may act on impulse. Both ADHD and dyslexia are genetic-neurological conditions that can present, in their academic history, school failure, whether determined by changes in entry, as occurs in ADHD.

According to Dakin and Erenberg (2005) and Tridas (2007), ADHD and dyslexia are distinct conditions that frequently overlap, thereby causing some confusion about the nature of these two conditions. ADHD is one of the most common developmental problems, affecting 3–5% of the school population. In Brazil, there are over 2 million cases of ADHD diagnostics per year. It is characterized by inattention, distractibility, hyperactivity and impulsivity. It is estimated that 30% of those with dyslexia have coexisting ADHD. Coexisting means the two conditions, ADHD and dyslexia, can occur together, but they do not cause each other. ADHD symptoms are exacerbated by dyslexia, and vice versa. According to the Learning Disabilities & Reading Disorders Foundation of America (LDRFA), “both ADHD and dyslexia have several symptoms in common, such as information-processing speed challenges, working memory deficits, naming speed, and motor skills deficits. So, it is easy for a parent or a professional to mistake dyslexic symptoms for ADHD" (the ADHD-dyslexia connection, n.d.).

Both ADHD and dyslexia run in families. Genetics play a role in about half of the children diagnosed with ADHD. For the other half, research has yet to identify a cause. Regarding dyslexia, about one third of the children born to a dyslexic parent will also likely be dyslexic (TRIDAS, 2007). ADHD and dyslexia are different brain disorders. But they often overlap. About 3 in 10 people with dyslexia also have ADHD (DARKIN;ERENBERG, 2005).

Treatment varies according to the difficulty and greatest need of the child. However, a recent study showed the positive effect of medication for ADHD on the reading performance of dyslexic children, even if they did not have a diagnosis for that disorder (SHAYWITZ *et al*., 2016); the psychological processes involved and their remediation must continue to be the subject of investigation in order to seek effective improvement in reading.

Studies have shown that individuals with ADHD may have deficits in working memory, particularly in tasks that require attentional control, such as holding and manipulating information in mind while filtering out distractions. This deficit in working memory can make it difficult for individuals with ADHD to sustain attention and complete tasks that require focused effort (KONRAD *et al*., 2006).

The deficits in working memory in individuals with ADHD can also affect academic performance, as many academic tasks require working memory, such as following multi-step instructions, organizing information, and problem-solving. Konrad *et al* (2006) used functional magnetic resonance imaging (fMRI) to investigate the neural mechanisms underlying working memory deficits in children with ADHD. The results showed that children with ADHD had reduced activation in the prefrontal cortex, a brain region critical for working memory, compared to typically developing children.

In particular, the participants of this study have diagnoses for both dyslexia and ADHD. This is essential information once it brings another variable to this study, influencing the results interpretation, once attention is key in tasks completion and performance. All participants were taking ADHD medication by the time of this study.

Moreover, the relation between dyslexia and bilingualism is essential to this study.

7 DYSLEXIA AND BILINGUALISM: AN UNEXPECTED MARRIAGE?

In Brazil, while bilingualism is becoming a more common phenomenon, the myth that dyslexics can never become bilingual is still very much alive. Dyslexic participants' parents shared that they have faced a lot of criticism by their choice of putting their children into an immersive English school.

Reading difficulties can vary according to the language. In the past, learning a second language for dyslexic individuals was seen as something undesirable. Shaywitz (2006) postulates that it is exceedingly difficult for a dyslexic individual to learn a second language and suggests that students be exempt from foreign language subjects, such as English, Spanish, German, among others due to their innate difficulty with language.

However, in Azevedo (2016), a group of bilingual dyslexics obtained a superior result in relation to a group of monolingual dyslexics in all components of reading and writing in Portuguese, in addition to presenting a performance closer to that of the control group, both in tasks in Portuguese, as in English. These results suggest that the apparent superiority in the performance of bilingual dyslexics in tasks in Portuguese may be linked to the issue of the opacity of the graphic representation of the language (English language opaquer and more unpredictable and Portuguese language more transparent and predictable). The hypothesis is that dyslexics are strengthened in the processing strategy via the lexical route, which at the same time is a strategy more compatible with their deficit, and possibly more adequate to deal with the opacity and irregularity in the granularity of the English spelling system.

It is noteworthy that the aforementioned study bilingual participants were Brazilians, native speakers of Portuguese and students of English as a foreign language since the age of 6 (or younger), whether in their school, language courses or private teacher, having formal exposure to the language 4 to 5 times a week , have a certificate of proficiency from the University of Cambridge or another.

In this sense, Azevedo (2016) presents functional magnetic resonance data (fMRI) which show that bilingual dyslexics showed a disengagement from the traditional areas of the phonological reading route (temporal parietal circuit), engaging the lexical route as well as the control group, while monolingual dyslexics seemed to engage the phonological route. That is, the control group (non-dyslexics) and bilingual dyslexics would be engaging more in the lexical route, according to this study.

Furthermore, in the same study, functional neuroimaging results showed that dyslexics show no additional activation (compared to resting state activation) in the Visual Word Form Area (AVFP) in response to reading words, whereas typical readers do. Dyslexics have more false font activation. False font activation, also known as orthographic interference or visual word recognition difficulty, is a common characteristic of dyslexia. It refers to the phenomenon in which a person with dyslexia has difficulty distinguishing between similar-looking letters or words, leading to errors in reading and spelling. This occurs because the visual word form area in the brain, which is responsible for recognizing and processing written words, is less efficient or less well-developed in individuals with dyslexia. As a result, the brain may activate incorrect or irrelevant visual representations of words, causing confusion and errors in reading and spelling (PUGH *et al.*, 2001). This result shows that cognitive processes supported by the AVFP have not yet automated and adapted to the identification of the visual form of words; instead, it is still responding more to pictures, which may be a strong indication of the intervention model proposed by the Double Deficit Theory (RAN type intervention).

Rapid Automatized Naming (RAN) type intervention in the Double Deficit Hypothesis refers to a specific type of intervention aimed at improving a child's ability to name a series of familiar visual stimuli quickly and accurately, such as letters, digits, colors, or objects. This intervention is based on the idea that children with dyslexia and the double deficit subtype of dyslexia have a specific weakness in their ability to name visually presented stimuli rapidly and accurately, which may contribute to their reading difficulties.

During a RAN-type intervention, a child is typically asked to name a series of visual stimuli as quickly and accurately as possible. The stimuli may be presented in different formats, such as a list or a grid, and may include different types of items, such as letters or colors. Over time, the child's speed and accuracy in naming the stimuli are expected to improve, which may lead to improvements in reading fluency and decoding skills.

RAN-type interventions are often used as a component of a comprehensive intervention program for dyslexia, which may also include other types of interventions aimed at improving phonological awareness, phonological decoding, and other cognitive and linguistic skills associated with reading (WOLF;BOWERS, 1999; COMPTON *et al.*, 2012). In the case of bilingual children RAN-type interventions as well testing for rapid naming might bring additional challenges given that lexical entries from L1 and L2 might be competing candidates for naming given that the lexicon for both languages usually co-activate depending on the lexical features, semantic context and language dominance (LIBBEN; GORAL; LIBBEN, 2017), Moreover, bilingual children especially tend to acquire complementary vocabulary, in the sense that for a given object he or she may prefer to name in L1, and for another in L2.

Studies have shown that bilingualism can be beneficial to dyslexics by improving phonological awareness skills, particularly in second language (HO *et al.*, 2005; LALLIER *et al.*, 2005; HEDMAN, 2012; AZEVEDO, 2016; VAN SETTEN *et al*., 2017; VENDER*et al.*, 2020).

As mentioned before, some studies also indicate that bilingual reading acquisition can be beneficial to dyslexics´ reading performance in L1 and L2. A study by Lallier *et al.* (2018) found beneficial transfer in Welsh-English bilinguals. However, they attributed this effect to the Grain Size Accommodation hypothesis (first proposed by Lallier & Carreiras, 2017), stating that the dyslexic adults exposed to the more predictable letter-sound correspondences in Welsh transferred their training in phonological processing to tasks such as pseudoword reading. They performed better on this task than monolingual English dyslexics, who in turn did better on tasks that rely on whole word mapping, such as irregularly spelled words. Although in the current study, we expect beneficial transfer in the opposite direction, this study does confirm that different language orthographic systems might preferably engage different reading strategies and that these influences can be carried over among languages in bilinguals. Other studies with bilingual dyslexic adolescents and adults also suggest transfer occurs (HEDMAN, 2012), while others report no beneficial transfer (SETTEN *et al.*, 2017).

Studies that approach the bilingual experience as advantageous for bilingual dyslexic children are still not quite common, although many studies explore additional difficulties dyslexic children might experience (HO *et al.*, 2005). However, research also makes it clear that although dyslexic children might experience difficulty due to their condition, L2 learning does not worsen their condition and may even be beneficial (VENDER *et al*., 2021). Nijakowska's (2008) study compared the cognitive and linguistic performance of bilingual and monolingual children with dyslexia in Poland (mean 17 years old). Although dyslexics had lower scores, the authors defend that a multisensory instruction would benefit not only dyslexics but algo on-dyslexic students.

However, the influence of L2 acquisition might not transfer to all tasks. A study by Vendi, Delfitto and Melloni (2018) compared bilingual (of a variety of L1 languages and Italian as L2) and monolingual dyslexic children with Italian as L1, specifically on the task of pseudoword repetition in Italian. They found no difference between dyslexic and monolingual children in this task. This suggests that the underlying cognitive mechanisms involved are not sensitive to reading strategy transfer, although L1s varied, and children were not formally trained in L1 reading. For a different task, a study by Vender et al. (2018) showed a positive influence for morphological skills, as measured by a wug-type test in bilingual children with Italian as L2 (mean age 10). Compared to monolingual dyslexics, with Italian as L1, the bilingual dyslexics performed better, in some cases even outperforming monolingual non-impaired children. Thus, it seems that some tasks are more sensitive to the metacognitive baggage that bilinguals acquire, which also benefits dyslexics.

In de Bree *et al*'s study (2022), the authors compared word reading of bilingual and monolingual children with and without developmental language disorder (including dyslexics), word reading outcomes of bilingual children resembled those of monolingual children. Groups with developmental language disorder showed low word reading outcomes and a high incidence of poor readers. In that sense, the authors concluded, poor word reading in bilinguals with developmental language disorder seems to be related to the developmental language disorder, not to bilingualism in itself.

Despite studies showing benefits, or at the least, no disadvantages to L2 learning in dyslexic children, there is not yet much research that empirically corroborates the claim that advantages in reading may occur due to the transferal of language specific reading strategies in bilingual dyslexic children. Azevedo’s study (2016) did show a beneficial effect of L2 (EN) learning on L1 (BP) reading. Based on the Dual Route model, the author attributed this effect to a selective recruitment of the direct lexical route in reading processing by dyslexic bilinguals, which might be better suited to English reading as well as being an effective strategy for dyslexics readers in L1.

We see that many studies foresee that bilingualism can have a beneficial effect on cognitive functioning, due to enhancement of general cognitive components, such as attention, or via metacognition - including in the case of dyslexics. Yet not many studies have empirically corroborated the claim that advantages in reading may occur due to the transferal of language specific reading strategies in children. As previously mentioned, Azevedo’s study (2016), by comparing bilingual and monolingual dyslexic children, showed a beneficial effect of L2 (EN) learning on L1 (BP) reading. The author attributed this effect to a selective recruitment of the direct lexical route in reading processing by dyslexic bilinguals, which might be better suited to English reading as well as being an effective strategy for dyslexics readers in L1. The participants of her study were teenagers and studied in traditional schools with regular, albeit frequent, English classes.

In this study, we investigated reading strategies in dyslexics aged eight to eleven, who are exposed to and use English on a daily level. We measured reading performance on a variety of reading tasks in both languages, comparing dyslexics to typical bilingual readers matched for age. We expected that if the lexical route rather than a phonological route is engaged in dyslexic bilinguals, these participants might be bad at some tasks (e.g. those that require mapping smaller and perhaps lexically non-existent or infrequent phonological sequences, such as the reading and writing of pseudowords and infrequent words), while tasks or stimuli that allow for direct lexical mapping are affected by their dyslexia to a lesser extent. Also, sentence reading should be less affected than word reading, given that semantic and syntactic contexts aid in lexical prediction. Finally, we expected weakness in recruiting the phonological route to affect Brazilian Portuguese more pronouncedly than English, as the opaque and granular nature of the English orthographic system seems to favor direct lexical mapping.

We expected to replicate and complement the effects of Azevedo (2016), whose study involved participants from schools where English was taught in English classes, whereas in this study participants are enrolled in an in immersive teaching environment, in which the entire school curriculum is taught in English (except for Portuguese classes), postulating that a high level of exposure to English has an influence on reading performance in Brazilian Portuguese even for young bilingual pupils. Besides the differences in the formal context of L2 learning and the age bracket of the participants in the study, we also want to note that the school has a non-traditional approach to learning, applying the Montessori methodology. This might be especially beneficial for dyslexics because it has a multisensory approach, individualized instruction, emphasis on creativity and problem-solving problems, focus on social and emotional development (GUTEK, 2003), also particularly beneficial for L2 learners (LILLARD; ELSE-QUEST, 2006; NIJAKOWSKA, 2008). Another aspect of this study is that all dyslexics in this study also present ADHD, which may be explained as a deficit in working memory, particularly on tasks that require attention control. This co-occurrence is quite common, affecting about

3 out of 10 people with dyslexia (DARKIN; ERENBERG, 2005), however, it does introduce a new variable to the study.

Equally, early and simultaneous exposure to reading different spellings results in spelling-specific plasticity that persists into adulthood (DAS *et al*., 2011). The adaptive capacity of the nervous system, more specifically of neurons, to changes in environmental conditions that occur in everyday life of all individuals is called neuroplasticity (LENT, 2010).

In Das *et al* (2011), results show that there are orthography specific routes in simultaneous proficient bilingual readers, a dominant role for proficiency in second language readers and a functional plasticity in early simultaneous proficient bilingual readers. Likewise, Jasinska *et al* (2016) suggests that structural characteristics of bilinguals' two languages and their orthographies have a significant impact on children's neuro-cognitive architecture for learning to read.

Also, in Cao (2016), an inverted U-shaped function has been revealed in the neural response with increased expertise of L2 reading. Brain activation for L2 seems to be driven by tangled variables such as the proficiency level of L2, age of acquisition in L2, and orthographic transparency of L2 in relation to L1. Moreover, the existing reading mechanisms and abilities developed in the first language (L1) have an impact on the learning process of the second language (L2) within the brain. Simultaneously, the acquisition of L2 also has a reciprocal influence on how the brain processes L1.

In some cases, such as in studies with early bilinguals in the literacy phase or highly proficient bilinguals in the L2, even if late, the comparison with monolinguals seems relevant to investigate whether the mastery of a second language can influence the use of reading routes in the L1.

Undoubtedly, there is room for investigation in terms of the effects on early L2 learning. Understanding the factors that influence the reading ability of bilingual subjects, identifying the differences in relation to monolinguals, is important for interventions in cases of dyslexia. Still, the specific characteristics of this L2 are indeed important.

8 OBJECTIVES

The general objective of this study is to investigate: (1) the relationship between reading performance and bilingualism in dyslexia; (2) reading performance in bilingual dyslexics in reading tasks in English and Portuguese, verifying if there is a transference of reading strategies.

The objective is to investigate the reading performance of different-aged dyslexics with a higher level of bilingualism in reading tasks in English and Portuguese comparing it with the reading performance of different-aged non-dyslexics with a higher level of bilingualism in the tame tasks, both groups being students of a Montessorian school. Also, this study has the secondary objective of defending and expanding immersive bilingual education for children with dyslexia, highlighting the importance of the learning method.

9 HYPOTHESIS AND EXPECTATION

A high frequency of use in varied communicative and thematic contexts positively affects the reading performance of the child with dyslexia both in L1 (Portuguese) and in L2 (English), since reading strategies different from those used in L1 will need to be developed, correlating with direct/indirect pathways.

We expect to expand and complement the effects of Azevedo (2016). Differently from Azevedo whose bilingual participants were 13-18 year-olds and only 1 of them was in a school that is a full-immersive English environment, other participants had English classes every day, and that the learning environment was not the main focus, the context of our study is 8-11 year-old participants, whose school is a full-immersive English environment and follow a Montessorian pedagogy, we intend to expand and complement Azevedo's (2016) results, but in immersive teaching, postulating that a high level of English exposure has an influence on reading performance in Brazilian Portuguese even for young bilingual pupils. The difference between our studies is the immersive teaching, importance of school methodology and participants' age.

This study highlights the importance of a teaching method that is more open and flexible, as a Montessorian method, as well as the high exposure to English in immersive environments, claiming that it is an effective method in acquiring a L2, influencing dyslexics' reading strategies for both languages.

Therefore, the current research aims to investigate the reading of dyslexics with a high level of exposure to English, having as the hypothesis that this learning positively affects the reading performance of the dyslexic child both in L1 (Portuguese) and in L2 (English), since reading strategies different from those used in L1 will need to be developed to read the L2, correlating with direct/indirect pathways. That is, the objective is to investigate the reading performance of young dyslexics (8–11-year-olds) with a higher level of bilingualism (more exposure to English in their daily lives, high levels of proficiency, exposure and use) in reading tasks in English and Portuguese.

The hypothesis is that the early age, high level of exposition and open and flexible methodology positively affects the dyslexics reading performance both in Portuguese and English due to different reading strategies that the participant may use that are the lexical route or the phonological route as postulated by Ellis (1996).

The expectancy is that the control group has better results on the English proficiency measures, Brazilian Portuguese digit span, RAN, repetition of pseudowords, Reading Speed of Sentences and dictation tests, English dictation, word and pseudoword reading, repetition of pseudowords and proficiency. There is no expectancy to the IQ measure once it is a control measure, as well as the proficiency test, although the results may vary. However, it is expected that dyslexic participants of this study have close results to the control group, having better results as they get older.

Concluding, the objective is to compare different-aged groups in different languages in different cognitive tasks involving writing and reading, that reading may be aloud or silent. The hypothesis is that if dyslexics of this study do use the lexical route due to English exposure, they will have difficulties with pseudowords both for BP and EN if compared to the control group. However, defending that the lexical route is beneficial to dyslexics, the use of this route will be assessed by better results in EN than BP, as the control group. If dyslexics of this study did adapt to using more the lexical route than the phonological one, we expect to have a weak performance on EN and BP pseudowords compared to controls.

Generally, we expect that dyslexic group is weaker in relation to control but not as much. In terms of sentence reading, we expect no significant difference between groups once sentence reading requires little on the phonological route, differently from pseudowords. That being said, another objective is to investigate to what extent these participants have difficulty in rapid naming, which could point to a more complex set of cognitive deficits underlying the dyslexia condition such as is suggested by the Double Deficit Hypothesis (WOFL; BOWERS, 1999).

Concluding, there are 3 main hypotheses:

- Hypothesis 1: is that dyslexics are strengthened in the processing strategy by the lexical route, which at the same time is a strategy more compatible with its deficit, and possibly more adequate to deal with the opacity and irregularity in the granularity of the English spelling system.

- Hypothesis 2: early age, high level of exposure and open and flexible methodology positively affect the reading performance of dyslexics both in Portuguese and in English due to different reading strategies (lexical route or the phonological route) postulated by Elis (1996).
- Hypothesis 3: If dyslexics use the lexical route due to exposure to English, they will have difficulties with pseudowords for both BP and EN compared to the control group. Arguing that the lexical route is beneficial for dyslexics, the use of this route will be evaluated for better results in EN than in BP, by the 2 groups.

10 THE STUDY

In order to solve the questions raised by the initial hypothesis in which the belief is that the more the children with dyslexia have contact with English the better they will read, a battery of non-verbal skills tests and linguistic profile verification tests, IQ test as well as reading (comprehension and production) and proficiency tests were applied.

The given research aims to investigate the reading of dyslexics with a high level of exposure to English, with the hypothesis that this learning positively affects the reading performance of the dyslexic both in L1 (Portuguese) and in L2 (English), since reading strategies different from those used in L1 will need to be developed, correlating with direct/indirect pathways. That is, the objective is to investigate the reading performance of dyslexics with a higher level of bilingualism by way of a variety of reading tasks in English and Portuguese. Based on the dual-route model (ELLIS, 1995) which predicts that the Phonological Route consists of the phonological segmentation of written words and the Lexical Route consists of the visual analysis of written words, we propose a study in which we will investigate reading strategies in dyslexics of different bilingualism levels and typical readers measuring reading performance in bilingual dyslexics on reading tasks in both languages. This is a neurolinguistic study which focuses on analyzing the reading process of dyslexic bilinguals.

10.1 RECRUITMENT AND PARTICIPANTS

At first, the intention was to compare different schools, one with an immersive English environment with an open and flexible methodology as Montessorian methodology and another non-immersive English environment in which students have English classes two to four times a week. Nonetheless, several schools have ignored our contact attempts and/or refused to participate.

Participants were recruited from a private bilingual school in Rio de Janeiro which follows an American and international curriculum that is the IB Programme (International Baccalaureate). All subjects are taught in English, with the exception of the Portuguese classes (the participants have 50 minutes of Portuguese class every day). They stay at school 8 hours every day. The school offers an English immersion environment and the reading instruction the students are exposed to is in English. It is a transdisciplinary, inquiry-based, and student-centered education that focuses on developing curiosity and critical thinking skills to solve complex problems. That being said, the methodology offers open-ended learning experiences, the learning journey is discussed with the student, the focus is on skills and competency building and the teacher is seen as a facilitator of learning. This information on the school is relevant because it evidences the amount of exposure to English the participants have.

The analyzed group is composed of 6 participants, 3 children with dyslexia and ADHD and 3 non-dyslexics, students of an international school in Rio de Janeiro. The participants in the experimental group had diagnostic reports of dyslexia and ADHD prior to inclusion in the list of participants, the clinical diagnosis of dyslexia being a criterion for participant inclusion The school itself, which has access to the diagnosis provided by the families, has contacted the families to ask for the participation of their child. The children in the control group had no known difficulties with reading, nor were they diagnosed with any other developmental issues.

In this sense, participants were matched by age and school grade, with 2 3rd grade participants aged 8/9 years old, 2 4th grade participants aged 9/10 years old, and 2 5th grade participants aged 11 years old. The first group under analysis was composed of 3 children with dyslexia previously diagnosed by a speech therapist, students at the school from this study. The second group was the control group composed of 3 children matched in age range, gender, level of non-verbal intelligence and school year of non-dyslexic children from the same school, so that we can have a control group in reference to the reading level of children with dyslexia comparing the reading levels with the reading level of non-dyslexic readers. They must have had a minimum 3 years of enrollment and diagnosis for both dyslexia and ADHD. Also, all of them were Brazilians, having Brazilian Portuguese as their mother tongue, residents of the west zone of Rio de Janeiro and students at the school from this study. In this way, the socioeconomic factor and degree of exposure to English is controlled. Dyslexic participants are represented by “D” and control participants are represented by “C”.

D1 - 3rd grade - dyslexia and ADHD - 8 years and 4 months old.

C1 - 3rd grade - 9 years and 1 month old.

D2 - 4th grade - dyslexia and ADHD - 9 years and 8 months old.

C2 - 4th grade - 10 years and 4 months old.

D3 - 5th grade - dyslexia and ADHD - 11 years and 1 month old.

C3 - 5th grade - 11 years and 3 months old.

After contacting the school, explaining the study and organizing the section dates, the school itself, which has access to the diagnosis provided by the families, contacted the families to publicize the research and share the researcher's contact if any of the caretakers wants and consents to the participation of their child. The families and the school were informed in detail about the confidentiality of the research, through the informed consent form that was given to both. Then, a meeting was scheduled with each parent to conduct the anamnesis, explain the study and sections dates as well as answer any possible question about the study. I will elaborate on further details on each of the participants in the experimental group later on.

The group of participants from this study was a small one, that is why the number of tests is large. These groups of participants are limited in social-cultural aspects once it is a very specific reality but is extraordinarily rich in cognitive terms.

10.2 THE LEARNING ENVIRONMENT AND TYPE OF READING INSTRUCTION

The school in which they study is an international school that follows the IB Programme (International Baccalaureate) which means that it is a transdisciplinary, inquiry-based, and student-centered education, as revealed by focus on curiosity and development of critical thinking skills to solve complex problems, according to school documents. That is to say that the school offers open-ended learning experiences, the learning journey is discussed with the student, there is a focus on skills and competency building and the teacher is a facilitator of learning. It is a completely English immersive environment and the reading instruction the students are taught is in English. Furthermore, the participants have 50 minutes of Portuguese class every day. This is a school that follows Montessorian pedagogy.

The Montessori (GUTEK, 2003) method was created by the Italian pedagogue, physician and educator Maria Montessori after her experience working with children with special needs. The methodology was initially applied in children's schools in Italy and later spread to institutions around the world. In Brazil it has been implemented since 1910 and has increasingly gained new followers. The pedagogical methodology aims to contribute to the development of children, without directly interfering with it, as in traditional education. For the pedagogue, the child can be encouraged to acquire knowledge from different activities with gradual degrees of difficulty. In Montessori education, too much interference from adults can be detrimental to learning. In addition, each individual has their own pace, which must be respected. A Montessori school conducts a class like a science project. Unlike traditional education, content is not transmitted from teachers to students in a vertical and rigid manner. Knowledge is built by the whole class with the mediation of the educator. The teacher uses the scientific method of observation, hypotheses, and theories. The contents are discovered by students through research, reasoning and discussion, collectively.

Therefore, in this school, there is a very individualized look to each student. It is important to mention that I did not have any bond to this school. The initial idea was to compare dyslexic bilinguals of different learning environments, however, due to the lack of interest of many schools as well as their (and parents) treatment of dyslexia as a taboo, it was not possible.

Language learning plays a key role in schools where the language(s) of instruction may not be the student’s first language (LANGUAGE SCOPE AND SEQUENCE, 2018).

In terms of reading instruction/literacy, the school does not use a specific scripted program. They use a lesson framework called Reading & Writing Workshop (ATWELL, 1988) that focuses on large group mini-lessons and small group center work for both reading and writing instruction. It is very individualized. They use additional phonics supplements and word work/vocabulary lessons based on the Primary Years Programme from the International Baccalaureate scope and sequence for language (2018), reading and writing. These are usually done in small groups and target students' language and learning needs.

During the 1980s, Nancie Atwell, with the assistance of Donald Graves, led a group of teachers who implemented reading workshops in their classrooms. Atwell (1988) collaborated with her students to develop a workshop based on the ideas presented by Donald Murray, who highlighted the disparity between the actual writing process and how it was typically taught in secondary English classrooms. Rief (1989) emphasized the importance of providing students with choice and autonomy in shaping the curriculum. Atwell (1988) described workshops as environments that are open-ended yet stable, fostering a high degree of literacy engagement. These workshops are characterized by established routines and structures that create a secure and comfortable learning environment, enabling students to derive meaning through authentic reading and writing experiences (ATWELL, 1988; ACKERMAN;OSTROW, 1995). Reading Workshop comprises three key elements: the mini-lesson, work time, and share time. Each of these elements necessitates distinct planning considerations. Teachers within this method emphasize the use of different tools while reading.

The partner school is currently developing our curriculum alignment with literacy, combining all those methods already used by their teachers.

Image 6 - Example of a tool teachers teach to their students retrieved from Children’s Literacy Initiative website (2016).

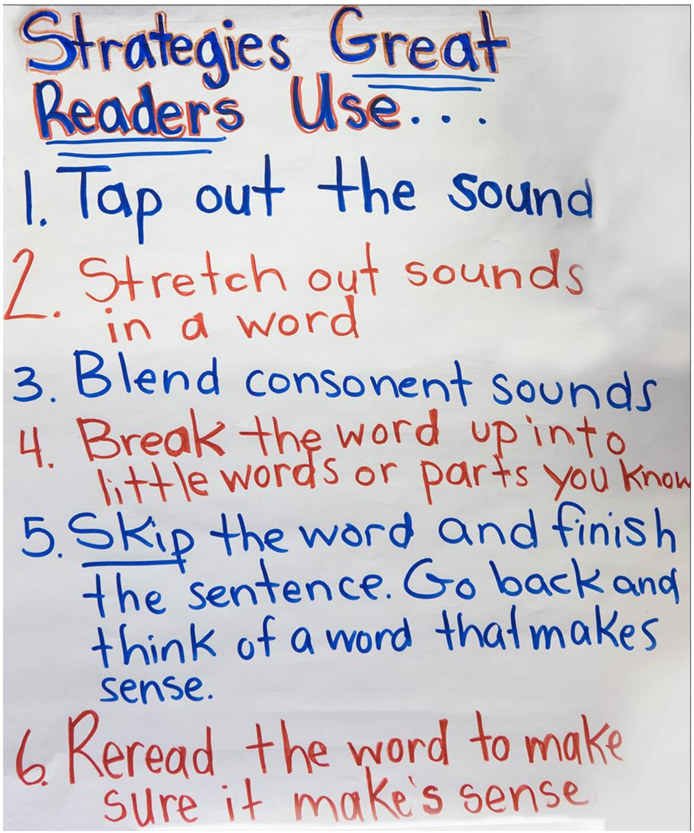

Image 6

The language scope and sequence utilized by the school, as outlined in the International Baccalaureate framework (2018), employs explicit teaching of language skills, but places primary emphasis on concept-based learning. Initially, learners develop an understanding that written text represents the real or imagined world. They recognize that reading provides both knowledge and enjoyment and can be pursued individually or in social settings. Learners grasp the concept of a "book" and become aware of its structural components. They rely on visual cues to associate sounds with the words they are "reading" in order to construct meaning. During this stage, they also begin to differentiate between visual representations such as symbols, numbers, technological icons, letters, and words, and demonstrate recognition of their own first name.

As learners progress, they acquire an understanding that language can be visually represented through codes and symbols. They expand their repertoire of printed codes and symbols and can identify them in various contexts. They comprehend that reading serves as a means for acquiring knowledge, and that the combination of codes conveys meaning. At this stage, learners actively participate in shared reading, engaging in question posing and response, as well as joining in refrains. They also partake in guided reading sessions, where they observe and apply appropriate reading strategies and effectively interact with the group. Furthermore, learners attentively listen and actively respond to read-aloud situations, making predictions and anticipating possible outcomes. They are also capable of comprehending self-selected and teacher-selected texts at an appropriate level, thereby understanding their meaning (LANGUAGE SCOPE AND SEQUENCE, 2018).

10.3 TESTING SECTIONS AND RESEARCH TEAM

The tests carried out were applied by me, by a team of psychologists and by a speech therapist. The tests applied were:

- Reading aloud words and pseudowords in Portuguese (RODRIGUES, 2015) and in English (SIQUEIRA, 2018)
- Reading Speed of Sentences of sentences in English and Portuguese (developed for this research that will be further validated and published)
- English proficiency (PVST-Picture Vocabulary Size Test) (ANTHONY;NATION, 2021)
- Dictation of words and pseudowords in English (developed for this research that will be further validated and published)
- Test of speed of naming objects, colors, numbers and letters (FERREIRA et al. Performance of proficient reading students in the rapid automatized naming test (RAN); v. 12 n. 69; 2003)
- Digit SPAN – ITPA
- Repetition of pseudowords (KESSLER, 1997)
- Dictation test BP– List of component psycholinguistic items (CAPOVILLA, 2000 – based on PINHEIRO, 1994)
- IQ: WASI - Wechsler Abbreviated Intelligence Scale
- Language Experience and Proficiency Questionnaire, known as QuExPLi (SCHOLL; FINGER, 2013) and a short interview with the participants regarding their use of English.

The tests were grouped into sections according to the applicant. The anamnesis was the first applied test due to gaining knowledge about the participants beforehand.

After that, I have decided to start with the speech therapist section with the participants once all the tests were in Portuguese, then the tests applied by me to have the comparison to the Brazilian Portuguese tests in performance fresher and, afterwards, the psychologists section. IQ, language proficiency and questionnaire, anamnesis, BP digit span and BP pseudowords repetition are control tests and for qualitative analysis.

The research team was composed by a neurolinguist, a speech therapist[3] and 2 psychologists[4]. The tests were divided into 5 individual 50 minutes sessions (totalizing 30 sessions) in which the first one was online; the other sessions were done in person. No session was conducted in groups, each session was individual. The first session was dedicated to the anamnesis with the parents as well as the completing of the QuExPLi questionnaire and consent forms.

Session 2 was carried out by the speech therapist and neurolinguist, the tests for this section were digit span, RAN, pseudowords repetition and dictation test in BP.

Session 3 tests were PVST, dictation test EN, reading aloud words and pseudowords in Portuguese and in English, carried out by the neurolinguist.

Session 4 tests were Reading Speed of Sentences in English and Portuguese and some extra bilingualism questions carried out by the neurolinguist. The last session was dedicated to the IQ, and it was carried out by the 2 psychologists and the neurolinguist.

That being said, the parents and the school have received a report on their children's performance in all tests.

In the following sections, the aim, content and procedures of each of the tests are explained in detail.

The anamnesis was done online with one of the caretakers, me and the speech therapist, though Google Meet platform. The caretakers of all children, both from the experimental group (D group) and the control group, were interviewed. During the online interview, the participant's caretaker (usually the mom, only for participant C3 it was his dad) answered questions about their child regarding health, development, family, routine, school and recurrent cognitive difficulties. The objective of the anamnesis is to better

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understand the participant's family, school history and clinical history, in order to verify at what age the difficulties in reading appeared, if any doctor, speech therapist or educational psychologist helped in the diagnosis and remediation of dyslexia, whether the participant studied in a public or private school, among other relevant information.

In terms of school history, the questions of the anamnesis were aimed at understanding how old the participants were, when they started to study at the participating school, if they studied at a different school before, why parents preferred a bilingual school, which subject participants liked most and which one they liked less, who chose the school and why, the amount of hours they stay at school, the preference of language at home, if the participants have support in the classroom, the main difficulties observed in the participant, what is the hardest and easiest school subject for the participant and if the school has ever called the caretakers to talk about any difficulties. The caretakers of the children in the experimental group were asked when the child was diagnosed (D group), the intervention history and psychopedagogical/speech therapist/psychological support (D group) and other relevant information. Therefore, an experienced anamnesis is especially important for data analysis.

The anamnesis questionnaire can be found in Appendix 1.

10.4 IQ

An IQ test needs to be done as a control measure for any neuropsychological research/experiment. IQ tests are often used as a control measure in neuropsychological testing because they provide an overall assessment of an individual's cognitive abilities, which can help to ensure that any specific deficits or strengths identified on other neuropsychological tests are not solely due to general cognitive abilities.

An IQ test measures an individual's intelligence quotient, which is a score that reflects their overall intellectual ability relative to their peers. IQ tests typically measure several cognitive abilities, including verbal comprehension, perceptual reasoning, working memory, and processing speed. By measuring these different cognitive abilities, an IQ test can provide an overall estimate of an individual's cognitive functioning.

When used as a control measure, an IQ test can help to ensure that any specific deficits or strengths identified on other neuropsychological tests are not solely due to general cognitive abilities. For example, if an individual performs poorly on a test of verbal fluency, it may be difficult to determine whether this is due to a deficit in language processing or due to a lower overall level of intellectual functioning. However, if the individual's IQ score is also low, this suggests that their performance on the verbal fluency test is likely due to both a deficit in language processing and a lower overall level of cognitive functioning. In summary, using an IQ test as a control measure in neuropsychological testing can help to ensure that any specific deficits or strengths identified on other tests are not solely due to general cognitive abilities, which can improve the accuracy and reliability of the results.

The Wechsler Abbreviated Scale of Intelligence (WASI Test) delivers an estimation of a student's general intellectual ability by measuring the verbal, nonverbal, and general cognition of individuals from 6 to 89 years of age. Likewise, the test is divided into different sections (WECHSLER, 2011).

The vocabulary subtest includes 3 picture items and 28 verbal items. For picture items, the tester names the object presented visually. For verbal items, the test taker will define words that are presented orally. This section is designed to measure the breadth of the individual's vocabulary, and overall understanding of words. On the updated version of the WASI-II, art was added for the picture items (WECHSLER, 2011).

The block design subtest measures the ability to analyze and understand abstract visual items. A total of 9 items from the WASI were kept and 4 new items were added. While viewing a sample model or picture in the stimulus book, the test taker makes use of red and white blocks in order to re-create the design. The test taker must finish the reconstruction within a set time limit (WECHSLER, 2011).

The individual will view an unfinished matrix or series and choose the option that completes the matrix. Within this section, 23 items will remain from the WASI, while 7 new items were added (WECHSLER, 2011).

For the picture items (items 1-3), the tester chooses the option that shares a specific characteristic with the target objects. For the verbal items (Items 4-24), the tester is shown two words that display common objects or concepts. It is the tester's job to say how they are similar (WECHSLER, 2011).

It is not appropriate to make generalizations about the IQ scores of dyslexic readers on the Wechsler Abbreviated Scale of Intelligence (WASI) test based solely on their age. While there may be some trends in IQ scores for dyslexic individuals at different ages, it is important to recognize that IQ scores can vary widely among individuals, and dyslexia can affect people in different ways.

It is also worth noting that the WASI test is not specifically designed to assess dyslexia, but rather provides a measure of general intellectual functioning. While the WASI includes measures of verbal comprehension and perceptual reasoning, which are relevant to dyslexia, it does not include specific measures of reading ability or other aspects of dyslexia.

Overall, it is important to approach the assessment of dyslexia and intellectual functioning on an individual basis, taking into account a range of factors beyond just age. A comprehensive assessment of dyslexia should include measures of reading ability, phonological processing, and other relevant cognitive skills, in addition to IQ tests, to provide a thorough understanding of an individual's strengths and weaknesses.

It is not appropriate to make generalizations about the IQ scores of individuals with ADHD on the Wechsler Abbreviated Scale of Intelligence (WASI) test based solely on their age. While there may be some trends in IQ scores for individuals with ADHD at different ages, it is important to recognize that IQ scores can vary widely among individuals, and ADHD can affect people in different ways.

Research has shown that individuals with ADHD may have lower scores on measures of attention, working memory, and other cognitive skills than individuals without ADHD. However, their scores on measures of general intellectual functioning, such as IQ tests, can be quite variable.

It is also worth noting that the WASI test is not specifically designed to assess ADHD, but rather provides a measure of general intellectual functioning. While the WASI includes measures of verbal comprehension and perceptual reasoning, which are relevant to ADHD, it does not include specific measures of attention or other aspects of ADHD.

Overall, it is important to approach the assessment of ADHD and intellectual functioning on an individual basis, considering a range of factors beyond just age. A comprehensive assessment of ADHD should include measures of attention, working memory, and other relevant cognitive skills, in addition to IQ tests, to provide a thorough understanding of an individual's strengths and weaknesses.

Therefore, dyslexics are expected to have a lower QIV (verbal IQ) than the control and a better QIE (execution IQ) than QIV. There are no expectations about IQ and ITQ (total IQ) since studies have revealed that the IQ measure does not identify dyslexia (ARDUINI *et al*., 2006; D’ANGIULLI;SIEGEL, 2003). According to Jepsen *et al* (2008), the associations between IQ and attention deficits in ADHD are generally modest, with the mean influence on IQ probably amounting to 2 to 5 IQ points.

In accordance, Fletcher (2019) states that the relationship between ADHD and IQ is not straightforward. An individual with ADHD can have varying IQ scores, ranging from high to average or low. Symptoms associated with ADHD, such as interruptions in class or poor test performance, may lead others to assume a lower IQ level. Conversely, individuals with ADHD may demonstrate hyperfocus on tasks they find engaging, creating an impression of above-average intelligence.

For the control group, according to Wechsler (2011), the WASI has separate normative tables for different age groups. For 8, 9, 10, and 11 year-old children, the normative data for the WASI indicate the following expectations for IQ scores:

- 8-year-olds: The average IQ score is 100, with a standard deviation of 15. Approximately 68% of children will have IQ scores between 85 and 115, and approximately 95% of children will have scores between 70 and 130.
- 9-year-olds: The average IQ score is 100, with a standard deviation of 15. Approximately 68% of children will have IQ scores between 85 and 115, and approximately 95% of children will have scores between 70 and 130.
- 10-year-olds: The average IQ score is 100, with a standard deviation of 15. Approximately 68% of children will have IQ scores between 85 and 115, and approximately 95% of children will have scores between 70 and 130.
- 11-year-olds: The average IQ score is 100, with a standard deviation of 15. Approximately 68% of children will have IQ scores between 85 and 115, and approximately 95% of children will have scores between 70 and 130.

It's important to keep in mind that IQ scores should be interpreted with caution and considered in conjunction with other measures of cognitive functioning to provide a comprehensive assessment of a child's strengths and weaknesses.

10.5 EXPERIENCE AND LINGUISTIC PROFICIENCY QUESTIONNAIRE

In line with Grosjean’s (2013) broad understanding of bilingualism as the use of two or more languages or dialects in daily life, according to need and with different levels of proficiency, a questionnaire was applied about the participants' habits of using the English language. In addition, we considered the age at which L2 was acquired and decided to apply a proficiency exam. Studies suggest that bilinguals are able to report their proficiency consistently with objective measures (MARIAN *et al.*, 2007; LUK *et al.*, 2013; GERTKEN *et al.*, 2014; BRANTMEIR *et al.*, 2012).

The questionnaire used was the "language history questionnaire for research with bilinguals" (SCHOLL; FINGER, 2014) which is a language history questionnaire (in Portuguese) to be used with bilingual individuals. The focus of the questionnaire is the selection of participants for research involving bilingualism. The target group of this questionnaire is Brazilian children. This questionnaire can be found in Appendix 2.

The questionnaire was completed independently by the parents and the participants due to the number of sections and tests participants would face afterwards and also because of the caretakers schedule. It was applied via Google Forms. The questions addressed in the questionnaire are divided into five groups: personal information, language history, functions and use of languages, proficiency and other information.

In Scholl *et al.* (2017), the age milestones, immersion time and current use of the language correlated significantly, for the most part, with the participants' self-rated proficiency, indicating an association between these factors. These results suggest that these factors should be taken into account when evaluating the linguistic profile of participants in research on additional language acquisition and bilingualism.

In Scholl *et al.* (2017), the time that participants spent immersed in a job or school where the additional language is predominantly used was also correlated with oral production ability. Factors related to age milestones had a significant negative correlation with reported proficiency in the four skills, which is to say that the sooner participants acquired, started using and became fluent in the English language, the higher their reported level of proficiency. As a measure of current language use, the greater frequency with which participants use English in different contexts indicates a better assessment of their self-reported proficiency.

The final part of the questionnaire entitled "Other Information" aims to seek information that may be useful for the researcher to understand a little more about the participant's experience. In addition, a short interview with the participants regarding their use of English was conducted, asking them the frequency in which they watch videos, listen to music, read and play games in English. The reason for that is that the original QuExPLi (SCHOLL; FINGER, 2014) does not approach this daily influence. The questions composing this interview can be found in Appendix 2.

The data collected by completing the questionnaire were analyzed and will be presented together with the results. This analysis is qualitative, to understand the use of English of all participants. There is also an expectancy of finding participant's self-reports with greater frequency with which participants use English in different contexts, young age milestones and greater time spent immersed in an English environment.

10.6 LANGUAGE PROFICIENCY

One of the many ways of testing language proficiency is by way of a picture-word matching test. This Picture Vocabulary Size Test (ANTHONY;NATION, 2021) is primarily designed for young pre-literate native speakers up to eight years of age and young non-native English speakers. The test was created in collaboration with Paul Nation of Victoria University of Wellington, New Zealand. The advantage of this test is that it does not rely on reading, it is engaging due to the presentation of the pictures, and it presents words in mini sentences. It is easy and quick to apply, with the words increasing in difficulty (lower frequency) as the test progresses. The score is calculated by adding 1 point to the correct answers and 0 for the wrong answers. The test consists of 96 questions and is performed on the computer. With each question, the participant hears a word and its placement in a sentence and needs to choose one of the 4 images that best illustrate what was said.

PVST's software already gives you a chart with the score, time used for each page and total time. Better performance is expected from the control group (more than 50 right answers) due to attentional issues. The test does not have a simple vocabulary and it is very long.

It is possible to see the words and sentences used in this test in Table 1.

Table 1 - PVST Words and Sentences

Behind: He's behind the car.	Award: This is an award.	Scandal: It was a scandal.
By: He's by the car.	Independent: He is doing it independently.	Thistle: It's a thistle.
Thirteen: Thirteen.	Investigate: It's investigating.	Spa: This is a spa.
House: This is my house.	Display: He can see the display.	Pulley: This is a pulley.

Wild: It's wild.	Adopt: He is adopted.	Canary: This is a canary.
Animal: It's an animal.	Flock: It's a flock.	Jig: This is a jig
Table: It's a table.	Calf: It's a calf.	Reap: He is reaping.
Grass: It's grass.	Laundry: It's the laundry.	Rinse: He is rinsing.
Message: It's a message.	Function: It's not functioning.	Trample: He is being trampled.
Attack: It's an attack.	Confirm: She confirmed it.	Enhance: He is enhancing it.
Lake: It's a lake.	Object: She objected.	Crimson: It's crimson.
Afraid: It's afraid.	Alert: She's very alert.	Smudge: It's smudged.
Breath: He takes a breath.	Horizon: She saw the horizon.	Sleet: It's sleet.
Believe: He believes me.	Bully: He is being a bully.	Gospel: It's the gospel.
Cream: Some cream.	Signature: He is making his signature.	Souvenir: It is a souvenir.
Beneath: You can see from beneath.	Rotate: He is rotating it.	Obnoxious: It's obnoxious.
Whip: It's a whip.	Thrust: He's making a thrust.	Anguish: Full of anguish.
Handkerchief: It's a handkerchief.	Cafeteria: This is a cafeteria.	Sag: It is sagging.
Check: It was checked.	Cushion: This is a cushion.	Brachiosaur: A brachiosaur
Beast: It's a beast.	Chap: This is a good chap.	Disillusioned: Disillusioned
Knowledge: He has a lot of knowledge.	Limb: This is a limb.	Goalie: A goalie
Earn: He earned it.	Grasshopper: It's a grasshopper.	Licorice: Licorice
Mail: He has some mail.	Quaint: It's quaint.	Pansy: It's a pansy
Frame: He has a frame.	Compass: It's a compass.	Sardine: It's a sardine
Tour: He's on a tour.	Savage: It's savage.	Volley: It's a volley
Video: He has a video.	Expedition: It's an expedition.	Stupendous: It's stupendous
Various: He has various things.	Shabby: He is shabby.	

Penalty: He has a penalty.	Chant: He's chanting.	
Hobby: It is a hobby.	Kite: He's got a kite.	
Hotel: This is a good hotel.	Portable: It's portable.	
Tape: This is a tape.	Lunar: It's lunar.	
Electric: This is electric.	Slick: There's a slick.	
Beef: This is beef.	Fatal: It's fatal.	
Gear: This is my gear.	Sloppy: It' s sloppy.	
Liquid: This is a liquid.	Merit: It has merit.	

Table 1

Overall, this measure is used as a control measure to match participants' proficiency levels. It is expected to have lower accuracy for dyslexics in general not because of the linguistic impairment but because of ADHD and because much of formal learning in a school involves reading. However, a slight improvement regarding age is expected (better results from older participants). This test measures more linguistic knowledge and less reading. However, it is important to mention that the results may vary due to personal background and attention.

10.7 DIGIT SPAN

The most commonly used forms of evaluation of phonological working memory are repetition of pseudowords and repetition of digits (BADDLEY 1986, GONÇALVES, 2002, UEHARA; LANDEIRA-FERNANDEZ, 2010, GRIVOL ;HAGE, 2011). It is important to say that nonsense words repetition tests assess more precisely the phonological memory because the input is unknown and it is not influenced by lexical influences (for example, phonological, semantic, syntax knowledge). In this case, the child will have to use the word representation without any meaning in memory to support its repetition (GATHERCOLE et.al., 1999). Ardila (2003) showed that measures of phonological memory, such as digit spans, have been shown to be associated with success in L2 learning in adults.

The pseudowords repetition task is of particular interest, because in its execution, this repetition depends entirely on the phonological ability, considering that there is no way to employ a compensatory strategy for the temporary storage of information in the working memory. Therefore, data from the development of both tasks will be analyzed, each one being analyzed separately.

A sequential repetition of 28 digits is distributed in ascending order from 2 to 7 numbers, the test starts by the experimenter saying the shortest and easiest sequence to the participant, so they can repeat (see table 2). TWO attempts are allowed for each sequence when an error occurs on the first attempt (the participant must repeat the spoken sequence out loud with no mistakes). The instruction for the experimenter is that the sequences must be presented orally, with uniform rhythm of 2 digits per second, requesting the immediate repetition of the items by the child. Results are computed by assigning a value of 2 points for each correct answer on the first attempt (A) and 1 point for each correct answer on the second attempt (B). This will be the raw score.

The digit span in Portuguese (ITPA) yields two values, the raw score (score obtained at the end of the test) and the scalar score (transformation of the raw score – it is on this score that the normality pattern is based). See image 7.

Image 7 - ITPA scalar score table for typical readers

Raw Score	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	Raw Score	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1	30	27								**22**		46	42	39	37	35	33	32	31
2	32	28								**23**		47	43	40	37	36	34	33	32
3	33	29								**24**		48	44	41	38	36	35	33	32
4	35	30	26							**25**		49	45	41	39	37	36	34	33
5	37	31	27	25	23					**26**		50	46	42	40	38	36	35	34
6	39	32	28	26	24					**27**		51	46	43	40	38	37	36	35
7	40	33	29	26	25	25				**28**		52	47	44	41	39	38	36	35
8	42	34	30	27	26	26				**29**		53	48	45	42	39	38	37	369
9	44	34	31	28	26	27				**30**			49	46	43	40	39	38	37
10	46	35	32	29	27	27	25	23		**31**			50	46	44	41	40	39	37
11	47	36	32	30	28	28	25	24	23	**32**				47	44	41	41	39	38
12	49	37	33	31	29	29	26	25	24	**33**				48	45	42	41	40	39
13	51	38	34	31	30	29	27	25	25	**34**				49	46	43	42	41	39
14	53	39	35	32	30	30	28	26	26	**35**				50	47	43	43	42	40
15	54	40	36	33	31	30	28	27	26	**36**					47	44	44	42	41
16	56	41	37	34	32	31	29	28	27	**37**					48	45	44	43	42
17	58	42	38	35	33	32	30	28	28	**38**					49	45	45	44	42
18	60	43	39	36	33	32	30	29	28	**39**					50	46	46	44	43
19		44	39	36	34	33	31	30	29	**40**					51	47	46	45	44
20		44	40	37	35	34	32	31	30	**41**					51	47	47	46	44
21		45	41	38	36	34	33	31	30	**42**						48	48	47	45

Image 7

Table 2 - Digit SPAN sequence list – ITPA

	Digit sequence
1º	9-1
2º	7-9
3º	6-4-9
4º	8-1-1
5º	5-2-8
6º	2-7-3-3
7º	6-3-5-1
8º	8-2-9-3
9º	1-6-8-5
10º	4-7-3-9-9
11º	6-1-4-2-8
12º	1-5-2-9-6
13º	7-3-1-8-4
14º	5-9-6-2-7
15º	2-9-6-1-8-3
16º	7-4-8-3-5-5
17º	6-9-5-7-2-8
18º	5-2-4-9-3-6
19º	4-7-3-8-1-5
20º	3-6-1-9-2-7-7
21º	5-3-6-9-7-8-2

Table 2

Better results are expected from the control group, once dyslexics show impairment with working memory (SILVA; CRENITTE, 2014; SMITH-SPARK;FISK,2007; MENGHINI *et al,* 2011).

This is a control test. The Digit Span test is a commonly used assessment tool for identifying dyslexia. The objective of this test is to assess an individual's ability to remember and recall a sequence of digits presented orally or visually.

The Digit Span test is used to assess an individual's working memory, which refers to the ability to temporarily store and manipulate information. Working memory is an essential cognitive process that is required for a range of academic tasks, such as reading, writing, and arithmetic. Individuals with dyslexia often experience working memory deficits, which can result in difficulties with tasks that require the recall of information, such as recalling the sequence of letters or numbers. The Digit Span test can help identify working memory deficits that are characteristic of dyslexia (GATHERCOLE *et al*., 2006).

In summary, the objective of the Digit Span test for dyslexics is to assess an individual's working memory, which can help identify the presence of dyslexia or other learning difficulties related to working memory deficits.

10.8 REPETITION OF PSEUDOWORDS

For the assessment of working memory, two of its components are commonly analyzed: the central executive and the phonological circuit. To evaluate the phonological circuit a task of repetition of pseudowords can be applied (KESSLER, 1997). This test is often used in learning assessments and when the school refers when there is a suspicion of dyslexia, it assesses short-term phonological memory.

The pseudowords repetition test is a commonly used assessment tool for identifying dyslexia. The objective of this test is to assess an individual's ability to repeat pseudowords or made-up words accurately. Individuals with dyslexia often struggle with phonological processing, which refers to the ability to recognize and manipulate the sounds of language. Pseudowords repetition tasks require individuals to break down the sounds in unfamiliar words and repeat them back accurately. If an individual struggles with this task, it may suggest that they have difficulty with phonological processing, which is a common characteristic of dyslexia (GATHERCOLE *et al*., 1992).

The pseudowords repetition test is a widely used cognitive assessment tool that measures an individual's ability to repeat pseudowords or made-up words accurately. While pseudowords repetition tests are not typically used as a diagnostic tool for ADHD, they can be helpful in assessing specific aspects of cognitive functioning that may be affected by ADHD. One of the main objectives of the pseudowords repetition test for individuals with ADHD is to assess their working memory, which is one of the cognitive domains that are often impacted by ADHD. Working memory refers to the ability to temporarily store and manipulate information, and individuals with ADHD often experience working memory deficits. By using the pseudowords repetition test, clinicians can assess an individual's ability to hold and manipulate phonological information in their working memory. This can provide valuable information about their cognitive functioning and help to identify areas of weakness that may be related to their ADHD symptoms (GATHERCOLE *et al*., 2005).

The most commonly used forms of evaluation of phonological working memory are repetition of pseudowords and repetition of digits (BADDLEY 1986, GONÇALVES, 2002, UEHARA;LANDEIRA-FERNANDEZ, 2010, GRIVOL;HAGE, 2011). The pseudowords repetition task is of particular interest, because in its execution, this repetition depends entirely on the phonological ability, considering that there is no way to employ a compensatory strategy for the temporary storage of information in the working memory. Therefore, data from the development of both tasks will be analyzed, each one being analyzed separately.

For the evaluation of the phonological loop of working memory, the Kessler Nonword Repetition Test (1997). This test is composed of 5 steps, each step has 5 pseudowords to be repeated.

Nilssen and Hulme (2014) assessed reading and spelling skills, working memory, phonological awareness and rapid naming of dyslexic adults and typical readers. Dyslexics, demonstrated marked failures in spelling, reading fluency and pseudowords decoding.

It was observed that the pseudowords repetition skill scores achieved in the second year are significantly higher than those obtained in the fifth and sixth years. The success of children in the task of repeating pseudowords at the beginning of elementary school can be explained by their correlation with the development of phonological awareness then observed at the syllable and rhyme level, as presented in the review carried out by Rodrigues and Befi-Lopes (2009).

"The phonological processing of novel words draws on sublexical representations at all grain sizes and these representations are phonological, unstructured and insensitive to morphemehood" (SZEWCZYK *et al*., 2018).

Pseudowords repetition tests are commonly used to measure phonological short-term memory, which is the ability to temporarily store and manipulate speech sounds. Research has found that pseudowords repetition performance is influenced by various factors, including age and bilingualism.

With regards to age, studies have consistently shown that pseudowords repetition performance improves with age, at least until early adolescence. This is likely due to the development of phonological memory capacity and the ability to use phonological strategies to support memory. Older children and adults generally perform better on pseudowords repetition tasks than younger children, although individual differences in pseudowords repetition ability can still be seen even among adults. Gathercole *et al* (1994) found that performance on the CNRep improved with age, with children in the oldest age group (9-10 years) performing significantly better than children in the youngest age group (4-5 years).

Bellocchi *et al* (2019) revealed different patterns of predictors for reading accuracy, predictors for monolinguals being lexical knowledge, phonological awareness and lexical knowledge, while pseudoword repetition was a predictor for bilinguals. That is to say that reading accuracy was only associated with pseudo-word repetition in bilinguals. In contrast, it also involved lexical knowledge for monolinguals.

Similarly, Orsolini *et al* (2023) found that in monolingual individuals, there was a positive relationship between non-word repetition and both reading speed and accuracy. However, in bilingual individuals, this correlation was significant only with reading speed. Additionally, the working memory index showed a positive correlation with reading accuracy exclusively in monolinguals, whereas it was positively correlated with reading speed and reading comprehension in bilinguals. Regarding listening comprehension, it exhibited a positive correlation with immediate narrative memory in monolinguals, whereas in bilinguals, it showed a positive correlation with non-word repetition and reading speed.

However, it should be noted that the relationship between bilingualism and pseudowords repetition performance is complex and may depend on a range of factors, such as the age of second language acquisition, language proficiency, and the type of pseudowords repetition task used.

That being said, better results are expected from the control group once dyslexic individuals tend to demonstrate impaired memory of phonological work (COSTA, 2011). The current literature states that working memory, being a component of temporal processing or phonological, is part of the central difficulty found in developmental dyslexia (SILVA AND CRENITTE, 2014).

For the assessment of working memory, two of its components are analyzed: the central executive and the phonological circuit. To evaluate the phonological circuit, a task of repetition of pseudowords was applied (KESSLER, 1997). This test is composed of 30 words divided into 5 categories (one syllable, two syllables, three syllables, four syllables, five syllables and six syllables). The examiner says the words one by one, and the participant must repeat them, their voice is recorded. The examiner does not repeat the words.

Table 3 - Pseudowords repetition in Portuguese (KESSLER, 1997).

UMA SÍLABA	DUAS SÍLABAS
Bó	Dalu
Lum	Leca
Rau	Nusa
Pin	Bunfe
Fe	Queuci
TRÊS SÍLABAS	QUATRO SÍLABAS
Quentagi	Palifemo
Belsifi	Romutega
Tonasso	Pefisuni
Lanasi	Morinati
Gamalo	Jalopurti
CINCO SÍLABAS	SEIS SÍLABAS

Dojabefari	Femurituzoli
Ranocidomi	Alcabinteroca
Zalivemafu	Zobisbecofari
Gocipobilo	Gerobinfoquemi
Agucafire	Chedizatocaro

Table 3

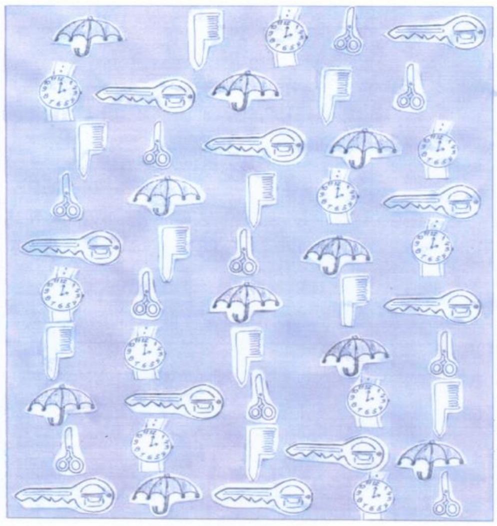
10.9 RAPID AUTOMATED NAMING

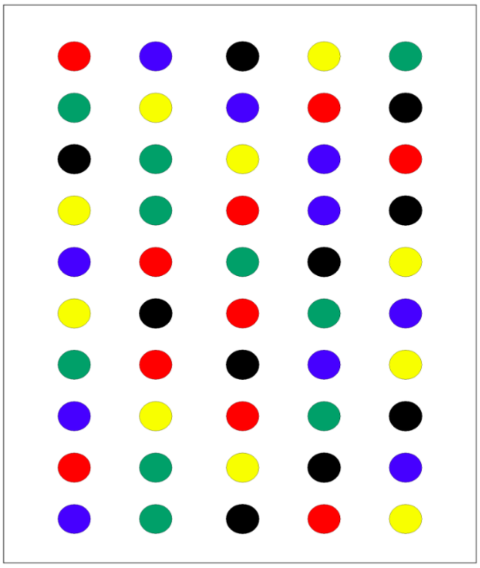
This test analyzes the child's lexical access ability enabling them to search for a word in their lexicon accurately and quickly, which is an essential skill for reading.

In this test, there are 4 subtests: naming objects, naming colors, naming numbers and naming letters. The subtests followed that exact order. This test analyzes the child's lexical access ability to search for a word in their lexicon accurately and quickly, which is an essential skill for reading. Participants were asked to name all the items in a paper following the reading order (left to right, up to bottom), the time they take to complete, and their oral performance is computed. They could name the objects both in English and Portuguese, no instruction was given in terms of which language to use.

It is important to mention that this test was not made for bilinguals, proficient bilinguals demonstrate slower lexical retrieval (SULLIVAN *et al*., 2018) once they have two options when naming an object. When a bilingual sees an image, the time considered involves the 2 inputs and the decision between them, hence, bilinguals take longer time to complete this task.

Image 8 - RAN test (DENCKLA, 1974 in CAPELLINI, 2007).





2	6	9	4	7
7	6	2	9	4
9	4	6	7	2
4	2	6	9	7
6	7	9	2	4
7	6	4	9	2
2	4	6	7	9
9	7	6	4	2
4	7	9	2	6
6	2	4	9	7

p	d	o	a	s
d	a	p	s	o
a	s	o	d	p
o	a	d	s	p
a	s	o	p	d
d	a	s	o	p
p	o	a	s	d
s	d	o	p	a
o	d	a	s	p
s	a	p	o	d

Image 8

As fast naming is part of phonological processing, it is expected that students with dyslexia have lower performance in the subtests of the RAN in relation to the control group, due to the occurrence of flaws in the phonological processing, determined genetically and neurologically (see table 4 with expectancies from the control group according to their grades). In the study from Capellini *et al* (2007), both students with ADHD and students with dyslexia showed impairment in rapid automatized naming; however, the students in the group with dyslexia performed worse than the group with ADHD. RAN and the double-deficit hypothesis are both related to reading difficulties, with RAN being one of the measures used to assess naming speed deficits, which is one of the two deficits proposed in the double-deficit hypothesis.

The literature (CAPPELLINI *et al.*, 2007) shows us that the speed of naming objects increased significantly throughout schooling from the second school year onwards. developed until the fourth year. The average color naming speed, measured in seconds, decreased significantly from year to year from the second to the fifth school year, evidencing the increase in the naming speed of this stimulus. The ability of automated naming of colors in the first year of elementary school is significantly correlated with that developed in the following years of schooling. The speed of number naming progressed significantly throughout schooling from year to year until fifth grade. The rapid automated naming of numbers in the first year of elementary school is significantly correlated with those developed in the following two years of schooling. Similar to automated number naming, letter naming speed became significantly faster throughout schooling up to the fifth grade. Automated letter naming skill in the first year is only significantly correlated with that developed in the second year (see table 4).

Table 4 - Correlation between the ability of rapid automated naming of objects, colors, numbers and letters in the first year and subsequent years of schooling.

			RAN – Objects			
	1st grade	2nd grade	3rd grade	4th grade	5th grade	6th grade
Average	71,44	67,50	55,42	49,27	45,40	41,09
Standard Deviation	23,47	15,35	8,55	7,88	8,27	6,82
			RAN - Colors			
Average	57,61	55,39	44,85	41,63	37,07	35,22
Standard Deviation	12,22	12,12	8,13	8,81	6,03	6,50
			RAN - Numbers			
Average	45,19	37,08	31,23	27,29	24,72	22,68
Standard Deviation	13,64	09,09	4,28	4,91	4,33	3,42
			RAN - Letters			
Average	41,42	35,28	28,83	24,10	22,16	20,55
Standard Deviation	12,67	08,09	5,03	3,89	3,78	3,73

Table 4

So as these results show, the relationship between age and performance on Rapid Automatized Naming (RAN) tasks is complex and depends on several factors, one of which is the type of stimuli used in the task. In summary, some studies have found that younger children perform better on RAN tasks that use pictures of familiar objects (e.g., animals, fruits) compared to abstract stimuli (e.g., letters, digits). In contrast, older children and adults may perform better on RAN tasks that use abstract stimuli, as they have had more experience with these types of stimuli (VAN DEN BOS, 2002).

Another factor that influences the relationship between age and RAN performance is the specific task demands. For example, some RAN tasks require participants to name a set of stimuli as quickly as possible, while others require participants to name the stimuli accurately, regardless of speed. These task demands can affect the relationship between age and RAN performance, as younger children may prioritize speed over accuracy, while older children and adults may prioritize accuracy over speed (VAN DEN BOS, 2002).

Overall, the relationship between age and RAN performance is complex, and depends on a variety of factors, such as the type of stimuli used in the task, the specific task demands, and individual differences in cognitive and neural processing. However, in general, RAN performance tends to improve with age, as children and adults gain more experience with the types of stimuli used in the task and develop more efficient neural processing mechanisms (CAPPELLINI, 2007).

Overall, we expect participants to vary in performance according to age, and perhaps experiencing some difficulty due to competition between possible candidates in two languages, with dyslexic participants showing more relative difficulties.

10.10 DICTATION

The construct that underlies this instrument is spelling precision/accuracy verified through the frequency of phoneme-grapheme converter errors. In this test, the participants must recognize the alphabetic writing system as a representation of speech sounds and identify phonemes and their representation by letters, relate sound elements (syllables, phonemes, parts of words) with their written representation. It is a tool to investigate how the grapheme-phoneme relationship is being implemented, the instrument aims to assess the accuracy of the participant's writing. The construct that underlies this instrument is spelling precision/accuracy and it is measured by the average number of errors.

For both languages, the words were divided into regular, irregular and pseudowords.

A regular word is a word that follows the established spelling and pronunciation rules of a language. In English, most words are regular, can be spelled, and pronounced according to established patterns. For example, the word "cat" is a regular word because it follows the pattern of the "CVC" (consonant-vowel-consonant) spelling rule, where a consonant is followed by a vowel, and then another consonant.

Regular words can also follow other established patterns or rules, such as the silent "e" rule, where the letter "e" is added to the end of a word to signal a long vowel sound, as in the word "cake". Regular words are often easier to read and spell because they follow predictable patterns (ex. bake, lake, make, etc.).

It is important to note that many words in English are irregular in terms of their spelling. Irregular words do not follow established patterns (or follow infrequent patterns) and must be memorized or learned individually.

Irregular words are words that do not follow the regular spelling rules of the language. They are words that are spelled differently from how they are pronounced, or vice versa. For example, the word "colonel" is pronounced as [kəɹnəl], and the word "receipt" may be pronounced as [rI'si:t]; that is, not all letters translate to an individual sound or they may map onto a different sound than expected; for example, the "o" in "cold" sounds like [oU], but the "o" in "color" may be pronounced as [Λ].Irregular words are real words with meanings that are commonly used in the language.

Pseudowords, on the other hand, are made-up words that do not have any meaning in the language. They are also known as nonsense words or pseudowords. Pseudowords are often used in linguistic and psychological experiments to test the ability of individuals to recognize and process unfamiliar words. For example, the pseudoword "glorb" does not have any meaning in English, but it can be used to test someone's ability to sound out and recognize unfamiliar words.

In summary, irregular words are real words with meanings that do not follow the regular spelling rules of the language, while pseudowords are made-up words that do not have any meaning in the language and are often used in experiments to test language processing abilities.

For Brazilian Portuguese, some examples of irregular words are "fiel" (faithful) in which the pronunciation of "el" in "fiel" is irregular, as it sounds like [ƐU] or [Ɛw] instead of [Ɛl], as in the word "elo" [ƐlU]. Another example is "hino", in which the first letter is not pronounced. Also, the word "fiz" (I did) in which the conjugation of the verb "fazer" (to do) in the past tense is irregular, where the "z" represents the [s] sound instead of the [z], whereas the letter "s" in "casar" souds like [z]. However, 'irregular' these patterns are, they are still much more predictable than in English. In BP, all alveolar fricatives at the end of a syllable or word sound like [s], whether they are written with a “z” or an “s”, and intervocalic alveolar fricatives tend to sound like [z], whether they are written with “s” or “z” (ex. “casar”, “azar”), and the “h” at the beginning of words is never pronounced.Some examples of regular words in BP are "amigo" (friend) in which the pronunciation and spelling of "amigo" follows regular Portuguese patterns, with the vowel "i" pronounced as [i] and "gato" (cat) in which the spelling and pronunciation of "gato" follow regular Portuguese patterns, with the "a" pronounced as [a] and the "o" as [u].

Dictation tests are commonly used to assess spelling skills, which are often impaired in individuals with dyslexia. Research has found that the relationship between dyslexia, age, and dictation tests is complex and may depend on a range of factors. With regards to age, studies have consistently shown that spelling skills generally improve with age, at least until early adolescence. This is likely due to the development of phonological and orthographic knowledge and the ability to use these skills to support spelling. Older children and adults generally perform better on dictation tests than younger children, although individual differences in spelling ability can still be seen even among adults (BERNINGER *et al.*, 2010).

With regards to dyslexia, studies have found that individuals with dyslexia often have poorer spelling skills compared to their non-dyslexic peers, even after controlling for age and other factors. Dyslexia is associated with difficulties in phonological processing, which can affect the ability to map sounds to letters and vice versa, leading to spelling errors.

However, it should be noted that the relationship between dyslexia, age, and dictation tests is not straightforward. For example, some studies have found that the spelling performance of individuals with dyslexia may improve more slowly with age compared to non-dyslexic peers. Other studies have suggested that individuals with dyslexia may have a developmental delay in orthographic knowledge, which can affect their spelling ability.

Overall, while age and dyslexia can influence dictation test performance, the exact nature of these relationships is still an area of ongoing research.

In both languages it is expected that the dyslexic group score worse than the control group. For the Brazilian Portuguese dictation test, there is a classification table with scores (see table 67 in appendix 5). It is expected that the control group is classified as high (answers correctly all the items). Aiming at comparison between languages, the focus is to compare scores for both languages.

10.10.1 DICTATION IN BRAZILIAN PORTUGUESE

The chosen test was "List of Psycholinguistic Items Components" (CAPOVILLA, 2000 – based on PINHEIRO, 1994). The 36 words that make up the writing test (dictation) were chosen based on their psycholinguistic characteristics of lexicality, frequency, regularity and length. For the evaluation of the dictation test, the average number of errors is computed.

Lexicality refers to the degree to which a word is recognized as a valid word in a particular language. A word that is considered lexical is a real word that is commonly used and recognized by speakers of the language. On the other hand, a non-lexical word, also known as a pseudowords, is a string of letters that does not form a valid word in the language but does not violate the phonological patterns in that language.

In linguistics, lexicality is an important concept because it is related to the processing of language. For example, when reading a sentence, the reader recognizes each word as either lexical or non-lexical. Lexical words are processed more quickly and accurately than non-lexical words, which can cause difficulty in tasks such as reading comprehension.

In addition, lexicality can also refer to the properties of words that make them easier or more difficult to recognize and process. For example, words that are more frequent in a language are typically more easily recognized and processed than less frequent words. Likewise, words with more consistent spelling and pronunciation are also easier to process than those with irregularities.

The words were divided into regular words (those that have a univocal relationship between phoneme and grapheme, ex: vila, porta, papai), rule words (regular, context-dependent, when it is necessary to apply orthographic context rules to obtain a univocal relationship between grapheme and phoneme, ex: casa, usam, porão) and irregular words (when the phoneme-grapheme relationship is irregular, that is, specific to a given word, ex: hino, açude, xerife).

Table 5 - List of Component Psycholinguistic Items (CAPOVILLA, 2000 – based on PINHEIRO, 1994).

	Regular		Rule		Irregular	
	2 syllables	3 syllables	2 syllables	3 syllables	2 syllables	3 syllables
High frequency words	duas	sílabas	casa	escreva	feliz	amanhã
	café	gostava	papel	galinha	cedo	criança
	folhas	palavras	disse	pássaro	texto	dezena
	chapéu	colegas	também	redação	muitas	extenso
Low frequency words	marca	olhava	vejam	empada	boxe	gemido
	seda	chegada	inglês	receita	órgão	xerife
	mostra	moeda	usam	marreca	ouça	tigela
	cabras	chupeta	nenhum	florido	certas	descida
Pseudo words	vesta	olhata	inha	tavinha	ezal	eçute
	dripas	coeta	pejam	tarrega	leço	friença
	jile	calafra	uram	jássaco	juzes	ciparro
	nosdra	vopegas	dampém	quiados	cerpas	pescita

Table 5

The participant received an A4 sheet already numbered, a pencil and an eraser. The examiner read the stimuli aloud word by word (and repeated it maximum 3 times, when necessary) and the participant had to write it on their sheet, one below the other. During the task, the examiner marked the time spent in the execution of the dictation, later the examiner corrected the participant's right and wrong answers to calculate the average of each participant.

For the evaluation of the dictation test, the average number of errors is computed. The result is by dividing the number of errors per the total quantity of words (36). This result corresponds to a total score that depends on the age bracket. For example, if an 8-year-old participant makes 6 mistakes out of 36, the resulting coefficient is 0, 167. In the Table presented in Appendix 5, we may look up the correspondent score, which is 65, out of a total of 122 for this age bracket. This would place this student at a very low classification (<70). The classification and scores are based on standardization tests with a large group of children (Cf. Tables in Appendix 5 reproduced from DIAS; CAPOVILA, 2013).

The sample used for standardization of the Dictation Test (reduced version) – PED-vr consisted of 406 children and adolescents aged between 6 and 11 years (M = 8.65; SD = 1.65), students from Elementary (1st to 6th grade) of municipal public schools, located in neighborhoods of medium and medium-low socioeconomic status of a city in the interior of São Paulo. There were no children in the sample with known uncorrected intellectual or sensory impairment (DIAS;CAPOVILLA, 2013).

In our study, it is expected that the control group is classified as high (answers correctly all the items), whereas dyslexic children fall into lower classifications.

10.10.2 DICTATION IN ENGLISH

An English dictation test was developed having as its target participants L2 English users from 7-13 years old, named "Dictation test for young English L2 learners". The words selected are more commonly frequent in L2 English classes as well as regular classes in their grades.

The dictation was composed of 70 words, 35 frequent words, 25 low frequency words and 10 pseudowords (made up words). The degree of frequency was measured by selecting words used in a school daily basis that the participants are most likely to hear or say every day. The participant received an A4 sheet already numbered, a pencil and an eraser. The examiner read the stimuli aloud word by word (and repeated it maximum 3 times, when necessary) and the participant had to write it on their sheet, one below the other. The participant needed to correctly write the words they heard. The words were pronounced one at a time, starting with the frequent words, then the infrequent ones, and then the pseudowords.

In terms of analysis, two different types were developed. The first was a quantitative analysis (similar to Capovilla's analysis, based on error frequency but without age correction) and the second qualitative. In the first analysis, any type of error is considered and converted to a score by means of calculating average error frequency and looking up the corresponding score for the specific age bracket; whilst in the second, qualitative, analysis, correctly spelled words received 1 point, those that were not spelled correctly but made phonological sense received 0.5 points, and misspelled words that did not make phonological sense (a possible grapheme-phoneme mapping that exists in English) received 0 points.

For instance, in the quantitative analysis, the word "connection" written as "conexion" would receive 0 points, whereas "connection" would receive 1 point. In the qualitative analysis, "connection" would receive 1 point, "conexion" would receive half of a point (0,5), once it makes sense phonologically speaking, and "conession" would receive 0 points once it doesn't make sense phonologically speaking. For this analysis, points were simply added up to a total, without calculating an average or correcting for age.

Table 6 - List of words "Dictation test for young English L2 learners".

High frequency words	body	person	drink	color	special
	idea	human	important	children	believe
	emotion	example	car	competition	connection
	room	seven	fall	long	keep
	music	dance	book	bag	cinema
	maybe	people	class	favorite	friends
	excited	first	everything	school	pencil
Low frequency words	Gym	knife	glass	wrong	thumb
	offensive	doubt	wallet	job	hold

	binocular	hast	gall	institution	medicine
	investigation	law	flute	personality	trailer
	mistake	original	mirror	tool	sensible
Made up words	fley* [‘fleI]	kek* [‘kɛk]	caboot [ka’but]	gib* [‘gɪb]	mentee* [mən’ti]
	bloatware [‘bloʊtwɛɹ]	jointery [‘ʤɔɪntəri]	peg* [‘pɛg]	drom [‘drom]	laper [‘leɪpəɹ]

Table 6

*: those are possible words[5], but they are so infrequent for this target group (even more so when they are out of context) that they can be considered pseudowords.

10.11 READING WORDS AND PSEUDOWORDS ALOUD

According to Shaywitz (2006), the ability to read nonsense words (pseudowords) is the best measure of phonological decoding in children. Reading tests generally refer to this ability as “word processing,” that is, the way in which the reader analyzes and produces words. “[...] the child has to really penetrate the sound structure of the word and pronounce it, phoneme by phoneme – there is no other way”. Most children reach their full capacity to utter nonsense words in adolescence (SHAYWITZ, 2006, p. 110).

This instrument assesses accuracy and fluency in oral reading of isolated words and pseudowords, which vary in their psycholinguistic characteristics of regularity, lexicality, length and frequency (frequent and infrequent). Therefore, it is expected that the dyslexic group score worse than the control group.

For analysis, participants' production is recorded so the pronunciation can be analyzed, attributing 1 point to correctly pronounced words and 0 to mispronounced words. Also, the time used for each word was computed by Psychopy 2nd version

[5] gib: a plate of metal or other material machined to hold other parts in place, to afford a bearing surface, or to provide means for overcoming looseness.
peg: a small usually cylindrical pointed or tapered piece (as of wood) used to pin down or fasten things or to fit into or close holes.
keck: to make the sounds of retching.
fley: fleyed; fleying; fleys - transitive verb.
mentee: one who is being mentored.
Retrieved from www.merriam-webster.com

(PEIRCE *et al*., 2019) software. It is expected to obtain greater scores from the control group and for the older participants for both languages.

It is expected that dyslexics face difficulties with pseudowords for both languages once pseudowords force them to use the phonological route. Also, better results from the control group are expected as well as better results in English for both groups.

10.11.1 READING WORDS AND PSEUDOWORDS ALOUD IN BRAZILIAN PORTUGUESE

To assess reading in Brazilian Portuguese (BP), the instrument created by Rodrigues *et al*. (2015), aimed at proficient readers in BP (children already literate, around 10 years old) was used. The task of reading words and pseudowords consists of 72 stimuli, 48 of which were selected according to criteria of concreteness, extension, frequency and regularity, and 24 pseudowords, created by the authors from real words, with letters and/or or inverted, substituted or omitted syllables, maintaining combinations that do not exist in the lexicon but that have the structure of words used in BP, categorized by length and regularity.

Some words were excluded for pairing variables with English (like cognates, false cognates, see table 7) and, after adapting the test, the final test consisted of reading aloud 63 words, of which 20 frequent words, 18 infrequent words and 25 pseudowords (invented words). In terms of length, half (31) were short (2 syllables long) and 32 were long (3 or more syllables long). The test was performed on a computer using Psychopy 2nd version (PEIRCE *et al*., 2019) software for the presentation and recording of response time. When a word appeared on the screen, the participant needed to read it aloud and press the spacebar to go to the next word. The words were shown in random order.

The words that made up the test were:

Table 7 - Reading aloud words and pseudowords in BP (RODRIGUES *et al*., 2015).

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**

Frequent Words	DINHEIRO	FILHO	ESCOLA	TERRA
	FAMÍLIA*	CARTA	EXÉRCITO	DROGA
	CRIANÇA	LEITE	TRANSPORTE*	SEXO
	CIDADE	CAMA*	CADERNO	FESTA
	FUTEBOL	REDE	JANELA	JOVEM
	COMIDA	MEIA	AMARELO	ROSA*
Infrequent Words	MACHUCADO	BARBA	ACEROLA	GOLA
	TABACO	GRADE*	CHINELO	TOSSE
	FERMENTO	LESMA	SAXOFONE*	SELVA
	CORRENTEZA	JAULA	TAXÍMETRO	GOSMA
	FELINO	CÁRIE	FARELO	TERNO
	PICADA*	GARRA	INSETO	TORTA*
Pseudowords	DIVAIRO	TILHU	MARALO	LAJAU
	ETIXERO	VARTE	CHONILE	SENJO
	TASBOPE	TEILE	FOSAXONE	GADRA
	CAVERMO	BAFAU	ZARRONTE	MOXE
	JENALA	ZAREO	TOMENFO	NURTO
	ROROLA	TISSO	BOLEFU	MESLA

Table 7

*= words excluded for pairing variables with English

Table 8 - Words excluded for pairing variables with English (SIQUEIRA, 2018).

Stimuli BP		
Word	**Cognate**	**SSI***
grade**	grade***	1
saxofone**	saxophone	0,834
rede	red***	0,819
transporte**	transport	0,805
tabaco	tobacco	0,79
fermento	ferment	0,785
carta	cart	0,751
barba	barb	0,751
terno	tern***	0,751
torta**	tort***	0,751
cama**	came***	0,738
familia**	family	0,731
sexo	sex	0,727
felino	feline	0,725
rosa**	rose	0,662
inseto	insect	0,643
futebol	football	0,504
droga	drug	0,5
escola	school	0,266

Table 8

*SSI = Spelling Similarity Index, being cognate words with ISO > 0.60.

**Words excluded from the BP instrument after statistical analysis for comparison between the language similarity.

***False cognate

Table 9 - Characteristics of the Portuguese reading task stimuli (RODRIGUES et al., 2015).

Words							
Item	**Letters**	**Syllable**	**Phoneme**	**Ort_Neigh**	**Freq.**	**Concr.**	**Imag.**
Acerola	7	4	7	0	66	681	569
Amarelo	7	4	7	3	1034	523	554
Barba	5	2	5	8	297	640	669
Caderno	7	3	7	1	7622	675	700
Cama	4	2	4	43	1197	684	700

Cárie	5	2	5	1	66	586	515
Carta	5	2	5	24	3590	619	685
Chinelo	7	3	6	1	70	649	692
Cidade	6	3	6	4	20492	615	600
Comida	6	3	6	6	1798	596	569
Correnteza	10	4	9	0	47	583	462
Criança	7	3	7	0	3710	657	631
Dinheiro	8	3	7	2	27555	599	631
Droga	5	2	5	2	1512	490	469
Escola	6	3	6	9	7193	596	631
Exército	8	4	8	1	4883	578	585
Familia	7	3	7	3	8287	476	531
Farelo	6	3	6	2	75	559	454
Felino	6	3	6	4	16	476	577
Fermento	8	3	8	2	67	605	438
Festa	5	2	5	17	5146	465	615
Filho	5	2	4	6	11275	621	446
Futebol	7	3	6	1	16887	559	600
Garra	5	2	4	18	261	525	477
Gola	4	2	4	34	62	639	638
Gosma	5	2	5	2	7	523	469
Grade	5	2	5	11	211	628	638
Inseto	6	3	6	2	118	578	562
Janela	6	3	6	4	1034	648	692
Jaula	5	2	5	1	53	650	631
Jovem	5	2	5	2	2977	487	531
Leite	5	2	5	6	4159	663	662
Lesma	5	2	5	2	25	661	631
Machucado	9	4	8	1	234	511	469
Meia	4	2	4	33	5829	618	654
Picada	6	3	6	12	63	530	392
Rede	4	2	4	18	7204	572	646

Rosa	4	2	4	34	2181	590	685
Saxofone	8	4	9	0	58	476	654
Selva	5	2	5	9	331	560	585
Sexo	4	2	5	17	2355	477	531
Tabaco	6	3	6	0	194	525	423
Taxímetro	9	4	10	0	11	473	500
Terno	5	2	5	16	334	476	662
Terra	5	2	4	21	6001	594	600
Torta	5	2	5	19	163	615	685
Tosse	4	2	3	3	100	535	454
Transporte	10	3	10	2	2335	501	477
Pseudowords							
Item	**Letters**	**Syllable**	**Phoneme**	**Ort_Neigh**	**Freq.**	**Concr.**	**Imag.**
Tilhu	5	2	4	-	-	-	-
Varte	5	2	5	-	-	-	-
Teile	5	2	5	-	-	-	-
Bafau	5	2	5	-	-	-	-
Zareo	5	2	5	-	-	-	-
Tisso	5	2	4	-	-	-	-
Lajau	5	2	5	-	-	-	-
Senjo	5	2	5	-	-	-	-
Gadra	5	2	5	-	-	-	-
Moxe	4	2	5	-	-	-	-
Nurto	5	2	5	-	-	-	-
Mesla	5	2	5	-	-	-	-
Divairo	7	3	7	-	-	-	-
Etixero	7	4	7	-	-	-	-
Taspobe	7	3	7	-	-	-	-
Cavermo	7	3	7	-	-	-	-
Jenala	6	3	6	-	-	-	-
Rorola	6	3	6	-	-	-	-
Maralo	6	3	6	-	-	-	-

Chonile	7	3	6	-	-	-	-
Fosaxone	8	4	8	-	-	-	-
Zarronte	8	3	7	-	-	-	-
Tomenfo	7	3	7	-	-	-	-
Bolefu	6	3	6	-	-	-	-

Table 9

10.11.2 READING WORDS AND PSEUDOWORDS ALOUD IN ENGLISH

To assess reading in English (EN), the instrument created by Siqueira (2018), aimed at native speakers of BP having English as their L2 (bilinguals whose mother tongue is BP, and the learning of additional language English is successive, with distinct levels of proficiency), was used.

This test consists of reading 64 words aloud, of which 20 frequent words, 20 infrequent words and 24 pseudowords (invented words). In terms of length, half (31) were short (2 syllables long), 33 were long (3 or more syllables long). The test was performed on the computer using Psychopy 2nd version (PEIRCE *et al*., 2019) software for the presentation and recording of response time. When a word appears on the screen, the participant needs to read it aloud and press the spacebar to go to the next word. The words were shown in random order. The participant needed to press the spacebar and correctly read the words that appear on the screen aloud.

Table 10 - Reading aloud words and pseudowords in EN (SIQUEIRA, 2018).

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT*	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECRETARY*	FIRE	PICTURE	HOUSE
	UNIVERSITY*	HEAD	CHILDREN	PAPER*

	OFFICER	BILL	AUDIENCE*	RIVER
Infrequent Words	BEVERAGE	SEAM	PINEAPPLE	LUNG
	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILE	ALLIGATOR*	NOOSE
	OVERCOAT	BARK*	BUTTERFLY	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW
Pseudowords	BUNDING	FORN	LANKERS	DESS
	GOUNDED	GOOT	MOLDEST	FRUG
	SLATTER	CATES	DEVERAGE	MACT
	COUNDING	SEANS	GISCOUNT	AMUDE
	MITTERS	DAKE	MENERATION	SMILL
	HENDING	PANK	SALICIOUS	TUZZLE

Table 10

*= words excluded for being cognates with Portuguese

Table 11 - Words excluded for pairing variables with English (SIQUEIRA, 2018).

Stimuli BP		
Word	**Cognate**	**SSI***
alligator	aligator	0,964
paper	papel	0,732
secretary	secretaria	0,731
audience	audiencia	0,718
government	governo	0,651
university	universidade	0,634
bark	barco***	0,599
officer	oficial	0,569
lung	longo***	0,488
property	propriedade	0,453
student	estudante	0,36

Table 11

*SSI = Spelling Similarity Index, being cognate words with ISO > 0.60.

**Words excluded from the BP instrument after statistical analysis for comparison between the language similarity.

***False cognate

Table 12 - Characteristics of the English reading task stimuli (SIQUEIRA, 2018).

Words							
Item	**Letters**	**Syllable**	**Phoneme**	**Ort_Neigh**	**Freq.**	**Concr.**	**Imag.**
alligator	9	4	7	0	4	624	627
audience	8	2	6	0	115	515	555
bark	4	1	4	14	14	563	539
basin	5	2	4	3	7	602	542
beverage	8	3	7	1	5	526	565
bill	4	1	3	16	143	528	535
book	4	1	3	13	193	609	591
butterfly	9	3	7	0	2	593	624
children	8	2	7	0	355	582	597
city	4	2	4	2	393	554	605
fire	4	1	3	13	187	595	634
furniture	9	3	6	0	39	583	588
gentleman	9	3	8	1	28	516	559
goat	4	1	3	7	6	636	585
government	10	3	8	0	417	426	594
head	4	1	3	13	424	603	593
house	5	1	3	5	591	608	606
hurricane	9	3	7	0	8	576	608
husband	7	2	7	0	131	549	537
land	4	1	4	11	217	604	566
lung	4	1	3	5	16	569	576
morning	7	2	6	1	211	515	579
noose	5	1	3	5	3	542	593
officer	7	3	5	1	101	550	593

overcoat	8	3	6	0	5	611	552
paper	5	2	4	4	157	599	590
picture	7	2	5	0	162	579	581
pile	4	1	3	14	25	504	513
pineapple	9	3	6	0	9	653	569
property	8	3	7	1	156	460	531
raspberry	9	3	7	0	1	594	513
river	5	2	4	7	165	585	633
road	4	1	3	6	197	583	609
seam	4	1	3	13	9	538	555
secretary	9	4	9	0	191	576	563
straw	5	1	4	3	15	603	568
tack	4	1	3	15	4	565	546
umbrella	8	3	7	0	8	606	592
university	10	5	10	0	214	533	615
wall	4	1	3	13	160	589	576
wind	4	1	4	12	63	552	535
Pseudowords							
Item	**Letters**	**Syllable**	**Phoneme**	**Ort_Neigh**	**Freq.**	**Concr.**	**Imag.**
amude	5	-	-	2	-	-	
bunding	7	-	-	7	-	-	-
cates	5	-	-	16	-	-	-
counding	8	-	-	7	-	-	-
dake	4	-	-	19	-	-	-
dake	4	-	-	19	-	-	-
dess	4	-	-	5	-	-	-
deverage	8	-	-	2	-	-	-
forn	4	-	-	13	-	-	-
frug	4	-	-	2	-	-	-
giscount	8	-	-	3	-	-	-
goot	4	-	-	13	-	-	-
gounded	7	-	-	7	-	-	-

hending	7	-	-	10	-	-	-
lankers	7	-	-	2	-	-	-
mact	4	-	-	9	-	-	-
meneration	10	-	-	2	-	-	-
mitters	7	-	-	9	-	-	-
moldest	7	-	-	2	-	-	-
pank	4	-	-	16	-	-	-
salicious	9	-	-	2	-	-	-
seans	5	-	-	13	-	-	-
slatter	7	-	-	8	-	-	-
smill	5	-	-	8	-	-	-
tuzzle	6	-	-	4	-	-	-

Table 12

10.12 READING SPEED OF SENTENCES

This test was designed to check participants' Reading Speed of Sentences in the target language. The test is carried out on the computer through Psychopy 2nd version (PEIRCE *et al.*, 2019) software for the presentation and recording of response time and introduces the participant to the narrative to help an alien that fell on planet Earth to understand how things work. The test consists of judging 40 sentences, judging them true or false by clicking on the green button for true sentences and red button for false sentences. For example, the sentence is "I use an eraser to write" and participants classify this information as true or false.

Sentences varied from short (up to 4 words), 5 to 6 words to medium and long (more than 6 words). The sentences were shown in random order. In this test, it is possible to check the Reading Speed of Sentences of simple sentences by reaction time, and its understanding by the accuracy of the true x false judgment. Participants had to attribute truth value to the sentences. The sentences were created aiming to refer to concrete knowledge and/or well-known information (i.e., "the sun is yellow", "we use the nose to smell"). There is room for interpretation in sentences that will be addressed later (i.e., the sentence "my heart is red", one could mark this sentence as false arguing that their heart is pink).

The test starts with the alien character (named Xic) orally explaining his situation and purpose of the task to the participant (see image 9 for BP test and image 10 for EN test) once participants' reading is not being assessed at this moment (the alien's voice was done by computer recording). The alien character asks for the participants' full concentration because he really wants to learn about our planet Earth.

Image 9 - First two screens of the BP Reading Speed of Sentences test - task explanation.

Image 9

Image 10 - First two screens of the EN Reading Speed of Sentences test - task explanation.

Image 10

Then, after that, participants practice seeing if they understood the task by reading one sentence and judging it true or false. When participants finish answering this first sentence, the alien character informs them that the real task will begin. (See image 11 for BP test and image 12 for EN test).

Image 11 - Practice set BP Reading Speed of Sentences test.

Image 11

Image 12 - Practice set EN Reading Speed of Sentences test.

Image 12

Finally, participants start the test, judging 30 sentences true or false one after the other.

Image 13 - First sentences for BP Reading Speed of Sentences test and EN Reading Speed of Sentences test.

Image 13

Better results are expected from the control group, with faster reading, quicker response times and reaction times decreasing with age, as well as a slower reading of long sentences and faster reading of short sentences.

10.12.1 STIMULI IN BRAZILIAN PORTUGUESE

I opted for phrases on subjects considered common for children, as well as words that children usually have contact with in school/children's books. I gave preference to short and medium sentences, as well as more objective sentences. The word count considered articles as words.

In this sense, there were 12 short sentences (up to 4 words), 15 medium sentences (5 to 6 words) and 3 long sentences (more than 6 words). Of all sentences, 16 were true and 14 were false. There is room for interpretation in sentences that will be addressed later (i.e., the sentence "my heart is red", one could mark this sentence as false arguing that their heart is pink).

Table 13 - List of sentences for the Reading Speed of Sentences Test BP

EU USO AS MÃOS PARA TOCAR.	A BICICLETA VOA NOS ARES.
EU USO OS PÉS PARA OLHAR.	BRANCO É UMA COR ESCURA.

EU MASTIGO COM A BOCA.	MATEMÁTICA É A MATÉRIA DAS LETRAS.
EU OUÇO COM OS DENTES.	OS DINOSSAUROS SÃO GRANDES.
É POSSÍVEL BEBER AR.	EU MORO NO RIO DE JANEIRO.
UM TELEFONE É USADO PARA FAZER LIGAÇÕES.	O FUTEBOL É UM ESPORTE JOGADO SEM BOLA.
O GATO MIA.	O CORAÇÃO É VERMELHO.
O CACHORRO LATE.	ÁGUA MATA SEDE.
O GATO ROSNA.	O PERFUME É PARA FICAR FEDIDO.
UM PASSARINHO SABE VOAR.	O COELHO PULA.
A COBRA SABE VOAR.	O SAPO PULA.
EU VARRO A CASA COM A VASSOURA.	AS ÁRVORES FICAM NO CÉU.
AS NUVENS FICAM NO MAR.	EU LAVO O CORPO COM SABÃO.
EU USO O LÁPIS PARA ESCREVER.	PEIXES NÃO SABEM NADAR.
UMA GARRAFA PODE CONTER ÁGUA.	NA PRAIA NÃO TEM AREIA.

Table 13

10.12.2 STIMULI IN ENGLISH

I've decided to choose phrases from topics considered common for children, as well as words that children usually have contact with in school/children's English books, videos and games. I've also decided to use English words already used in Brazilian Portuguese. I gave preference to short and medium sentences. The word count considered articles as words.

In this sense, there were 11 short sentences (up to 4 words), 16 medium sentences (5 to 6 words) and 3 long sentences (more than 6 words). Of all sentences, 16 were true and 14 were false. There is room for interpretation in sentences that will be addressed later (i.e., the sentence "my heart is red", one could mark this sentence as false arguing that their heart is pink). Also, the sentences "I am a girl" and "I am a boy" could be true or false depending on the participant's gender.

Table 14 - List of sentences for the Reading Speed of Sentences Test EN

I AM A BOY.	THE AIRPLANE CAN NOT FLY.
I AM A GIRL.	BIRDS CAN'T FLY.
I CAN FLY.	I TAKE A SHOWER IN THE BATHROOM.
I CAN PLAY GAMES ON MY PHONE.	FLOWERS CAN BE COLORFUL.
PEOPLE DANCE ON TIK TOK.	I SMILE WITH MY MOUTH.
I LEARN WITH MY TEACHERS.	THERE ISN'T MONEY IN THE BANK.
I LEARN AT SCHOOL.	I DON'T WATCH MOVIES IN THE CINEMA.
THE DOG IS A PERSON.	SHARKS SWIM.
CATS ARE ANIMALS.	THE TURTLE WALKS VERY FAST.
PINK IS NOT A COLOR.	I USE A PEN TO WRITE.
WATER IS NOT A LIQUID.	WE WEAR SOCKS IN OUR NOSES.
I CAN JUMP.	AN ELEPHANT FITS IN MY BACKPACK.
I AM HUMAN.	THE SUN IS PURPLE.
ALICE IS A GIRL'S NAME.	THE OCEAN IS YELLOW.
I SEE WITH MY EARS.	RABBITS LIKE TO EAT CARROTS.

Table 14

11 RESULTS

In this section, I will address the results of each test/assessment. The results descriptions start with anamnesis, IQ, Experience and Linguistic Questionnaire, Language Proficiency, Digit Span in Brazilian Portuguese, Repetition of Pseudowords in Brazilian Portuguese, Rapid Automatized Naming in Brazilian Portuguese, Dictation in Brazilian Portuguese, Dictation in English, Reading Words and Pseudowords Aloud in Brazilian Portuguese, Reading Words and Pseudowords Aloud in English, Reading Speed of Sentences in Brazilian Portuguese and Reading Speed of Sentences in English.

11.1 ANAMNESIS

Participant D1[6] entered the school of this study in October 2020, before that, this participant used to study in another international/bilingual school which he entered at the age of 3. During the anamnesis, his mother reported that she opted for the bilingual school, as she studied at a more traditional school as a child and considered the methodology to be very content-oriented. Therefore, she was looking for a methodology for her son that did not focus only on content, and she also wanted to introduce English, considering that when she finished school proficiency in English was required of her and she didn't have it. At home, D1 prefers Portuguese. D1 has a learning support assistant at school and has been doing speech therapy twice a week since July 2022, which was when he was diagnosed with dyslexia (working in English and Portuguese with the same therapist). According to his mother's report, D1 has reading difficulties, attention deficit, impulsiveness, is easily distracted and exhibits agitated behavior, he is unable to sit down to study and eat if he is not medicated. In writing, D1 swaps letters and tries to guess the end of the word. He prefers to read books with few words. The mother reports that the child works well with positive reinforcement, and that he has never repeated in school. Also, D1 spends around 8 hours at school and shows ease with mathematics. At the age of 4, he was diagnosed with ADHD and has been taking Ritalin ever since. This participant was almost 9 years old at the time of this study. D's parents reported that D1 is a very insecure boy. D1 also receives language support at school.

Participant C1 is the control of D1. This participant started bilingual school at the age of 3 (close to turning 4). The preference for the bilingual school is due to the experience of his own mother, who lived in the USA for 9 years and is literate in English. His mom arrived in Brazil at the age of 9 and reported that her childhood experience brought benefits later on, facilitating her entry and continued employment in the job market. Having studied in a Montessorian school, it was her ideal for her son to study in an international Montessorian school, aiming at his future and opportunities. His father has also had experiences outside Brazil. At home, the child listens to a lot of content in English (such as music and movies), however, they talk more in Portuguese. The mother

[6] In order to help out the reader, we repeat participant codes: D1 - 3rd grade - dyslexia and ADHD; C1 - 3rd grade, control; D2 - 4th grade - dyslexia and ADHD; C2 - 4th grade, control; D3 - 5th grade - dyslexia and ADHD; C3 - 5th grade, control.

reported that Portuguese prevails, however, English has a lot of influence. According to the family's report in the anamnesis, C1 does not present any issues related to learning. The child spends around 8 hours a day at school. This participant was 9 years old at the time of this study.

Participant D2 started bilingual school at the age of 6, with this preference on the part of the family due to the desire that he could learn English from an early age. At home, according to the family's report, the mother, whose L1 is Portuguese, usually plays in English with the child; however, D2 is resistant to speaking English at home. The choice of school was made by the mother. D2, after leaving preschool at another school, went straight to the bilingual school. The child has had a learning support assistant twice a week and tutoring once a week since 2021. According to the mother's report, D2 has difficulties in reading, difficulties in concentrating, occasionally mixes up sentence structures, changing the order of words; however, positive advances have been observed in these aspects. D2 currently does speech therapy once a week (since 2021) – now with the confirmed diagnosis of dyslexia that was previously a hypothesis. D2 also has psychological support once a week (since 2021). The child spends 8 hours a day at school and shows greater ease in mathematics. He uses medication for ADHD, and according to the family's report, he has shown significant improvement since he started using it. This participant was almost 10 years old at the time of this study.

Participant C2 is the control of D2. This participant started bilingual school as soon as he turned 5 years old. The preference for this school is due to the fact that the mother is a school employee. At home, preference is given to Portuguese. Previously, C2 had only attended a traditional Brazilian school, however, there C2 had few English classes. His mother explained that the child had never repeated a grade, however, when he entered the current school, he had to go back 6 months – entering preschool. His mother reported that today she would have preferred to put him in a class above, as she did not know that the child would learn English so quickly. According to the family's report in the anamnesis, C2 does not have any issues related to learning. The child spends 8 hours a day at school. This participant was 10 years old at the time of this study. C2 was classified with high abilities according to the IQ test (see section 11.2), and after talking to the school and the parents, the suspicion is that his high ability is with language, the participant reads a lot, multiple comic strips and books per day.

Participant D3 entered a different bilingual school at the age of 2 years and 11 months, with this preference on the part of the family due to the teaching structure

(Montessorian school) and the proximity to home. At home, preference is given to Portuguese. D3 used to study in a non-international school before the current international one. For this reason, D3 has daily support in the classroom. The child was diagnosed with dyslexia at the age of 7. According to the family's report, his greatest difficulties are fine motor coordination (in writing) and reading (D3 often gets lost while reading). Currently, D3 no longer attends speech therapy, but he did so for 3 years, during the period he was in preschool. The child spends 8 hours a day at school. D3 is also diagnosed with ADHD. This participant was 11 years old at the time of this study.

Participant C3 is the control of D3. This participant entered the bilingual school at the age of 4, in preschool. The preference for the school was due to the fact that the father is a school employee. At home, preference is given to Portuguese. Previously, C3 had only been in daycare (not bilingual). His mother explained that when he entered the current school, he could go straight to kindergarten (a class above his age bracket), but the family chose to leave him in preschool so that the child could adapt better. According to the family's report in the anamnesis, C3 does not present any issues related to learning. The child spends 8 hours a day at school. This participant was 11 years old at the time of this study.

In Table 15, there is a synthesis of the most relevant information to facilitate comparison between participant profiles. All participants are boys and have been diagnosed with ADHD as well as dyslexia. We can see that the differences in age between participants in the experimental group are 16 (between D1 and D2) and 17 months (between D2 and D3), and that the matched control participants tend to be a little bit older: differences are 9 months (D1 and C1) , 8 months (D2 and C2) , and 2 months (D3-C3). We see that the age they entered into contact with English in a school setting varies from 2 years and 11 months (D3) to 6 years (D2). Participants C1, D3 and C3 have spent the longest time at the bilingual school (approx. 6, 8 and 7 years), compared to D1, D2 and C2 (approx. 3,5 to 5 years). All dyslexic participants received the original diagnosis around the same time, between 6 and 7 years of age, and have spent at least 26 months at speech therapy. Of the three, D1 seems to have spent the most time (longer and more frequently) doing speech therapy, for 38 months. This participant also receives most learning support outside of school (3 times a week, compared to once a week for D2, and none for D3), although all participants have daily learning support at school.

Table 15 - Synthesis of the most relevant participants' information in anamnesis

Participant	D1	C1	D2	C2	D3	C3
Current age (Y-years, M-months)	8y 4m	9y 1m	9y 8m	10y 4m	11y 1m	11y 3m
Age entering school/daycare	3y	5m	5y	4y	2y	2y
Age entering 1st bilingual school	3y	3y 10m	6y	5y	2y 11m	4y
Age entering current bilingual school	5y	3y 10m	6y	5y	2y 11m	4y
Age of Dyslexia diagnosis	6y	-	6y	-	7y	-
Length (months) and frequency of Speech Therapy	38 months 2x a week	-	26 months 1x a week	-	26 months 2x a week	-
Additional issues	ADHD	-	ADHD	-	ADHD	-
Frequency of Learning Support at school	daily	-	daily	-	daily	-
Frequency of Learning Support out of school	3x a week	-	1x a week	-	-	-

Table 15

11.2 IQ

For this test, dyslexics are expected to have a lower verbal IQ and to have a better execution IQ (QIE) when compared to the verbal IQ (QIV) based on the findings of Arduini *et al*. (2006), D'Angiulli; Siegel (2003), even though there is not a direct relation between ADHD and IQ (JEPSEN *et al*, 2008; FLETCHER, 2019). Also, according to the same scholars, the total IQ measure (QIT-4) does not identify dyslexia. However, it is important to have an IQ measure when it comes to neurolinguistics once it is a measure of control.

The WASI subtests have distinct functions with regard to the assessed cognitive domains. In relation to performance, in the Vocabulary subtest, D1 obtained a T-score (total score) of 37 in this measure that consists of a task that generically assesses language development, which implies semantic knowledge. In the Cubes subtest, D1 presented a T-score of 39 in this task that evaluates the expression of visuospatial and visoconstrictive skills. This score reflects both accuracy and task completion time. In the Similarities subtest, D1 obtained a T score of 50. This measure assesses verbal concept formation, abstract verbal reasoning, and general intellectual ability.

According to Wechsler (2011), verbal concept formation refers to an individual's ability to understand and use abstract language to form concepts or mental representations of objects, ideas, or events. This ability involves the use of language to categorize and classify information and to recognize and differentiate between different characteristics or features of objects or ideas. Verbal concept formation is an important cognitive skill that is closely related to language development, problem-solving, and critical thinking. It is essential for academic success, as it is required for understanding complex concepts in subjects such as math, science, and social studies.

Individuals with strong verbal concept formation skills are able to think abstractly, understand complex ideas, and make connections between different pieces of information. They are also able to communicate effectively and clearly using abstract language and are often able to express themselves in creative and imaginative ways. On the other hand, individuals with weak verbal concept formation skills may struggle to understand abstract language, have difficulty with problem-solving and critical thinking, and may have difficulty with academic subjects that require abstract thinking and language skills.

Regarding the Matrix Reasoning subtest, D1 obtained a T score of 50 in this fluid reasoning task and general intellectual ability. Regarding the WASI Verbal IQ, which is a measure of acquired knowledge, verbal reasoning and attention to verbal information, D1 obtained a score of 89 (with a 95% confidence interval between 82 and 98), classified as Lower Middle. As for the Execution IQ, which is a measure of fluid reasoning, spatial processing, attention to detail and visual-motor integration, D1 demonstrated a score of 92 (with a confidence interval of 95% between 85 and 100), performance rated as Medium. Finally, taking all scores of all tasks into account, D1 had a Total-4 IQ of 88 (with a 95% confidence interval between 82 and 95), which corresponds to a Lower Medium performance rating. According to the percentile in Table 16, D1’s score in QIV is higher than 23% of children in this age group (i.e. on average 23% of children tested get similar or lower scores than D1 got), his score was above 30% of his age group in QIE and above 21% in QIT-4. In the same table, the confidence interval means that if

D1 takes this IQ test again, his score will most likely be between those numbers. Also, if he took WISC-IV or WAIS-III, his score would likely be between those numbers.

Table 16 - D1's performance in WASI IQ test and standard scores according to his age

	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	87	89	23%	82-98				
Execution (QIE)	89	92	30%	85-100				
Total Scale-4 (QIT-4)	176	88	21%	82-95	87-89	87-89	85-91	86-90

Table 16

In comparison, in relation to performance in the Vocabulary subtest, C1 obtained a T-score of 66. In the Cubes subtest, C1 presented a T-score of 73. In the Similarities subtest, C1 obtained a T-score of 69. Regarding the Matrix Reasoning subtest, C1 obtained a T-score of 59. Regarding the WASI Verbal IQ, C1 obtained a score of 131 (with a 95% confidence interval between 120 and 136), classified as Upper Superior. As for the Execution IQ, which is a measure of fluid reasoning, spatial processing, attention to detail and visuomotor integration, C1 demonstrated a score of 127 (with a 95% confidence interval between 117 and 132), performance classified as Superior. Finally, C1 had a Total-4 IQ of 132 (with a 95% confidence interval between 123 and 137), which corresponds to an Upper Superior performance rating. Therefore, C1 was classified as an individual with high abilities and giftedness. According to the percentile in Table 17, C'1's score is above 98% of the children in his age group in QIV, above 96% in QIE and above 98% in QIT-4. In the same table, the confidence interval means that if C1 were to take this IQ test again, his score would be between those numbers. Also, if he were to take WISC-IV or WAIS-III, his score would be between those numbers.

Table 17 - C1's performance in WASI IQ test and standard scores according to his age

	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	135	131	98%	120-136				
Execution (QIE)	132	127	96%	117-132				
Total Scale-4 (QIT-4)	267	132	98%	123-137	128-136	130-134	129-135	130-134

Table 17

Additionally, in the Vocabulary subtest, D2 obtained a T score of 49. In the Cubes subtest, D2 presented a T-score of 59. In the Similarities subtest, D2 obtained a T-score of 61. Regarding the Matrix Reasoning subtest, D2 obtained a T score of 59. Regarding the WASI Verbal IQ, which is a measure of acquired knowledge, verbal reasoning, and attention to verbal information, D2 obtained a score of 108 (with a 95% confidence interval between 99 and 115), rated as Medium. As for the Execution IQ, which is a measure of fluid reasoning, spatial processing, attention to detail and visual-motor integration, D2 showed a score of 115 (with a confidence interval 95% between 106 and 121), being classified as Upper Medium. Finally, D2 had a Total-4 IQ of 114 (with a 95% confidence interval between 106 and 120), which corresponds to an Upper Medium performance rating. According to the percentile in Table 18, D2's score is above 70% of children in his age group in QIV, above 84% in QIE and above 82% in QIT-4. In the same table, the confidence interval means that if D2 were to take this IQ test again, his score would be between those numbers. Also, if he were to take WISC-IV or WAIS-III, his score would be between those numbers.

Table 18 - D2's performance in WASI IQ test and standard scores according to his age

	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	110	108	70%	99-115				
Execution (QIE)	118	115	84%	106-121				
Total Scale-4 (QIT-4)	228	114	82%	106-120	112-116	113-115	112-116	113-115

Table 18

In contrast, in relation to performance in the Vocabulary subtest, C2 obtained a T score of 67. In the Cubes subtest, C2 presented a T-score of 69 in this task that evaluates the expression of visuospatial skills and visuoconstructive skills and considers the time to perform the task. In the Similarities subtest, C2 obtained a T-score of 63. Regarding the Matrix Reasoning subtest, C2 obtained a T score of 65 in this task of fluid reasoning and general intellectual ability. Regarding the WASI Verbal IQ, C2 obtained a score of 126 (with a 95% confidence interval between 116 and 132), rated as Superior. As for the Execution IQ, C2 demonstrated a score of 129 (with a 95% confidence interval between 119 and 134), performance rated as Superior. Finally, taking all scores of all tasks into account, C2 had a Total-4 IQ of 130 (with a 95% confidence interval between 121 and 135), which corresponds to an Upper Superior performance rating. Therefore, C2 was classified as an individual with high abilities and giftedness. According to the percentile in Table 19, C2's score is higher than 96% of children tested in his age group in QIV, above 97% in QIE and above 98% in QIT-4. In the same table, the confidence interval means that if C2 were to take this IQ test again, his score would be between those numbers. Also, if he were to take WISC-IV or WAIS-III, his score will be between those numbers.

Moreover, when giving feedback to C2's parents and school psychologists, both mentioned that he reads lots of different books per day and probably has a high ability for language.

Table 19 - C2’s performance in WASI IQ test and standard scores according to his age

	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	130	126	96%	116-132				
Execution (QIE)	134	129	97%	119-134				
Total Scale-4 (QIT-4)	264	130	98%	121-135	126-134	128-132	127-133	128-132

Table 19

Furthermore, in the Vocabulary subtest, D3 obtained a T score of 37. In the Cubes subtest, D3 presented a T score of 48. In the Similarities subtest, D3 obtained a T-score of 50. Regarding the Matrix Reasoning subtest, D3 obtained a T score of 60. Regarding the WASI Verbal IQ, D3 obtained a score of 89 (with a 95% confidence interval between 82 and 98), being classified as a Lower Middle. As for the Execution IQ, D3 demonstrated a score of 106 (with a 95% confidence interval between 98 and 113), performance rated as Medium. Finally, D3 had a Total-4 IQ of 98 (with a 95% confidence interval between 91 and 105), which corresponds to a medium performance rating. According to the percentile in Table 20, D3’s score in QIV is higher than 23% of children tested in his age group, above 66% in QIE and above 45% in QIT-4. In the same table, the confidence interval means that if D3 were to take this IQ test again, his score would be between those numbers. Also, if he were to take WISC-IV or WAIS-III, his score would be between those numbers.

Table 20 - D3’s performance in WASI IQ test and standard scores according to his age

	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	87	89	23%	82-98				
Execution (QIE)	108	106	66%	98-113				
Total Scale-4 (QIT-4)	195	98	45%	91-105	97-99	97-99	96-100	97-99

Table 20

Similarly, in the Vocabulary subtest, C3 obtained a T-score of 58. In the Cubes subtest, C3 presented a T-score of 52. In the Similarities subtest, C3 obtained a T-score of 69. Regarding the Matrix Reasoning subtest, C3 obtained a T score of 58. Regarding the WASI Verbal IQ, C3 obtained a score of 123 (with a 95% confidence interval between 113 and 129), rated as Superior. As for the Execution IQ, C3 demonstrated a score of 108 (with a 95% confidence interval between 100 and 115), performance rated as Medium. Finally, taking all scores of all tasks into account, C3 had a Total-4 IQ of 118 (with a 95% confidence interval between 110 and 124), which corresponds to an Upper Medium performance rating. According to the percentile in Table 21, C3’s score in QIV is higher than 94% of children in his age group, above 70% in QIE and above 88% in QIT-4. In the same table, the confidence interval means that if C3 were to take this IQ test again, his score would be between those numbers. Also, if he were to take WISC-IV or WAIS-III, his score would most likely be between those numbers.

Table 21 - C3's performance in WASI IQ test and standard scores according to his age

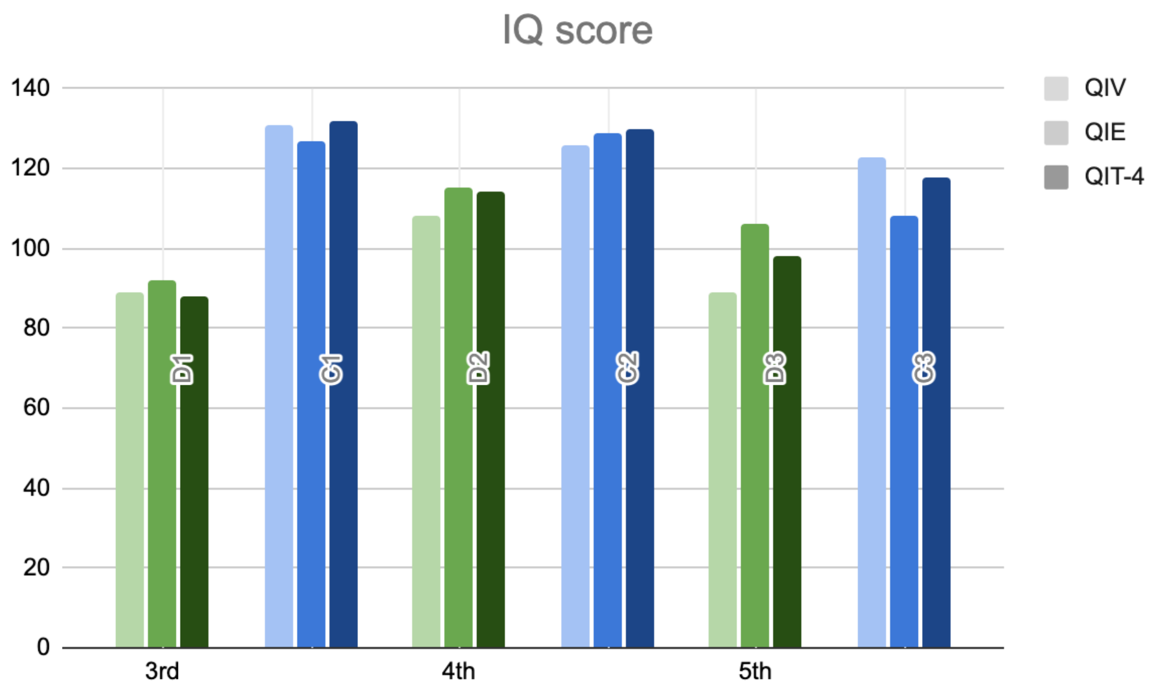
	WASI IQ Scores				Prediction Intervals			
	Sum of T Scores	IQ	Ranking Percentile	95% Confidence Interval	WISC-IV		WAIS-III	
					90%	68%	90%	68%
Verbal (QIV)	127	123	94%	113-129				
Execution (QIE)	110	108	70%	100-115				
Total Scale-4 (QIT-4)	237	118	88%	110-124	115-121	116-120	116-120	117-119

Table 21

To sum up the IQ results description, in Graph 1 it is possible to compare the participants performances regarding the total IQ score whereas in Graph 2 it is possible to compare the participants performances regarding classification (reading 1 as much lower, 2 as lower, 3 as medium lower, 4 as medium, 5 as upper medium, 6 as upper and 7 as upper superior). This analysis is important for my study because it shows that participants do not have any cognitive impairment and, as controls were classified highly (above average), specially C1 and C2 that were classified as having super giftedness and high abilities, this may be interpreted as an enhancement on dyslexics performances when they get close results to the control group. However, we must be cautious with that type of interpretation, once there is no control with 'average' score (i.e., around 70% percentile), except for C3, to be able to say that results show effects of being gifted rather than reflect typical performance.

Concerning the classification of C1, a "lower middle" classification on the WASI (Wechsler Abbreviated Scale of Intelligence) test is not classified as impaired. The WASI provides standard scores, and percentile ranks for four index scores: Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed. Each index score has a mean of 100 and a standard deviation of 15. It's important to note that a classification of "lower middle" is not a standard score or percentile rank, but rather a descriptive label that may be used by some clinicians or educators to describe a score that falls within a certain range (e.g., between 85 and 95). This label may be used to help understand a person's performance on the test, but it does not necessarily indicate impairment or a clinical diagnosis. A "lower middle" classification on the WASI test does not necessarily indicate impairment, but rather falls within a range of scores that are generally considered to be within the average to low average range (WESCHLER, 2011).

Graph 1 - IQ score



Graph 1

Table 22 - IQ score

IQ score			
IQ	**Participants**	**Dyslexics**	**Controls**
QIV	1	89	121
	2	108	126
	3	89	123
QIE	1	92	137
	2	115	129
	3	106	108
QIT	1	88	132
	2	114	130
	3	98	118

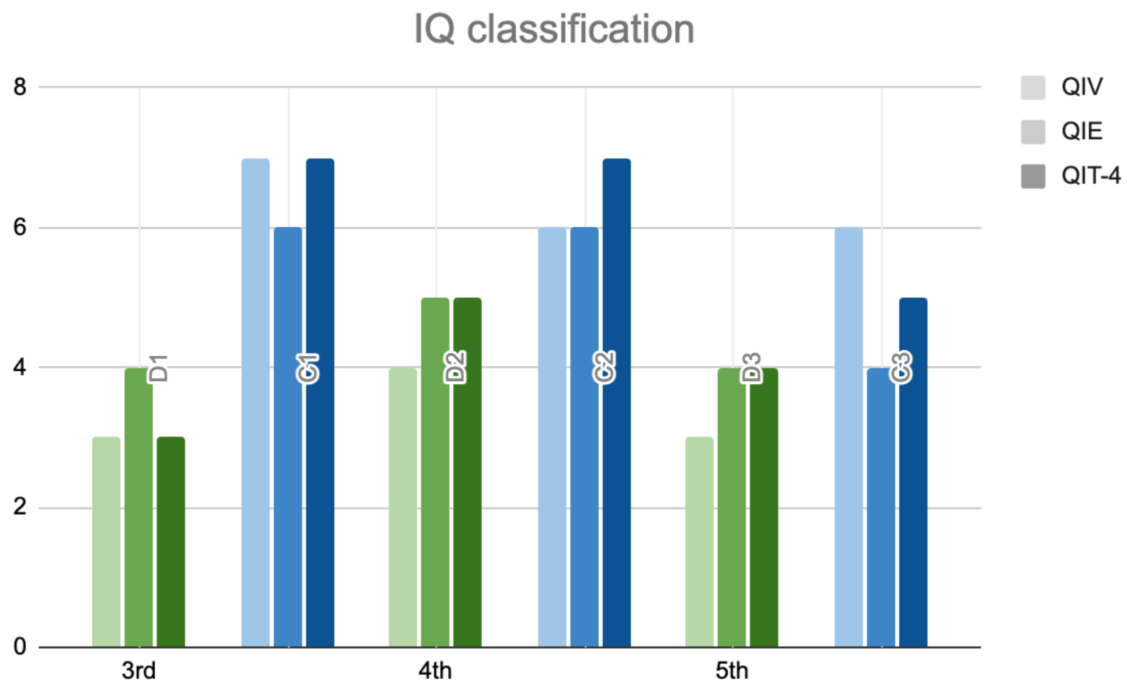
Table 22

I did not know about the giftedness of C1 and C2, nor did the parents. This justifies some unexpected differences. The WASI test results were not planned as a criterion for participant inclusion, and, therefore, we maintained C1 and C2 as controls; however, we must consider that this may skew comparability: overall better performance by controls in the other tests may not be that typical. Therefore, some of the differences between dyslexic participants and control participants may be augmented, due to the giftedness of C1 and C2, and not necessarily due to impairment of D1 and D2.

By looking at the results, the execution IQ (QIE) of D3 and C3 is the same. The distribution patterns are remarkably similar. 4th grade participants' scores reveal an increasing tendency (QIE bigger than QIV, QIT bigger than QIE).

D1 is the dyslexic participant with the most severe symptoms that may be increased by immaturity (age), that is to say that his results may increase a little after some time. In one way, the difference of these results compared to other participants' results may the effect of ADHD (both in a general cognitive sense, but also in how this affects behavior during the test taking in terms of concentration, etc.); on the other hand, it may be a genuine intelligence effect, once the score is corrected for age.

Graph 2 - IQ classification



Graph 2

There is objective data to say that D1 is less functional (compared to D2 and D3, for example). Accordingly, D2 seems to be the most functional of the dyslexic participants. There is a high probability that the contrasts between D1 and C1 are greater due to the fact that both are at more opposite poles, whereas D3 and C3 seem to be more closely matched.

Table 23 - IQ classification

IQ classification			
IQ	**Participants**	**Dyslexics**	**Controls**
QIV	1	medium lower	upper superior
	2	medium	upper
	3	medium lower	upper
QIE	1	medium	upper
	2	upper medium	upper
	3	medium	medium
QIT	1	medium lower	upper superior
	2	upper medium	upper superior
	3	medium	upper medium

Table 23

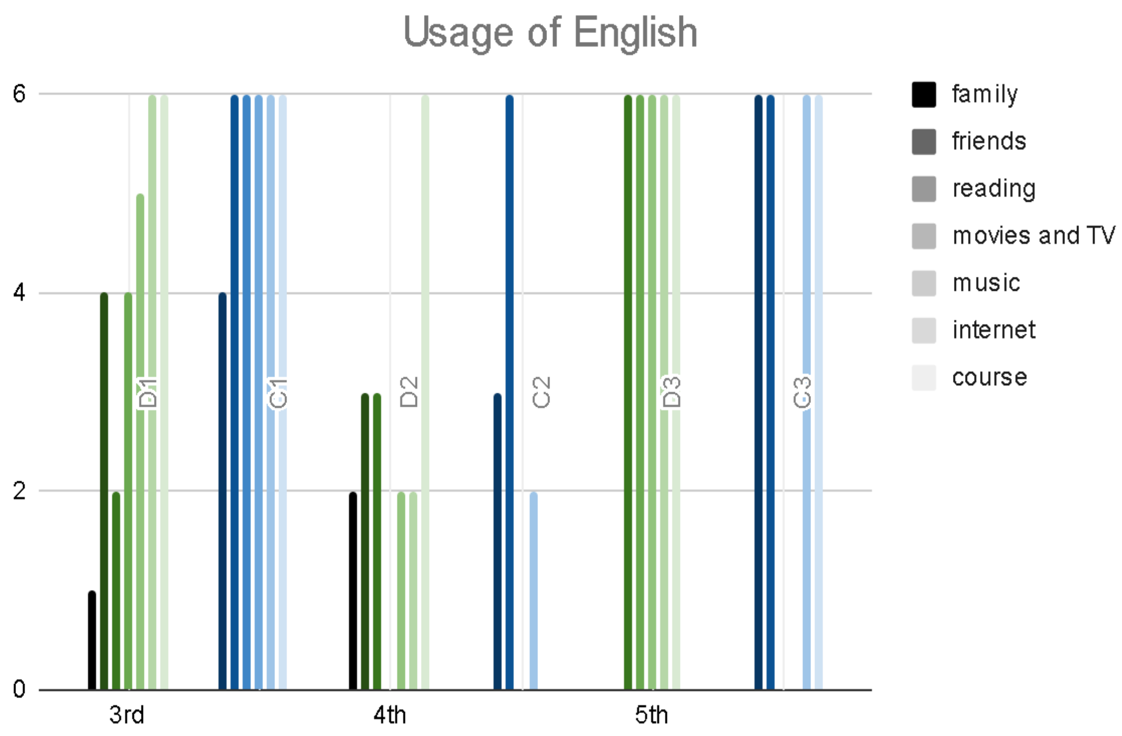
11.3 EXPERIENCE AND LINGUISTIC PROFICIENCY QUESTIONNAIRE

For this assessment, there were two types of tasks. For the first task, the participants had to answer the QuExPLi (Language Experience and Proficiency Questionnaire) as an online form with their parents help and for the the second one, they had to answer some questions about their contact with the English language in a short interview during one of the sections.

Based on the QuExPLi, in terms of usage of English (the frequency in which the English language is used in different contexts) participants in widespread use 100% of English when it comes to music and the internet, for other activities the percentage varies (see Graph 3). This graph shows a comparison between groups, dyslexic (in blue) and control (in green), on the y axis we see the points of the judgment scale (0=never, 6=a lot), the shading of colors (from lightest to darkest) represent different contexts. Another thing that stands out is that both C3 and C2 indicate using English with their family and friends: C3 attributes 6 for both categories and C2 indicates 3 and 6. C1 indicates 4 for friends and none for family; while D2 and D1 indicate, respectively, 4 and 1 (D1) and 3 and 2 (D2), and D3 none for both. This suggests that there might be differences in proficiency due to use of English in social environments that are different from school. Reading is marked as a little impacting activity by almost all, except C1, which shows that questionnaires tend to yield more subjective answers, as in reality, all of them spend a great deal of their time reading in English at school.

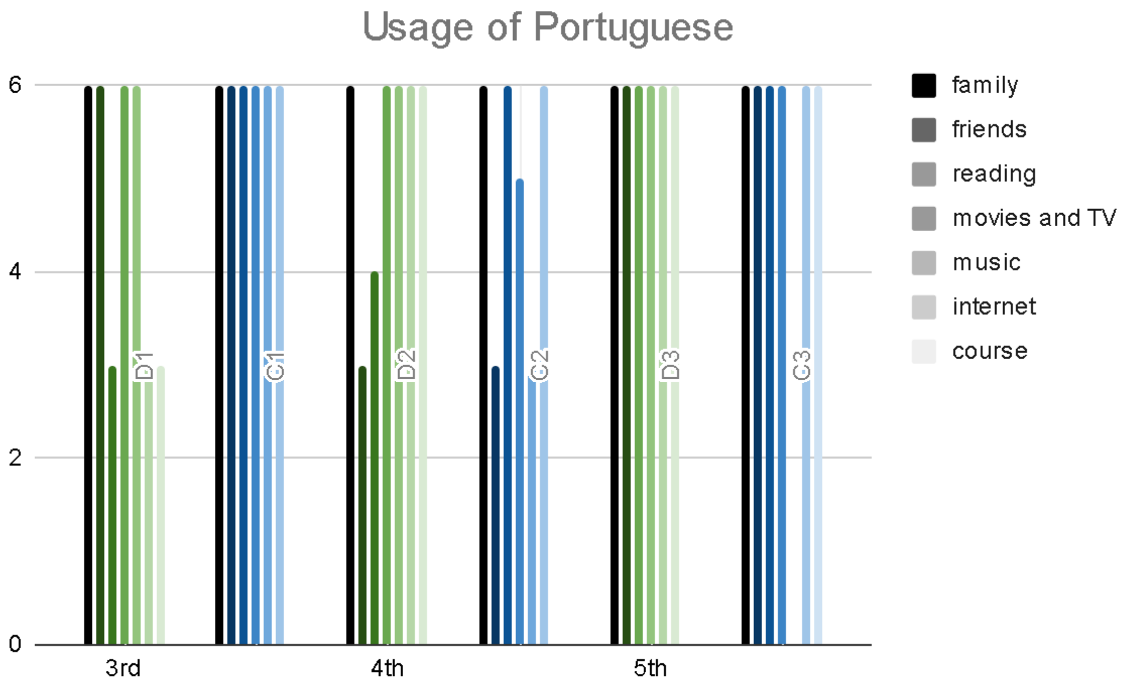
In Portuguese, the participants have a more consistent percentage of usage in comparison to English (see Graph 4). Participants were asked to indicate, on a scale of 0 to 6 (0 = not at all, 3 = fairly, 6 = a lot), how much each of these things helped them learn English/Portuguese.

Graph 3 - Usage of English according to QuExPLi



Graph 3

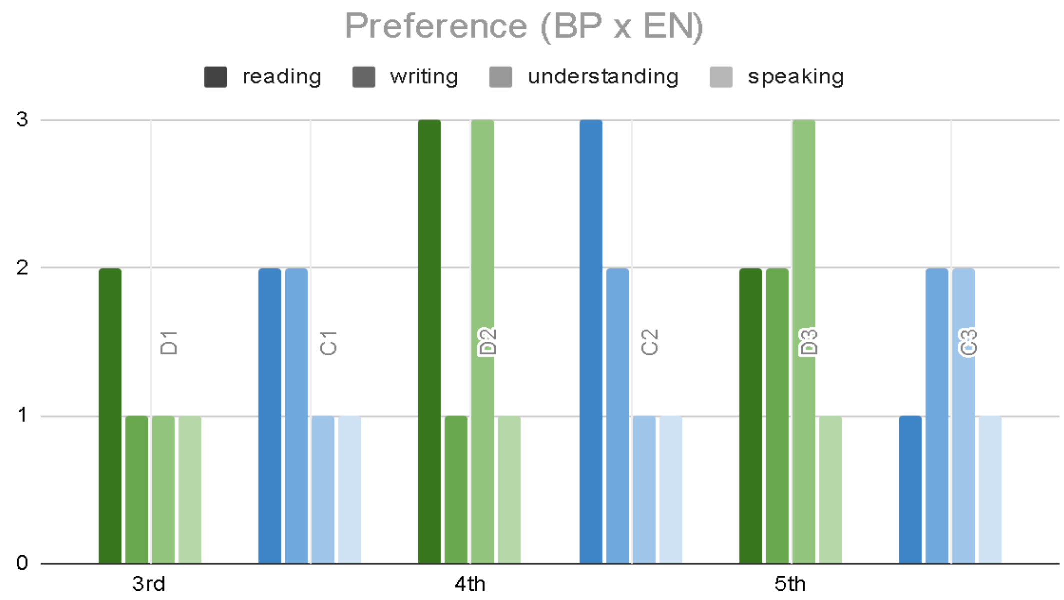
Graph 4 - Usage of Portuguese according to QuExPLi



Graph 4

That being said, in terms of preference, according to Graph 5 (read 1 as preference for Portuguese, 2 for English and 3 for both) most participants prefer reading in English, while D2 and C2 have no specific preference. For writing most dyslexics prefer writing in Portuguese, with the exception of D3. This might be because D1 has just finished his reading instruction process in English and is the one that has had less contact with English compared to the other dyslexic participants, as well as D2 that also prefers writing in Brazilian Portuguese, D2 is the participant that has had less contact with English. D3 along with all control participants prefer writing in English. All the participants prefer speaking in Portuguese. In terms of comprehension, D1, C1 and C2 prefer Brazilian Portuguese, D2 and D3 prefer English and C3 has no preference (understands both well).

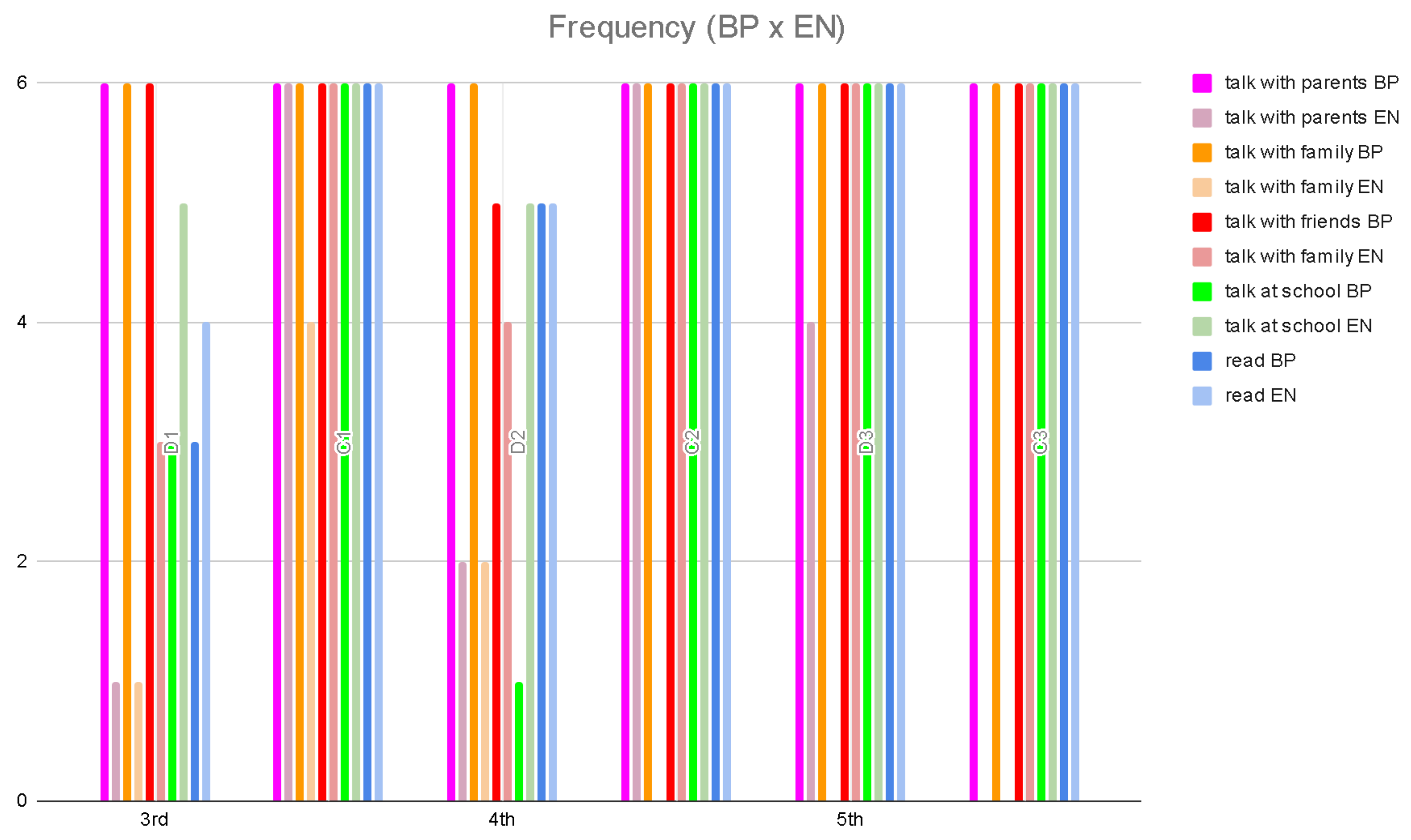
Graph 5 - Preference (BP x EN) according to the QuExPLi (1=preference for Portuguese, 2 for English and 3 for both)



Graph 5

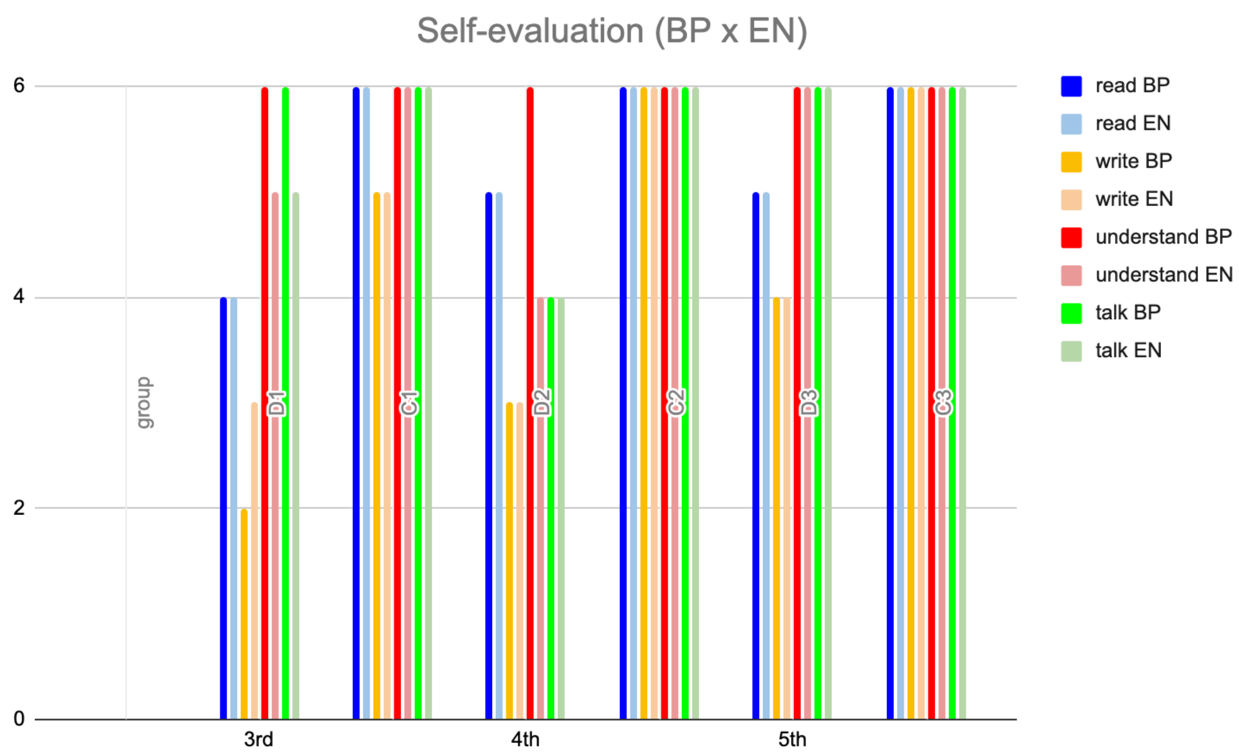
When it comes to frequency, the participants were asked to measure how often they talk in English and Portuguese in a variety of situations (with their parents, with their families, with their friends, at school and in reading). They were asked to indicate according to a score from 1 to 6: 1=a few times a year; 2= once a month, 3= every fortnight; 4= once a week; 5= more than once a week; 6=daily. It is possible to see in Graph 6 that all participants use more Portuguese to talk with their parents and family, D1 and D2 use more English at school and C1, C2, D3 and C3 use both Portuguese and English at school.

Graph 6 - Frequency of use (BP x EN) according to QuExPLi



In Graph 7, we can see how participants rated their performance in each language in reading, writing, talking and understanding (1=very low, 2=low, 3=average, 4=good, 5=very good, 6=proficient). None of the dyslexic participants rated themselves as proficient in both languages reading, D1 classified himself as a 4 and D2 and D3 classified themselves as a 5 in both languages, whereas all control participants classified themselves as very good in both languages reading (6). In terms of writing, C3 and C2 classified themselves as very good in both languages (6), C1 classified himself as good in both (5). When it comes to the dyslexic group, they self-evaluated themselves better as they got older. D1 classified himself as a 2 in Brazilian Portuguese writing and 3 in English writing, D2 classified himself as a 3 in both languages writing and D3 classified himself as 4 in both languages. It is also interesting to see that all participants regarded themselves as very good or proficient in talking and understanding English, except for D2 who still considered himself good at it.

Graph 7 - Self-evaluation (BP x EN) according to QuExPLi



Graph 7

It is possible to notice that the age influenced the answers about self-evaluation because they consider themselves more proficient in the 6 abilities that were assessed.

This might be because older participants have had more contact with English language reading and writing.

For this second assessment, in terms of reading in English, all participants answered that they read in English every day. Also, all participants prefer listening to music in English rather than Portuguese. C1, C2, D3 and C3 watch videos in English a few times per week, meanwhile, D1 rarely does so and D2 does so every day. Likewise, D1 and C3 never play videogames in English, whereas C1 and D2 do so every day and C2 and D3 do so a few times per week. Besides, C1, D2, D3 and C3 mentioned that they started to learn English by the age of 1 to 5 years old, as well as actively using it. In contrast, D1 and C2 mention that they started to learn English by the age of 5 to 10 years old, as well as actively using it and becoming fluent. C1 and D3 considered that they became fluent in English between the age of 1 and 5 years old[7] and D2 considered that he became fluent in English between the age of 5 and 10 years old.

Overall, dyslexics prefer reading and writing in English with the exception of D1 who prefers writing in Portuguese. This might be because he has just finished his reading instruction process in English and is the one that has had less contact with English compared to the other dyslexic participants. The extra questions showed that all participants read in English every day and prefer listening to music in English rather than Portuguese. Out of all participants, D1 is the only one that is not exposed to English out of school. D2 watches videos and plays video games in English every day, whereas D3 does it a few times per week. C1 plays video games in English every day and watches videos in English a few times per week. C2 watches videos in English and plays video games in English a few times per week. C3 watches videos in English a few times per week and never plays video games in English. This shows that all participants have a high exposure to English out of school, with the exception of D1 that does not have any, which may explain the difference in some results.

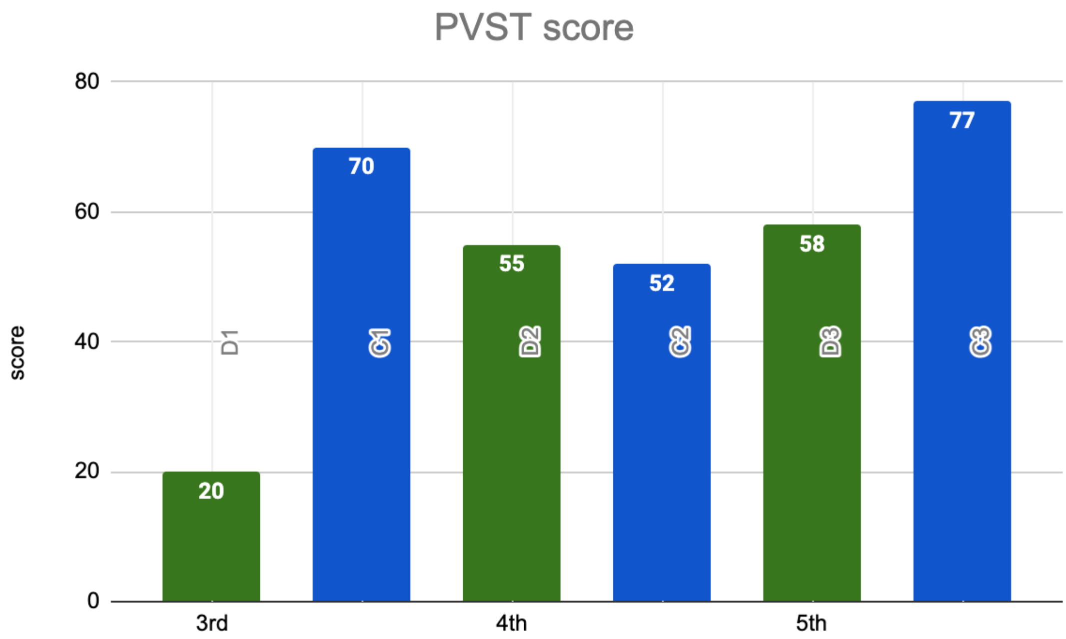
[7] It is important to mention that this is a self-assessment that is not subject to technical knowledge (since no linguist would say that a 1–2-year-old child is fluent).

11.4 LANGUAGE PROFICIENCY

In this test, better performance is expected from more proficient participants, but also the dyslexic group might do worse due to attentional issues. That being said, the test does not have a simple vocabulary and it's not a short test. This test measures more linguistic knowledge and less reading.

In Graph 8 we can see the dyslexic participants in green and the control group in blue. The maximum score of this test is 80 points. D1 scored 20 points (25%) while C1 scored 70 points (87.5%), D2 scored 55 points (68.75%) while C2 scored 52 points (65%), D3 scored 58 points (72.5%) while C3 scored 77 points (96.25%). D1 took 11 minutes and 21 seconds to complete this task, C1 took 15 minutes and 48 seconds to complete this task, D2 took 12 minutes and 27 seconds,C2 took 11 minutes and 10 second to complete this task, D3 took 14 minutes and 57 seconds to complete this task and C3 took 11 minutes and 50 seconds to complete this task.

Graph 8 - Picture Vocabulary Size Test scores



Graph 8

Table 24 - PVST score

PVST score		
Participants	**Dyslexics**	**Controls**
1	20	70
2	55	52
3	58	77

Table 24

Therefore, the results obtained were expected, with less accuracy for dyslexics on the whole, however with sleight improvements with age. The results may furthermore have been influenced by the time spent in the bilingual school, C1, C3 and C3 who showed best results, have spent the most time (approx. 6, 8 and 7 years, respectively).

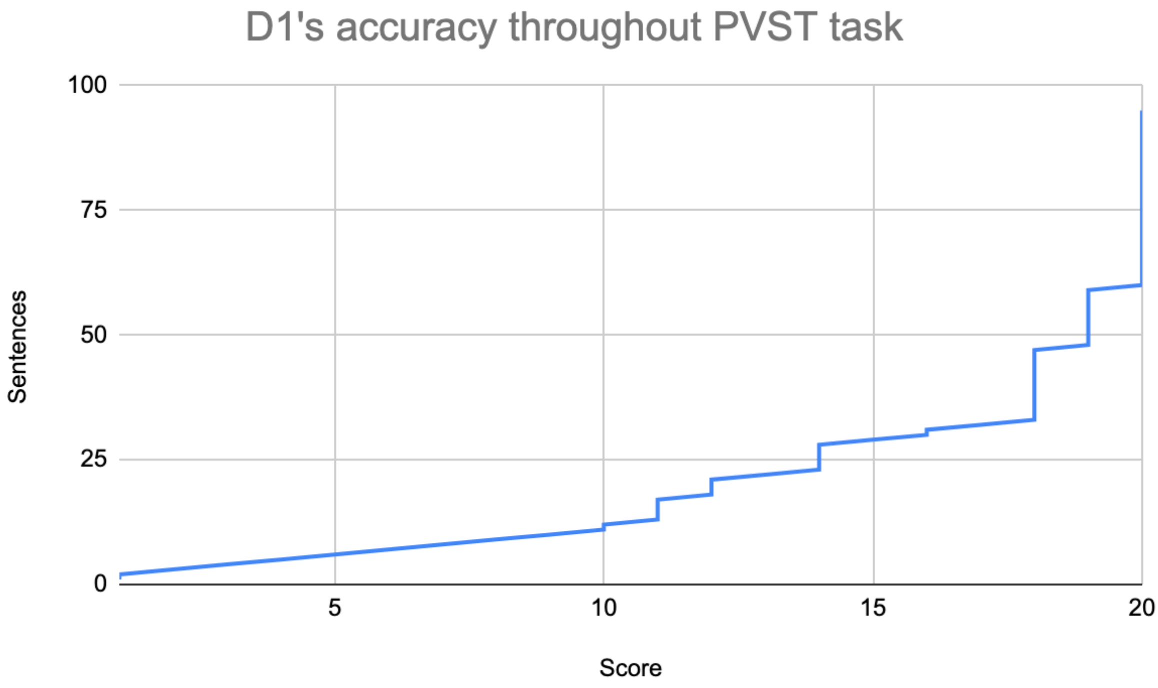
There was a decrease of accuracy (the number of correct answers) as the participants got closer to the end of the test. In the graphs below, straight lines represent correct answers and line deviations mean wrong answers. The y axis represents the sentences from the test (that are 96 sentences). The x axis represents the scores. This can be explained by the fact that the level of difficulty increases towards the end of the test, as well as the attention factor. In this graph, the continuum of the line's inclination means correct answers, whenever this inclination is interrupted, this means wrong answers.

D1 was very distracted during the tests in general, especially this one. Also, D1 is not exposed to English outside school. This may explain the difference in results. D2 obtained very similar results to C2. D2 watches videos and plays video games in English every day, being highly exposed to English outside school, which may explain his result.

This result shows a difference between linguistic capacity to comprehend and recognize vocabulary from auditory stimuli and specific tasks like reading and writing by the dyslexics, they do well in this task, revealing good linguistic development. C1 and C3 are exposed to English outside school daily through movies, music and videos which may explain his score. C1 plays video games in English every day and C3 does it a few times per week.

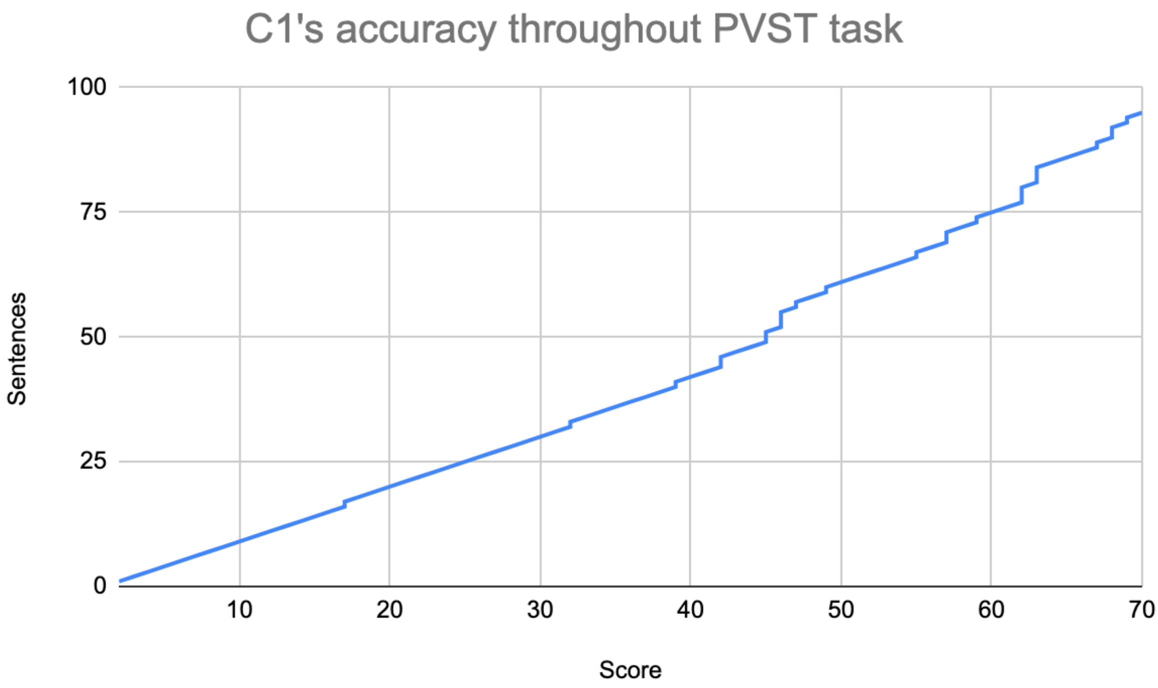
The expectations were confirmed. It was expected to have lower accuracy for dyslexics in general not because of the linguistic impairment but because of ADHD and because much of formal learning in a school involves reading. A slight improvement regarding age was expected (better results from older participants).

Graph 9 - D1's accuracy throughout PVST task



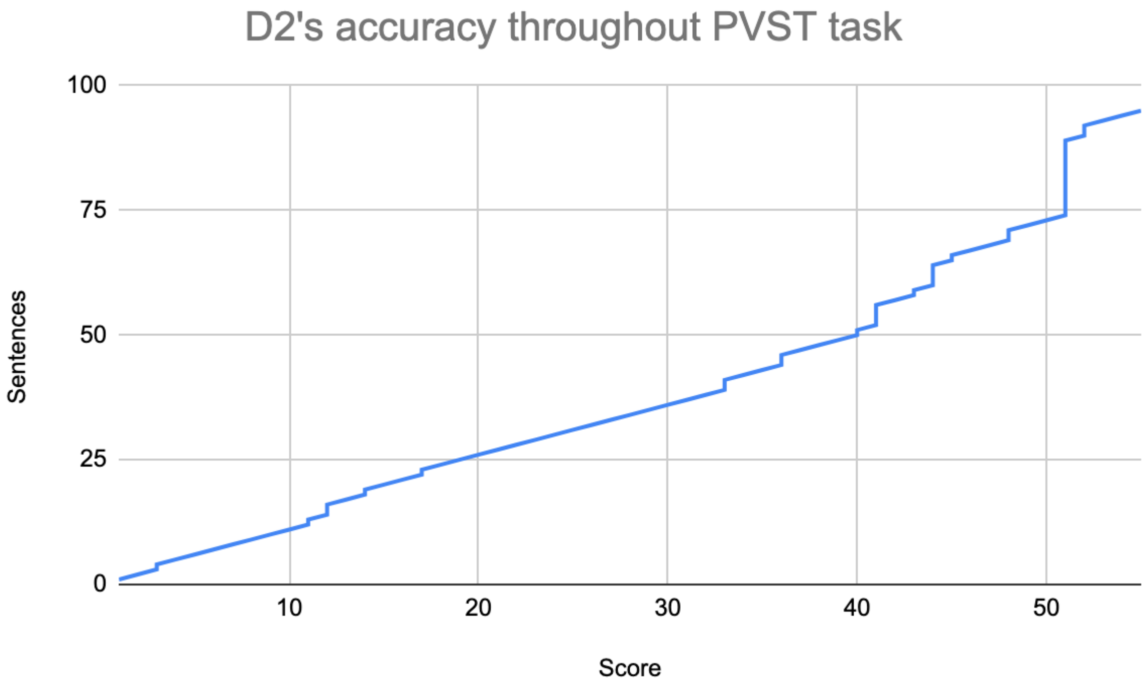
Graph 9

Graph 10 - C1's accuracy throughout PVST task



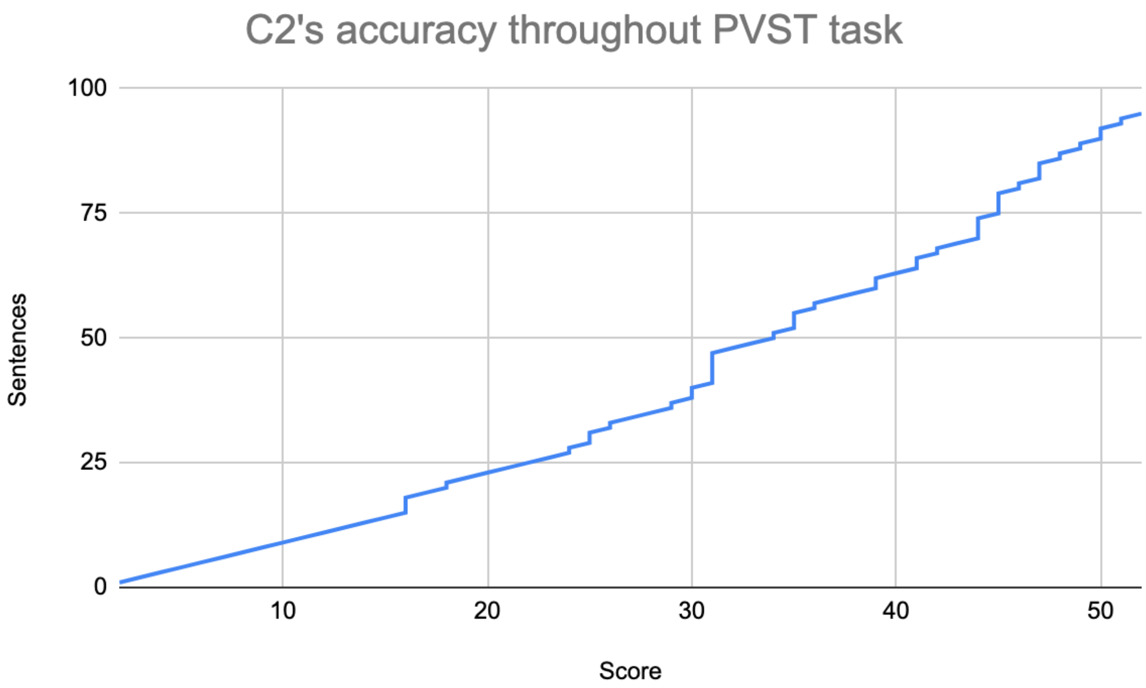
Graph 10

Graph 11 - D2's accuracy throughout PVST task



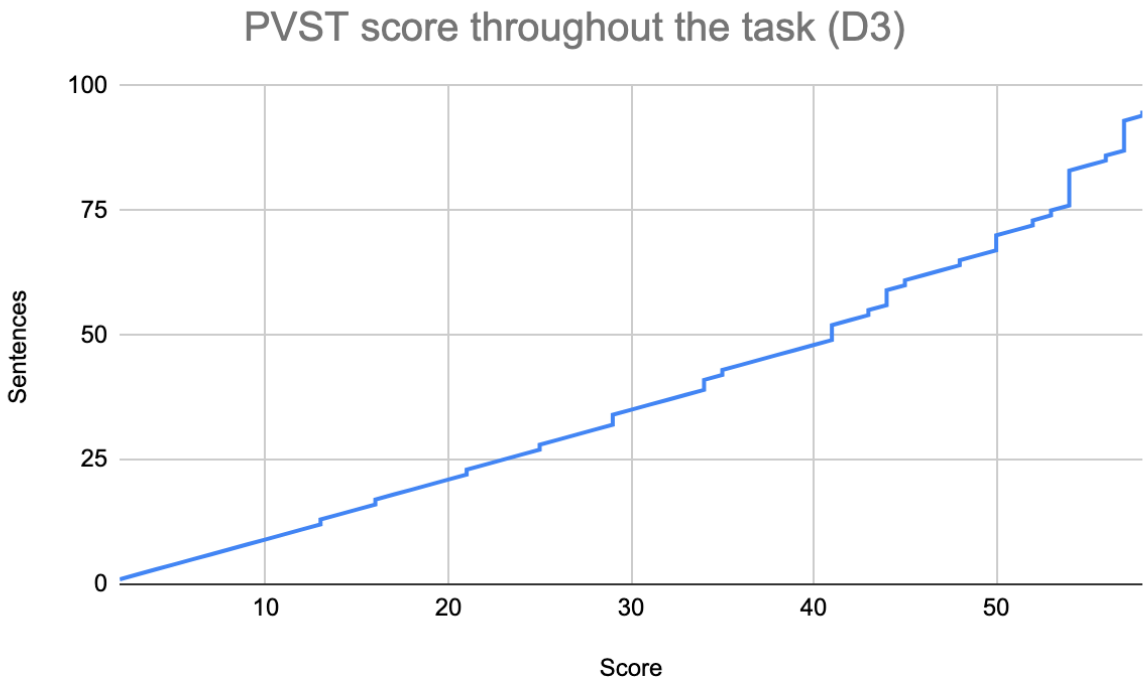
Graph 11

Graph 12 - C2's accuracy throughout PVST task



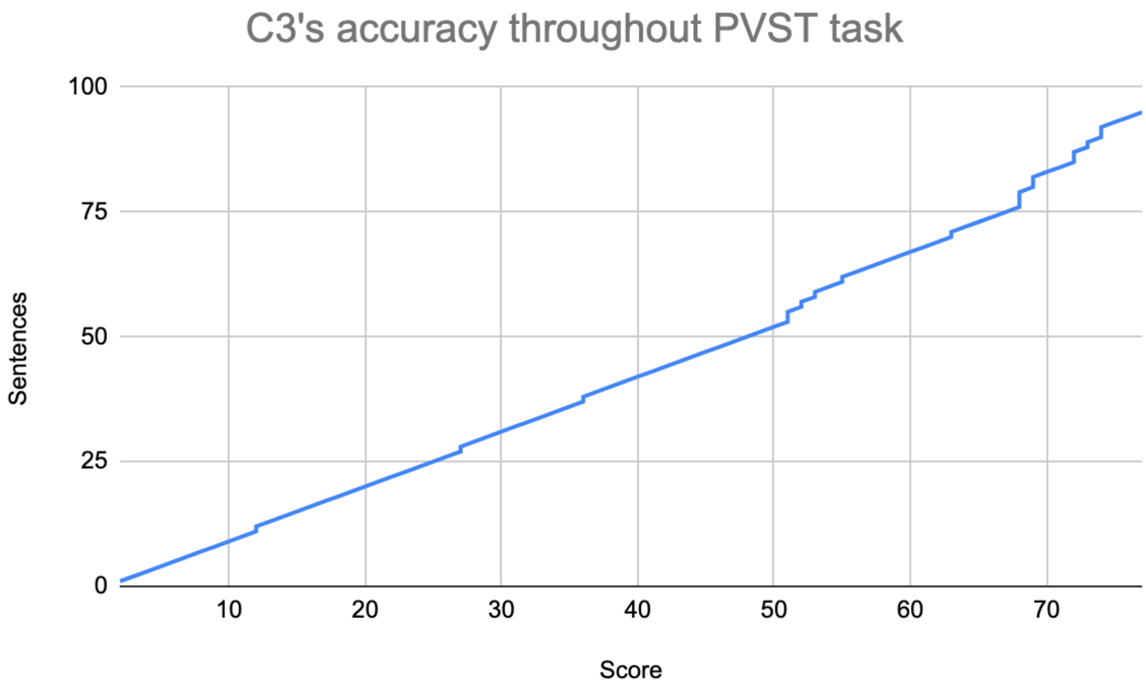
Graph 12

Graph 13 - D3's accuracy throughout PVST task



Graph 13

Graph 14 - C3's accuracy throughout PVST task



Graph 14

11.5 DIGIT SPAN BP

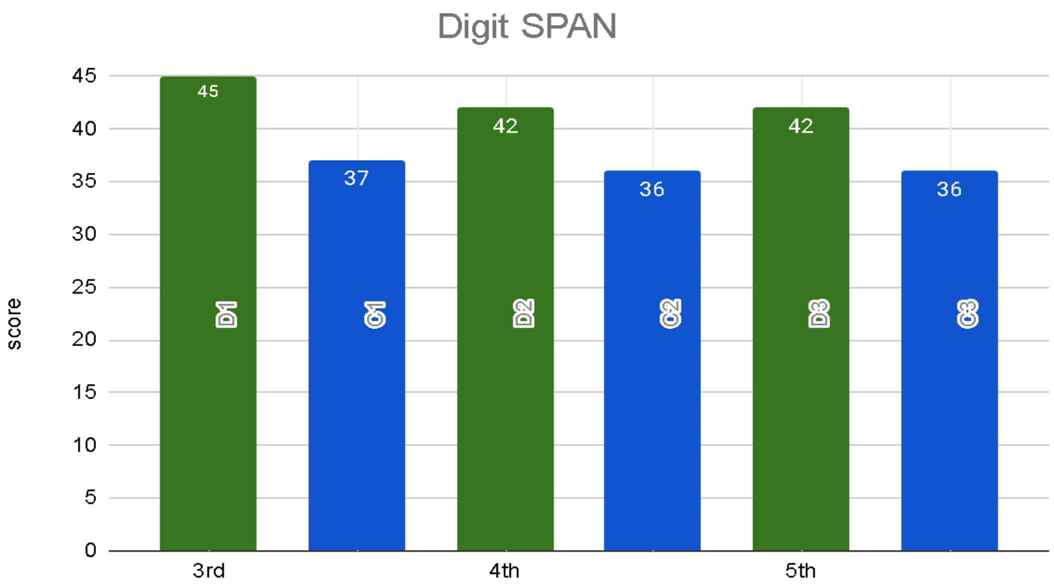
In this assessment, better results were achieved by the dyslexic group (see Graph 15). The score is represented in the y axis, dyslexic participants are represented in green and control participants in blue. Dyslexics scored higher overall: D1 scored 45, D2 and D3 42; compared to relatively lower scores by the controls: C1 37 and C2 and C3 36. So, dyslexics show better performance irrespective of age, and, likewise, controls have pretty much the same performance (36 to 37).

Better results were expected from the control group, once dyslexics show impairment with working memory (SILVA; CRENITTE, 2014; SMITH-SPARK;FISK,2007; MENGHINI et al, 2011). The data was very surprising, once dyslexics scored better than controls. This can be further investigated in future research, to assess if there is a correlation between the digit span and any other marker such as proficiency, math task, English task, or others and to discover what is the correlation between a satisfactory performance in this task. Besides, it is interesting to investigate the inhibition task to verify if bilinguals have better inhibition (executive functions).

It's important to note that the relationship between dyslexia and working memory is complex, and may depend on a variety of factors, such as the type of task, the severity of dyslexia, and the individual's cognitive and neural profile. Therefore, further research is needed to better understand the nature of the relationship between dyslexia and working memory, and to develop targeted interventions to improve reading and cognitive outcomes in dyslexics.

Overall, both dyslexic and control group participants were equally engaged in this task. Despite the variability of individuals, this test confirms that they reflect their profile.

Graph 15 - Digit SPAN scores



Graph 15

Table 25 - PVST score

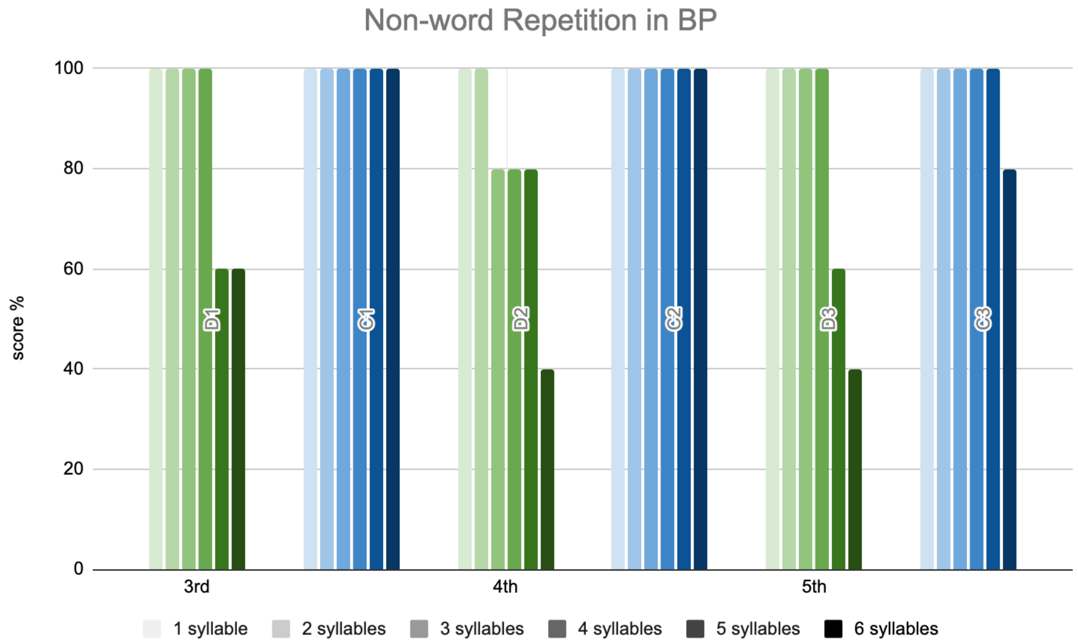
Digit SPAN score		
Participants	**Dyslexics**	**Controls**
1	45	37
2	42	36
3	42	36

Table 25

11.6 REPETITION OF PSEUDOWORDS IN BRAZILIAN PORTUGUESE

In this test, the control group got better results than the dyslexic group and this was an expected result. In Graph 16, we see the score on the y-axis (max. 100) and the participants are either in green (dyslexic group) or in blue (control group). The different toned columns represent an increasing number of syllables (ex. ‘rau’ to ‘alcabinteroca’). We see that all participants reach a 100% accuracy in pseudowords from 1 to 2 syllables. However, although the dyslexic group in general had great results (average score: D1 86,7%; D2 80%, and D3 83,3%), they had relatively lower results with 5-6 syllable words (D1: 60% for both 5 and 6 syllable words, D2: 80% and 40%, respectively, D3: 60% and 40%, respectively) , which can be explained by their innate difficulty (see graph 8). For all grades, the control group scored better.

Graph 16 – Scores for Pseudowords repetition in BP (in %)



Graph 16

Table 26 - Scores for Pseudowords repetition in BP (in %)

Scores for Pseudowords repetition in BP (in %)			
Syllables	**Participants**	**Dyslexics**	**Controls**
1	1	100	100
	2	100	100
	3	100	100
2	1	100	100
	2	100	100
	3	100	100
3	1	100	100
	2	80	100
	3	100	100
4	1	100	100
	2	80	100
	3	100	100
5	1	60	100
	2	80	100
	3	60	100
6	1	60	100
	2	40	100
	3	40	80

Table 26

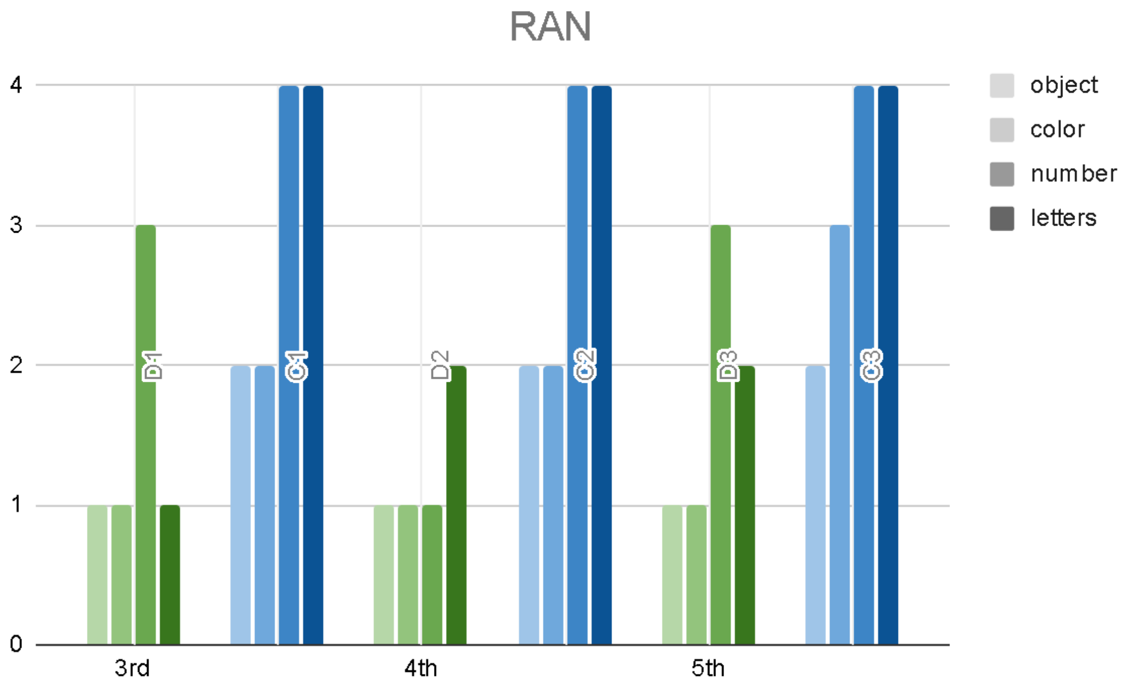
The results here do not reveal that the dyslexic participants face difficulties with their phonological loop once they achieve high marks in the smaller words and due to the fact that all words require a certain level of phonological analysis. But, when it comes to a high cognitive charge and high cognitive pressure (longer words), the performance is affected. This test involves memory, attention and the articulatory planning, given that the participant is required to repeat the word; this is an operation that also becomes more complex with longer words, possibly also because words of this size would be very rare in common speech.

11.7 RAPID AUTOMATED NAMING BP

We expected dyslexics to present lower performance compared to control, with possible differences between more concrete categories (objects) and more abstract categories (such as numbers and letters).

As is possible to see in Graph 17, all dyslexic participants (in green) scored worse than the control group (in blue) in all naming tasks. In this graph, the y axis represents participants' classification, being 1 for relegation/displacement, 2 for light relegation, 3 for a good performance and 4 for a great performance. The X axis refers to participants' grades.

Graph 17 - Rapid Automatized Naming results



Graph 17

Table 27- RAN classification.

RAN classification			
Naming	**Participants**	**Dyslexics**	**Controls**
Objects	1	relegation	light relegation
	2	relegation	light relegation
	3	relegation	light relegation
Colors	1	relegation	light relegation
	2	relegation	light relegation
	3	relegation	good
Numbers	1	good	great
	2	relegation	great
	3	good	great
Letters	1	relegation	great
	2	light relegation	great
	3	light relegation	great

Table 27

Dyslexics have difficulty with this test. This result shows that dyslexic participants are comparable in that sense, pointing to similar underlying cognitive deficits in this group. Globally, dyslexics have the lowest scores, however, the difficulty proportion is similar (i.e., all participants are better in numbers and letters). This contradicts the expectancy that younger participants might be better in more concrete categories. It is interesting to note that all participants, including dyslexics, seem to do better either in numbers (D1 and D3) or letters (D2 and D3). This might be due to the high frequency or predictability of the words in these categories, especially if we consider that English is the language for instruction in school.

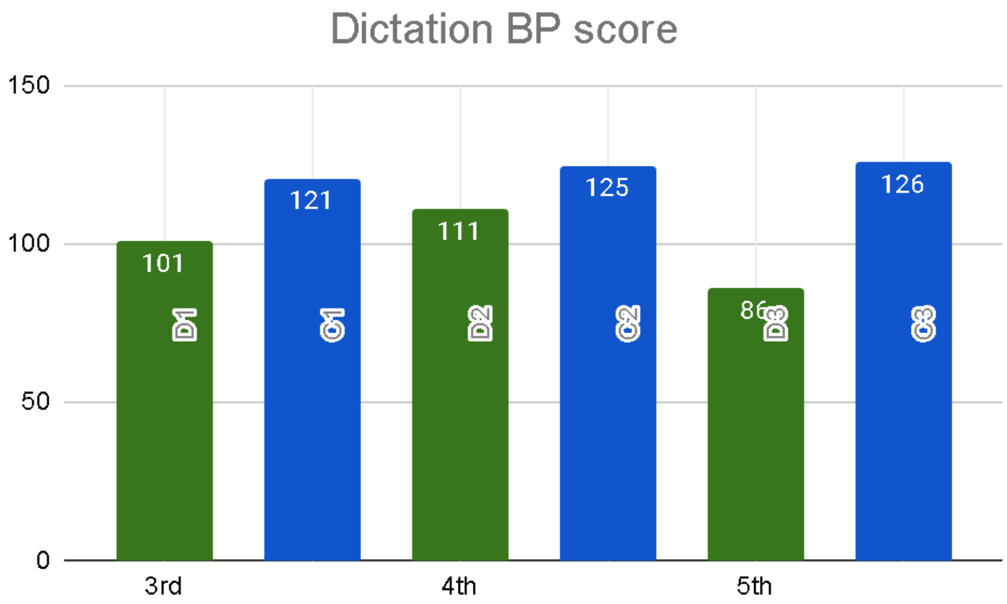
Besides, this test was not made for bilinguals, once they will take more time to complete the task due to lexical choice (both inputs, one for each language, comes to their minds when facing an item).

Last but not least, ADHD is also an important influencer here once it is also a task that requires concentration. D1, for example, skipped a whole line of objects. Overall, not only did dyslexic participants have lower scores, but they also needed more time to complete the rapid automatized naming tests. The results confirm the expectations that the naming process is a type of weakness in dyslexia as proposed by the double-deficit hypothesis.

11.8 DICTATION IN BRAZILIAN PORTUGUESE

In both languages it is expected that the dyslexic group score worse than the control group. It is also expected that older participants score better than young ones. Hence, in Graph 18 it is possible to see the control group in blue and the dyslexic group in green, for all grades, the control group scored better. For the control group we can see a slight improvement with age: C1 scored 121 (out of a maximum of 130), C2 scored 125 and C3 scored a 126. In the dyslexic group, the influence of age is not exactly as expected: D1 scored 101, D2 scored111, and D3 scored 86. These scores are based on average frequency error converted to a score compatible with their age according to the Dias and Capovilla Table (see Appendix 5).

Graph 18 - Dictation BP score (max. 130)



Graph 18

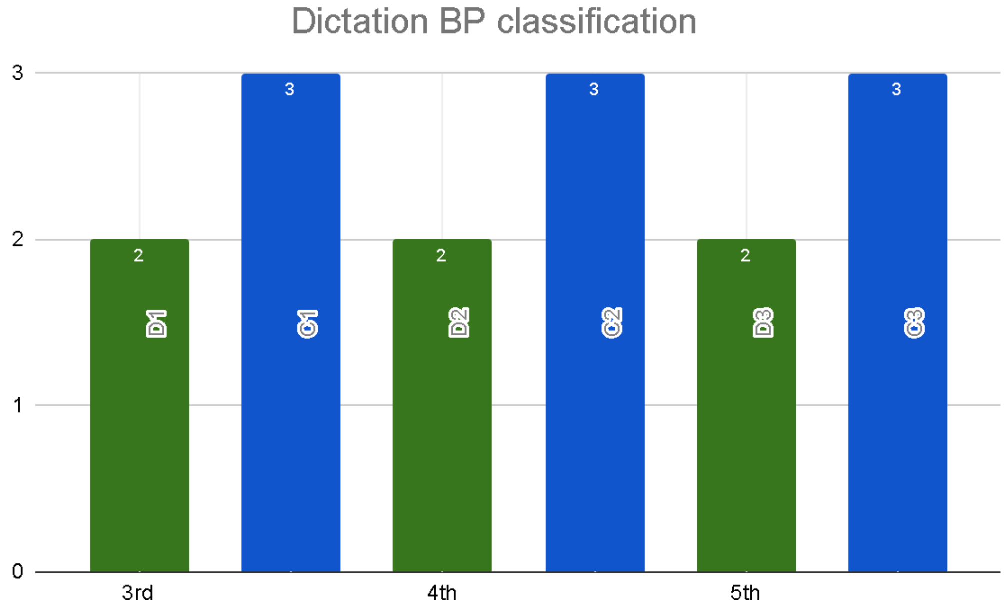
Table 28 - Dictation BP score

Dictation BP score		
Participants	**Dyslexics**	**Controls**
1	101	121
2	111	125
3	86	126

Table 28

In Graph 19 it is possible to see that the control group achieved better classification (i.e., 3) in comparison to the dyslexic group (i.e., 2) (read 1 as low classification, 2 as medium classification and 3 as high classification), in similar fashion across all ages, according to Capovilla (2000), an analysis that takes age into account.

Graph 19 - Dictation BP classification



Graph 19

Table 29 - Dictation BP classification

Dictation BP classification		
Participants	**Dyslexics**	**Controls**
1	medium	high
2	medium	high
3	medium	high

Table 29

It is important to mention that this analysis was made by following the standard procedures of this test, that is to say that the quantitative analysis was owing to the original instructions. For instance, for the evaluation of the writing test under dictation, the average number of errors is computed.

Starting with D1, in this dictation test, for high frequency regular 2-syllable words, D1 corrections were:

- “folhas” - “foliyas”: making a mistake in adding a grapheme when adding “liya” to the word.
- “duas” - “doas”: committing the error of disrespecting the rules of grapheme-phoneme correspondence (by using “o” instead of “u”).

For high frequency regular 3-syllable words, D1 corrections were 100% correct. For high frequency rule words of 2 syllables, D1 corrections were:

- “também” - “tubem”: committing the error of disrespecting the grapheme-phoneme rules with phoneme changes (replacing /a/ by /u/) and grapheme omission (by omitting m in the word also).

For high frequency rule words of 3 syllables, the words used were “galinha” and “redação” and D1 corrections were:

- “galinha” - “galiya”: making a mistake in the grapheme-phoneme rules with changes in phonemes (by using y instead of nh) - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.
- “redação” - “redasao”: making a mistake disrespecting the correct spelling determined by spelling (by replacing ç with s).

For high frequency irregular 2-syllable words, D1 corrections were:

- “texto” - “teishto”: making a mistake in adding a grapheme (by adding i after the syllable “te”) and making a mistake in disrespecting the correct spelling determined by spelling (by using “sh” instead of “x”) - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.

For high frequency irregular 3-syllable words, D1 corrections were:

- “criança” - “ciasa”: committing a grapheme omission error (by failing to use “cr” and “n”), an error of disrespect for the grapheme-phoneme rules with a change of phonemes (when using only c) an error of disrespect to correct writing determined by spelling (when using “s” instead of “ç”)
- “pássaro” - “pasaro”: committing the error of disrespecting the rule of position (using only “s” and not using “ss”).

For low frequency regular 2-syllable words, D1 corrections were:

- “mostra” - “moshtra”: committing an error disrespecting the correct spelling determined by spelling (when using “sh” instead of “s”) - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.

For low frequency regular 3-syllable words, D1 corrections were:

- “olhava” - “oyava”: making a mistake in the grapheme-phoneme rules with changes in phonemes (by using “y” instead of “lh”) - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.

For low frequency rule words of 2 syllables, D1 corrections were:

- “órgão” - “orgam”: making a tonic accentuation error (that is, having a change of syllable stress that objectively disrespects orthographic or accentuation rules, by using “m” instead of “ão”).

For low frequency rule words of 3 syllables, D1 corrections were:

- “empada” - “eimpada”: committing error of committing grapheme addition error (by adding “i” after the syllable “ne”).
- “marreca” - “mareca”: committing the error of disrespecting the rule of position (by using only “r” instead of “rr”).

For low frequency irregular 2-syllable words, D1 corrections were:

- “boxe” - “boxs”: making a grapheme addition error (by adding “s” at the end of the word).
- “ouça” - “osa”: committing the error of omitting a grapheme and the error of disrespecting the grapheme-phoneme rules with a change of phonemes (by omitting “u” and putting “s” in place of “ç”, respectively).

For low frequency irregular 3-syllable words, D1 corrections were:

- “gemido” - “jemido”: committing error of committing error of disrespect to the correct spelling determined by spelling (by using “j” instead of “g”).
- “chupeta” - “shupeta”: committing an error of disrespect to the correct spelling determined by spelling (by putting “sh” in the place of “x” in the word) - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.

For pseudowords, regular 2-syllable words, D1 corrections were:

- “inha” - “iyna”: committing an error of disrespect to the correct spelling determined by spelling - note: this may demonstrate that the child confuses grapheme-phoneme in Portuguese and English.

For pseudowords, regular 3-syllable words, D1 corrections were:

- “calafra” - “clafra” – committing a grapheme omission error, changing the phoneme (by using “cl” instead of “cala”).

For pseudowords, rule words of 2 syllables, D1 corrections were:

- “pejam” - “peja”: making a mistake omitting the grapheme at the end of the word (by failing to use /m/ at the end of the word “pejam”).

For pseudowords, rule words of 3 syllables, D1 corrections were:

- “tarrega” - “tarega”: committing the error of disrespecting the rules of position (by putting only an “R” in the word).

For irregular 2-syllable pseudowords, D1 answered 100% correctly. For irregular 3-syllable pseudowords, D1 correction was:

- "ciparro" - "siparo": making the mistake of disrespecting the rules of position (by putting only an "R" in the word).

Overall, we can see that the majority of D1's spelling errors are a result of not following grapheme to phoneme conventions, but the errors do no present arbitrary changing of position of letters or an altogether illogical interpretation of the sound to letter mapping.

Now, C1 corrections were:

- Rule 2-syllable word "vejam" - "vejão": committing tonic accentuation error (change of syllable stress, when using "ão" at the end of the word "vejam").
- Irregular 2 syllable word "ouça" - "ousa": committing an error of disrespect to the correct writing determined by spelling. (By using "s" in the word "listen").
- Regular 2-syllable word "vesta" - "veichta": making a mistake in adding the grapheme and in disrespecting the writing determined by the spelling (by adding "i" and using "ch" in place of "s" in the word "vesta").

We see that C1 makes few spelling mistakes, with the type of mix-up that is quite common for children in his age group, such as -ão for -am, and -s for -ç. Moreover, D2 corrections were:

- High frequency regular 2-syllable word "folhas" - "folias":making a mistake in adding the grapheme when he added "i" to the word "folhas".
- High frequency rule 2-syllable word "também" - "tabem": committing the error of omitting grapheme and tonic accent (by failing to use "m" and failing to use the acute accent).
- High frequency rule 3-syllable word "galinha" - "galhia": committing an error of disrespect to the correct spelling determined by spelling and omission of grapheme (by putting "lh" in place of "L" and omitting "nh", respectively).

- High frequency irregular 2-syllable word “texto” - “testo”: committing an error of disrespect to the correct spelling determined by spelling (by using “s” instead of “x”).
- Low frequency rule word of 2 syllables “vejam” - “vejão”: committing a tonic accentuation error (by placing “ão” at the end of the word “vejam”).
- Low frequency irregular 2-syllable word “boxe” - “boxi”: committing an error of disrespect to the correct spelling determined by spelling (by putting “i” instead of “e”).
- Low frequency irregular 2-syllable word “ouça” - “ousa”: committing the error of disrespecting the grapheme-phoneme rules with a change of phonemes (by putting “s” instead of “ç”).
- Regular 2-syllable pseudoword “inha” - “ehna”: making a mistake in inverting the “nh” consonants and disrespecting the grapheme-phoneme rules with phoneme changes (by using “hn” and using “e” instead of “i”, respectively).
- Regular 3-syllable pseudoword “olhata” - “ohnata”: making a mistake of inverting the “nh” consonants and making a mistake of disrespecting the grapheme-phoneme rules with a change of phonemes (by using “nh” instead of “lh”)
- Rule 2-syllable pseudoword “pejam”- “pegão” – making a tonic accentuation error (by placing “ão” at the end of the word “pejam”).
- Rule 2-syllable pseudoword “dampém” - “tampém”: committing the error of disrespecting the grapheme-phoneme rules with a change of phonemes and omission of grapheme (by using “t” instead of “d” in the word dampém).
- Rule 3-syllables pseudoword “tarrega” - “tarega”: committing the error of disrespecting the rules of position (by putting only one “R” in the word).

Most of D2's participant corrections were based on the transference between the oral production of the word and writing, in violation of orthographic conventions ("folhas" > "folias"), or imprecise approximation ("ouça" > "ousa").

C2 and C3 scored 100% in this assessment, with no mistakes.

Finally, D3 corrections were:

- High frequency rule word of 3 syllables “redação” - “redasão”: committing the error of disrespecting the rules of position (by putting “S” in the place of “ç” in the word).
- High frequency irregular 2-syllable word “texto” - “tesxto”: making a grapheme addition error (by adding “s” in the word)
- High frequency irregular 3-syllable word “pássaro” - “pásaro”: making the mistake of disrespecting the rules of position (by putting only an “S” in the word)
- High frequency irregular 3-syllable word “criança” - “criansa”: making the mistake of disrespecting the rules of position (by putting “S” instead of “ç” in the word)
- Low frequency regular 2-syllable word “mostra” - “moichitra”: making a mistake in adding a grapheme and disrespecting the correct spelling determined by spelling (by adding “i” to the word and replacing “s” with “ch”, respectively).
- Low frequency rule words of 2 syllables “vejam” - “vegeo”: committing an error of disrespect to the correct spelling determined by spelling and an error in tonic accentuation (by using “g” instead of “j” and using “geo” in place of “am” in the word “vejam”, respectively).
- Low frequency rule words of 2 syllables “órgão” - “órgan”: making a tonic accentuation error (by putting “n” at the end of the word). Also, this may demonstrate that the child remembered the word in English while writing.
- Low frequency rule words of 3 syllables “marreca” - “mareca”: making an error of disrespecting the rule of position (by putting only an “R” in the word).
- Low frequency irregular 2-syllable word “boxe” - “boxi”: committing an error of disrespect to the correct spelling determined by spelling (by putting “i” in place of “E”).
- Low frequency irregular 2-syllable word “ouça” - “ousa”: committing a mistake in tonic accentuation and an error in disrespecting the correct spelling determined by spelling (by placing m at the end of the word and using “s” instead of “ç”).

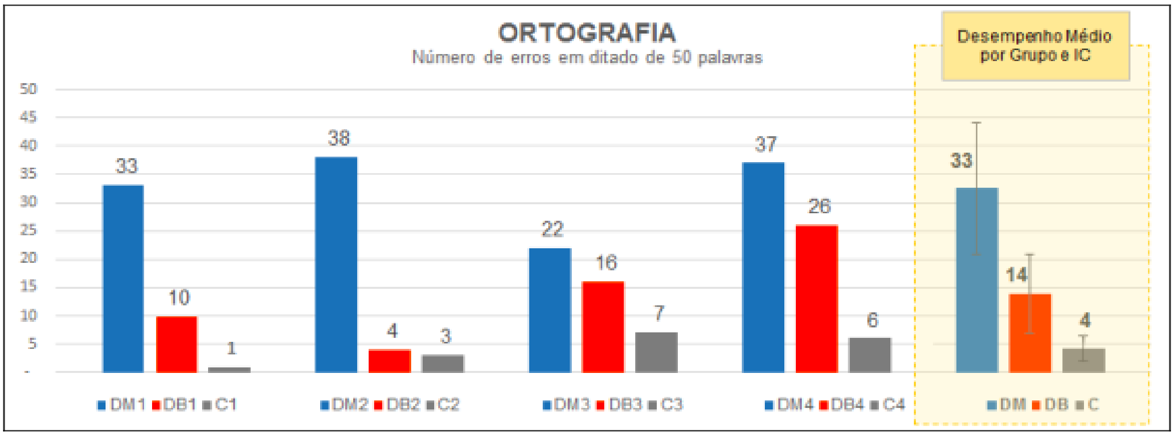
- Regular 2-syllable pseudoword “inha” - “innha”: making a mistake in adding the grapheme (by putting the letter n twice in the word).
- Rule 2-syllables pseudoword “dampém” - “dupém”: committing the error of disrespecting the grapheme-phoneme rules by changing phonemes and omitting the grapheme (using “u” instead of the letter “a” and omitting “m” in the word).
- Rule 2-syllables pseudoword “pejam” - “pegan”: committing the error of disrespecting the grapheme-phoneme rules with phoneme changes (by replacing “j” with “g” in the word).
- Rule 3-syllables pseudoword “tarrega” - “tarega”: making the mistake of disrespecting the rules of position (by putting only an “R” in the word).
- Irregular 3-syllables pseudoword “ciparro” - “ciparo”: making the mistake of disrespecting the rules of position (by putting only an “R” in the word).

D3 does not have learning support outside or goes to speech therapist anymore, this may have influenced his results. In terms of numbers (scores), his results were not that low, but when you take a closer look at the error types there is a difference in production compared to other dyslexics. For example, in his spelling of “vejam”, he writes “vegeo”, which when we follow Portuguese grapheme to sound mapping, is pronounced as [ve’ʒeU] or [ve’ʒeo]; thus, deviating a long way from the regularities of the Portuguese spelling system. Furthermore, the scores here calculated take into consideration participants' ages, and we see, indeed, that D3 commits the type of errors we might expect from children who are the beginning of the literacy process.

The hypothesis that dyslexics' Portuguese would be somehow remediated by English structure was not truly evidenced in this BP Dictation analysis. This task just confirmed the hypothesis of dyslexics having a lower result. Even so, dyslexics were not classified as "low" but "medium".

Compared to Azevedo's (2016) study, even though it is not possible to make a direct comparison due to methodology differences, the difference between control and dyslexic group was much smaller in relation to the comparison between her bilingual dyslexics and control group when it comes to proportionality, even though the ages of our participants are very different (see Graph 20). That is, the difference between dyslexic bilinguals and controls in her study are greater than mine. This can support the hypothesis of English immersion benefits, once the bilinguals from my study are inserted in this context, as well as the hypothesis of the benefits of elevated level of exposure at a young age. It is important to highlight that it is exceedingly difficult to make a direct comparison between the results once the subjects and tasks are very different.

Graph 20 - Azevedo's (2016) results of number of mistakes (Dictation BP)



Graph 20

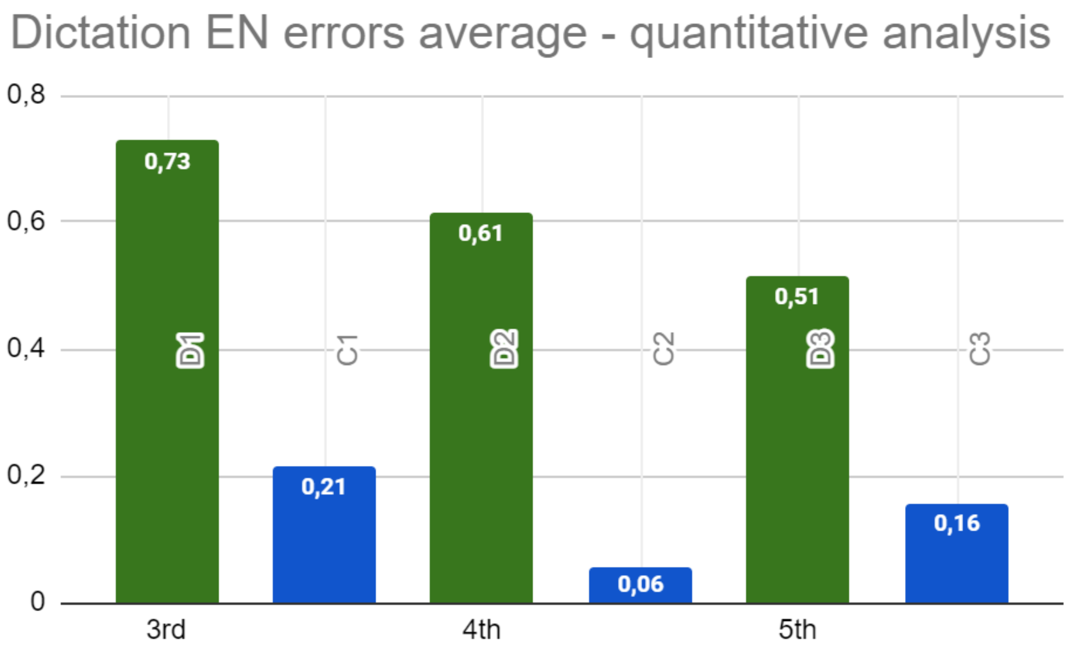
11.9 DICTATION IN ENGLISH

Differently from the Portuguese dictation test, the English dictation test that was developed aimed to analyze the writing of the target language as a second language. For this reason, along with a quantitative analysis (aiming a comparison between Portuguese and English scores), a qualitative analysis was done due to a wider possibility of written registry (the same sound can be written in different ways, e.g., /p ɛg/ can be written as “pag” or “peg”).

The maximum score of this test was 70 points (1 point per word). For the quantitative analysis, a misspelled word scored 0 points and correctly spelled words received 1 point (i.e., "conexion" scored 0 and "connection" scored 1). From the number of errors, the frequency of errors (number of errors divided by the total number of words) was calculated. This score is not corrected for age. Alternatively, in the qualitative method, if the misspelled word is phonologically accepted according to English correspondence rules (it is possible to pronounce the misspelled word that is written with the same pronunciation as the right-spelled one even though it is not spelled correctly) it would receive half of a point (i.e. "conession" scored 0, "conexion" scored 0,5, "conection" scored 0,5 and "connection" scored 1 point). In the word “taxi”, the letter “x” spells [kʃ] similar to “ct” in the context of the word “connection”.’’’ This was done because of the opacity of the target language once the objective of this task is to assess the phonological processing.

In Graph 21, the y axis represents the score in terms of error frequency (per item), the x axis represents the grades. Dyslexic participants are in green and control participants are in blue. In the quantitative analysis (see Graph 21), the control group scored better than the dyslexic group, and the frequency of errors decrease with age for the dyslexic group: D1 scores 0.73, D2 scores 0.62, and D3 scores 0.51, probably due to reading/writing exposition in English. Their error frequencies are still on average at least triple of the control scores, with 0.21 forD1, 0.06 for D2, and 0.16 for D3. Surprisingly, D2’s score is much better than those of D1 and D3. This might indicate that D2’s spelling is extraordinarily good, as his results break the pattern of the decline of errors with age as would be expected.

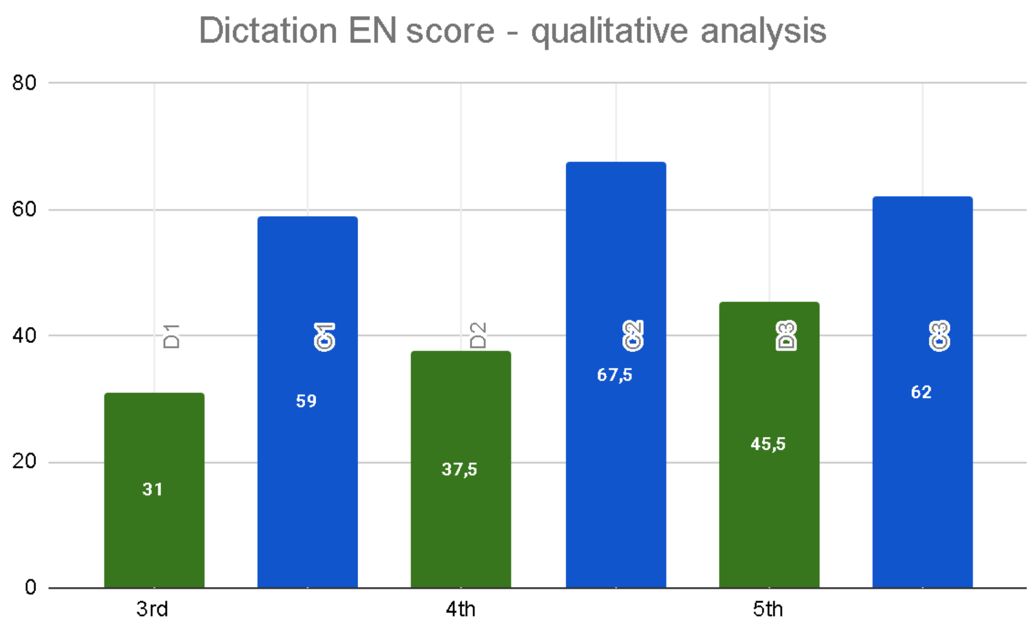
Graph 21 - Dictation EN errors average - quantitative analysis



Graph 21

Nevertheless, in the qualitative analysis (see Graph 22), although the control group scored better than the dyslexic group (C1 scores 59 whereas D1 scored 31, C2 scores 67.5 whereas D2 scored 37.5, C3 scores 62 whereas D3 scored 45.5), there is a significant improvement of the dyslexic group as the school years pass, and the difference are proportionally less extreme compared to the quantitative analysis.. The y axis represents the score, the x axis represents the grades. Dyslexic participants are in green and control participants are in blue. The calculus for the qualitative analysis was different from the quantitative one. For this analysis, the maxim score is 70 (1 point per word) and it was not corrected for age. Indeed, regarding participants from the control group, C2 is the one that prefers English for reading and writing (see Graph 5), therefore, this can explain the short difference between controls.

Graph 22 - Dictation EN score - qualitative analysis



Graph 22

The graph above is not corrected by age, so, naturally, there is an increasing effect (older participants are better than the young ones). There is an improvement of dyslexics, but, looking at the official classification (that is, the quantitative analysis), this improvement is not that great.

In the tables below, each participant's production is described, being analyzed in the qualitative way, for comparison target spelling is shown in parentheses. Boxes colored in red received 0 points, yellow half of a point and green 1 point.

Table 30 - D1's production and qualitative analysis in the EN Dictation test

High	boria (body)	prsun (person)	jrink (drink)	color	speshool (special)
	idiya (idea)	rumen (human)	inportent (important)	children	bliv (believe)
	emoshion (emotion)	ecspol (example)	car	soechon (children)	conshn (connection)
	room	seven	fol (fall)	long	keep
	misek (music)	dens (dance)	book	beg	senema (cinema)
	mambe (maybe)	pepol (people)	clas (class)	favorit (favorite)	frends (friends)
	exaitd (excited)	frst (first)	evrifin (everything)	school	pesel (pencil)
Low	jim (gym)	naith (knife)	glas (glass)	rong (wrong)	tham (thumb)
	othsev (offensive)	dat (doubt)	wallet	job	hod (hold)
	binok (binocular)	hast	gol (gall)	insho (institution)	men (medicine)
	ifyishu (investigation)	lô (law)	foot (flute)	prsonalty (personality)	chrala (trailer)
	mytak (mistake)	riinol (original)	mirror (mirror)	tooll (tool)	sesibll (sensible)
Made up	flay	cac	cbot (caboot)	gib	mnt (mentee)
	blotwer	jonteri	peg	jrom (drom)	lapr (laper)

Table 30

Table 31 - C1's production and qualitative analysis in the EN Dictation test

High	body	person	drink	color	special
	idea	human	important	children	believe (believe)
	emotion	exeple (example)	car	competition	connection (connection)
	room	seven	fall	long	keep
	music	dance	book	bag	cinema
	maybe	people	class	favorite	friends
	exited (excited)	first	everything	school	pencil
Low	gim (gym)	knigh (knife)	glass	wrong	thumb
	offensive (offensive)	dout (doubt)	wallet	jog (job)	hold
	binocular (binocular)	hast	gall	institution	medicine
	investigation	law	floot (flute)	personality	traylor (trailer)
	mistake	original	mirror (mirror)	tool	sensible
Made up	flay	cack	caboot	gibe	mente (mentee)
	bloutwhere	jointery	bag (peg)	drom	laper

Table 31

Table 32 - D2's production and qualitative analysis in the EN Dictation test

High	body	person	drink	color	spellcial (special)
	idia (idea)	humen (human)	important (important)	children	bilevel (believe)
	emotion	exemple (example)	car	compentiton (competition)	conexion (connection)
	rum (room)	seven	fall	long	kep (keep)
	muisc * (music)	dance	boock (book)	bag	cinema (cinema)
	mabe (maybe)	people	clas (class)	favorit (favorite)	frinds (friends)
	exited (excited)	parsd (first)	everything (everything)	shcool * (school)	pencil
Low	jim (gym)	nith (knife)	glass	rong (wrong)	thong (thumb)
	onthencive (offensive)	dount (doubt)	waled (wallet)	job	hold
	bincler (binocular)	hast	gall	institation (institution)	medicin (medicine)
	investigation	low (law)	flut (flute)	parsonlalty (personality)	traler (trailer)
	mistak (mistake)	origilal (original)	mirow (mirror)	tooll (tool)	sensivle (sensible)
Made up	fay	cack	kaboot	gib	menty
	bloutwhere	joitreny (jointery)	peg	drom	laker (laper)

Table 32

Table 33 - C2’s production and qualitative analysis in the EN Dictation test

High	body	person	drink	color	special
	idea	human	important	children	belive (believe)
	emotion	example	car	competition	connection
	room	seven	fall	long	keep
	music	dance	book	bag	cinema
	maybe	people	class	favorite	friends
	exited (excited)	first	everything	school	pencil
Low	gym	knife	glass	wrong	thumb
	ofensive (offensive)	thought (doubt)	wallet	job	hold
	binocular	hast	gall	institution	medicine
	investigation	law	flute	personality	trailer
	mistake	original	mirror	tool	sensible
Made up	flay	cack	caboot	gib	mentee
	blowtwear	jointeree	peg	drome	laper

Table 33

Table 34 - D3's production and qualitative analysis in the EN Dictation test

High	body	person	drink	coler (color)	speshel (special)
	idea	human	important	chudren (children)	bleav (believe)
	emosnun (emotion)	exemple (example)	car	competisnon (competition)	conecksho (connection)
	room	seven	fool (fall)	long	keep
	mucic (music)	dence (dance)	book	beg	sinima (cinema)
	maby (maybe)	people	clace (class)	favorie (favorite)	friends
	exsited (excited)	firerst (first)	everything (everything)	school	pencil
Low	gim (gym)	nife (knife)	glace (glass)	rong (wrong)	thumb
	ofensiv (offensive)	daut (doubt)	wallet (wallet)	job	hold
	benoculer (binocular)	hast	gal	instutusion (institution)	medsin (medicine)
	investigasion (investigatio n)	law	flut (flute)	personnalate (personality)	traler (trailer)
	mistak (mistake)	original	miraw (mirror)	tool	sensibal (sensible)
Made up	flai	cak	cabut	gib	mentee
	blotwer	gointere (jointery)	pag	drom	laper

Table 34

Table 35 - C3's production and qualitative analysis in the EN Dictation test

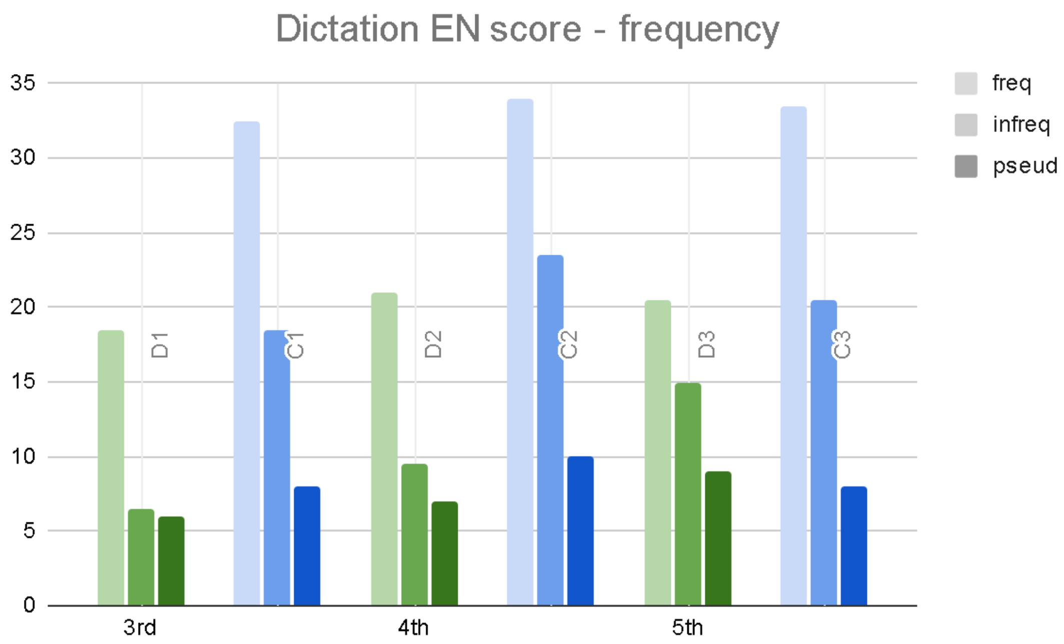
High	body	person	drink	color	special
	idea	human	important	children	belive (believe)
	emotion	example	car	competition	conection (connection)
	room	seven	fall	long	keep
	music	dance	book	bag	cinema
	maybe	people	class	favorite	friends
	exited (excited)	first	everything	school	pencil
Low	gym	knife	glass	wrong	thumb
	offencive (offensive)	thought (doubt)	wallet	job	hold
	binoculer (binocular)	hast	goal (gall)	institution	medicine
	investigation	law	flute	personality	trailer
	mistake	original	mewer (mirror)	tool	senscible (sensible)
Made up	flay	cack	caboot	gib	menty
	blodwear (bloatware)	jointery	pag	drone (drom)	laper

Table 35

In the graph below the results specified for word class (frequent, infrequent and pseudo) for all participants are summarized. These results are also not age corrected. Dyslexic participants are in green and control participants are in blue, the lightest colors represent frequent words, the light colors represent infrequent words, and the darkest colors represent pseudowords. In the y axis, it is possible to see the scores and in the x axis, the grades of participants. Then, analyzing the word frequency, all the participants scored better in frequent than infrequent words and scored better in infrequent words than pseudowords. Also, the control group had greater results than the dyslexic group, as expected (see Graph 23). Frequent words were the higher scores for all participants, followed by infrequent words, having pseudowords as the lowest score for all participants. Nevertheless, dyslexic participants' performance increased slightly as the school year passed, for all variations, except for frequent words that improved comparing D1 to D2, but not when comparing D2 to D2. This confirms the results for Portuguese spelling in which D3 also showed the most difficulty.

D1 makes serious errors in 12 out of 25 frequent words, and in 15 out of 25 of the frequent words. This shows, as is predictable, that he has more difficulty adhering to spelling conventions due to infrequencies. However, for pseudowords his error rate is 4 out of ten, which shows that he has some sensibility for sound to spelling regularities. However, by the number of errors in the pseudoword category (2 out of 10), C1's mastery of these regularities is higher. If we compare the other dyslexic participants, D2 makes 3 out of 10 mistakes, and D3 1 out of 10 mistakes for the pseudoword category. Interestingly, D3 was much worse in Portuguese (see Graph 23), but much better in English, which shows an improvement.

Graph 23 - Dictation EN score per frequency.



Graph 23

Table 36 – Dictation EN score per frequency.

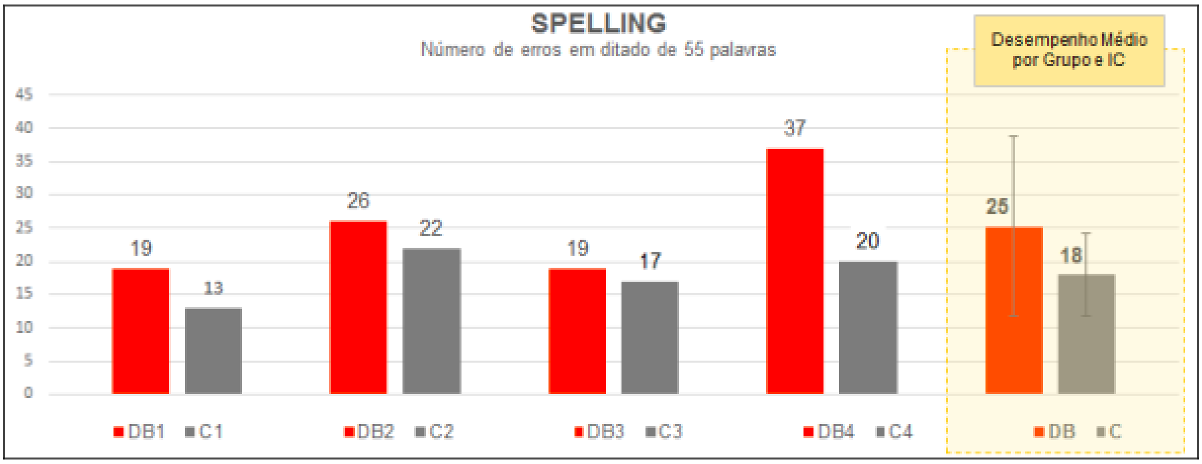
Dictation EN score per frequency			
Freq	**Participants**	**Dyslexics**	**Controls**
Freq	1	18,5	32,5
	2	21	34
	3	20,5	33,5
Infreq	1	6,6	18,5
	2	9,5	23,5
	3	15	20,5
Zero (pseudo)	1	6	8
	2	7	10
	3	9	8

Table 36

Importantly, this test takes into consideration infrequent and pseudowords. Azevedo's EN dictation test does not mention those types of words. In part, this may explain the difference in our results (results in her study show a small difference between groups, dyslexics and controls. Results here show a greater difference between dyslexics and controls).

In terms of classification, this analysis does not relate to standardized results, and can, therefore, not be corrected for age. Therefore, we can only compare directly between dyslexics and controls within the same age bracket. In that sense differences between C3 and D3 seem less pronounced than between D1 and C1 and between D2 and C2. Regarding participants from the control group, C2 is the one that prefers English for reading and writing (see Graph 5), therefore, this can explain the difference between controls and between the dyslexic pair in his age bracket. Regarding the dyslexic group, D1 is the participant that has more intervention in the current moment and has relatively little experience with the reading process, this can explain his difficulty.

Graph 24 - Azevedo's (2016) results of number of mistakes (Dictation BP)



Graph 24

11.10 READING WORDS AND PSEUDOWORDS ALOUD IN BRAZILIAN PORTUGUESE

In this test, participants saw words (frequent, infrequent and pseudowords) in Portuguese on a computer screen and had to read them out loud and push the spacebar on the keyboard to go to the next word. Accuracy as well as reaction time were recorded.

In the following tables, participants' production will be described. In green are the words for which the participant scored 1 point and in red the words for which the participant scored 0 points. Examples of errors are the production of [si'rãsɐ] instead of [kri'ãsə] for the frequent word "criança" (D1) or mach[iku]da for the infrequent word "machucada" (D1), and ro[x]óla, instead of ro[ɾ]óla for the pseudoword "rorola" (D2). Only parts of the word that contained the mispronunciation are transcribed phonetically. When participants produced a different word (ex. "México" for "exército" (D1), the word is written in graphemes.

D1 produced the postalveolar trill /r/ instead of the postalveolar tap or flap /ɾ/ in some words. C1 read the pseudoword "zarronte" 3 times. In general, D1 had 6 mistakes for frequent words, 14 for infrequent words and 11 for pseudowords, whereas C1 1 mistake for infrequent words and 3 for pseudowords. D2 had 1 mistake for frequent words, 2 for infrequent words and 7 for pseudowords, whereas C2 had 1 mistake for pseudowords. C2 was classified with high abilities according to the IQ test (see section 11.2), and after talking to the school and the parents, the suspicion is that his high ability is with language, the participant reads a lot, multiple comic strips and books per day. D3 had 3 mistakes for infrequent words and 7 for pseudowords, whereas C3 had 1 mistake for infrequent words and 4 for pseudowords.

It is interesting to note that D1 had more difficulties in reading out loud than in the dictation test, in the sense that for the reading task, not only were there imprecise interpretations of grapheme-phoneme correspondences, such as laj[o] for “lajau”, but various instances of letter/sound switching, such as [takabU] for “tabaco”, or even changing the syllable structure, such as [si’ɾansɐ] for “criança”, or deletion, such as [ɾa] for “garra”. In some instances, different real words substituted the written word, such as is the case for “méxico” instead of “exército”. In comparison, D2 and D3 mostly struggled with pseudowords, as did C3.

Table 37 - D1's performance on Reading Words and Pseudowords aloud in BP

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**
Frequent Words	DINHEIRO	FILHO	ESCOLA	TERRA
	[sir]ANÇA (criança)	LEITE	MÉXICO (exército)	DROGA*
	COMIDA	CARTA	AM[irɐ] (amarelo)	SEXO
	[‘kudɐ] cidade	MEIA	CA[dr]ERNO* (caderno)	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MA[ʃiku]DA (machucada)	LESMA	A[kaɾU] (acerola)	GOLA
	TA[kabU] (tabaco)	CAR (cárie)	IN[st]ETO (inseto)	TE[ɾe] NO (terno)
	FE[tre]MENTO	JAULA	[mo]CHIN	SELVA

	(fermento)		(chinelo)	
	CO[tɾ] ENZ (correnteza)	[ɾ]A (garra)	[tɾe]XÍMETRO (taxímetro)	TOSSE
	FELI (feline)		[fral] ELO* (farelo)	GOMA (gosma)
Pseudowords	DIVARIO	[tuksU] (tilho)	MARALO	LAJ[o] (lajau)
	[eʃkɾi] (etixero)	VARTE	CHÔNILE	SENJO
	JENALA	TEILE	BOFU (bolefu)	MÊSLA
	ROLA (rolóla)	TISSO	FOXAN [foksã] (fosachone)	GA[ɣdə] (gadra)
	TASBO (tasbope)	ZARREO	ZARøTE (zarronte)	NU[tɾ] O (nurto)
	[kr]AVERMO* (cavermo)	BAFAU	TOMENFO	MOCHE

Table 37

*: words in which the participant produced the postalveolar trill /r/ instead of the postalveolar tap or flap /ɾ/.

Table 38 - C1's performance on Reading Words and Pseudowords aloud in BP

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**
	DINHEIRO	FILHO	ESCOLA	TERRA
	CRIANÇA	LEITE	EXÉRCITO	DROGA

Frequent Words	COMIDA	CARTA	AMARELO	SEXO
	CIDADE	MEIA	CADERNO	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MACHUCADO	LESMA	ACEROLA	GOLA
	TABACO	CÁRIE	INSETO	TERNO
	FERMENTO	JAULA	CHINELO	SELVA
	CORRENTEZA	GARRA	TA[ʃ] IM[Ɛ]TRO (taxímetro)	TOSSE
	FELINO		FARELO	GOSMA
Pseudowords	DIVA[ɾiU] (divairo)	TILHU	MARALO	LAJAU
	ETICH[EI]RO (etixero)	VARTE	CHÔNILE	SENJO
	JENALA	TEILE	BOLEFU	MÊSLA
	RORÓLA	TISSO	FOSACHONE	GADRA
	TASBOPE	ZA[x]EO (zareo)	ZARRONTE (3X)	NURTO
	CAVERMO	BAFAU	TOMENFO	MOCHE

Table 38

Table 39 - D2's performance on Reading Words and Pseudowords aloud in BP

	Regular		Irregular	
	Long	**Short**	**Long**	**Short**
Frequent Words	DINHEIRO	FILHO	ESCOLA	TE[ɾ]A (terra)
	CRIANÇA	LEITE	EXÉRCITO	DROGA
	COMIDA	CARTA	AMARELO	SEXO
	CIDADE	MEIA	CADERNO	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MACHUCADO	LESMA	ACEROLA	GOLA
	TABACO	CAR[ɛ] (carié)	INSETO	TERNO
	FERMENTO	JAULA	CHINELO	SELVA
	CORRENTEZA	GARRAFA (garra)	TAXÍMETRO	TOSSE
	FELINO		FARELO	GOSMA
Pseudowords	DIVAIRO	TILHU	MARALO	LAJ[o] (lajau)
	ETIXERO	VARTE	CH[alon] E (chonile)	SENJO
	JANELA (jenala)	TEILE	BOLEFU	MESLA
	RO[xo]LA (roróla)	TISSO	FOSA[ks]ON (fosachone)	GADRA

	TASBOPE	ZAREO	ZA[ɾ]ONTE (zarronte)	NURTO
	CAVERMO	BAF[u] (bafau)	TOMENFO	MOXE

Table 39

Table 40 - C2's performance on Reading Words and Pseudowords aloud in BP

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**
Frequent Words	DINHEIRO	FILHO	ESCOLA	TERRA
	CRIANÇA	LEITE	EXÉRCITO	DROGA
	COMIDA	CARTA	AMARELO	SEXO
	CIDADE	MEIA	CADERNO	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MACHUCADO	LESMA	ACEROLA	GOLA
	TABACO	CÁRIE	INSETO	TERNO
	FERMENTO	JAULA	CHINELO	SELVA
	CORRENTEZA	GARRA	TAXÍMETRO	TOSSE
	FELINO		FARELO	GOSMA
	DIVAIRO	TILHU	MARALO	LAJAU
	ETÍZERO	VARTE	CHÔNILE	SENJO
	JENALA	TEILE	BOLEFU	MÊSLA
	RO[x]ÔLA	TISSO	FOSACHONE	GADRA

Pseudowords	(roróla)			
	TASBOPE	ZÁREO	ZARRONTE	NURTO
	CAVERMO	BAFAU	TOMENFO	MOXE

Table 40

Table 41 - D3's performance on Reading Words and Pseudowords aloud in BP

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**
Frequent Words	DINHEIRO	FILHO	ESCOLA	TERRA
	CRIANÇA	LEITE	EXÉRCITO	DROGA
	COMIDA	CARTA	AMARELO	SEXO
	CIDADE	MEIA	CADERNO	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MACHUCADO	LESMA	ACEROLA	GOLA
	TABACO	CÁRIE	[ĩsẽ] TO (inseto)	TERRENO (terno)
	FERMENTO	JAULA	CHINELO	SELVA
	CORRENTEZA	GARRA	TAXÍMETRO	TOSSE
	FELINO		FA[x]ELO (farelo)	GOSMA
	DIVAIRO	TILHU	MA[x]ALO (maralo)	LAJAU
	ETIXERO	VA[xe]TE	CHONILE	SENJO

		(varte)		
Pseudowords	JANELA (jenela)	TEILE	BOLEFU	MESLA
	RO[x]OLA (rorÓla)	TISSO	FOSAXONE	GADRA
	TASBOPE	ZAREO	ZARRONTE	NARUTO (nurto)
	CAVERMO	BAF[o] (bafau)	T[omĕfu] (tomenfu)	MOCHE

Table 41

Table 42 - C3's performance on Reading Words and Pseudowords aloud in BP

	Regular		**Irregular**	
	Long	**Short**	**Long**	**Short**
Frequent Words	DINHEIRO	FILHO	ESCOLA	TERRA
	CRIANÇA	LEITE	EXÉRCITO	DROGA
	COMIDA	CARTA	AMARELO	SEXO
	CIDADE	MEIA	CADERNO	JOVEM
	FUTEBOL	REDE	JANELA	FESTA
Infrequent words	MACHUCADO	LESMA	ACEROLA	GOLA
	TABACO	CÁRIE	INSETO	TERNO
	FERMENTO	JAULA	CHINELO	SELVA
	CORRENTEZA	GARRA	TAXIMÉTRO (taxímetro)	TOSSE

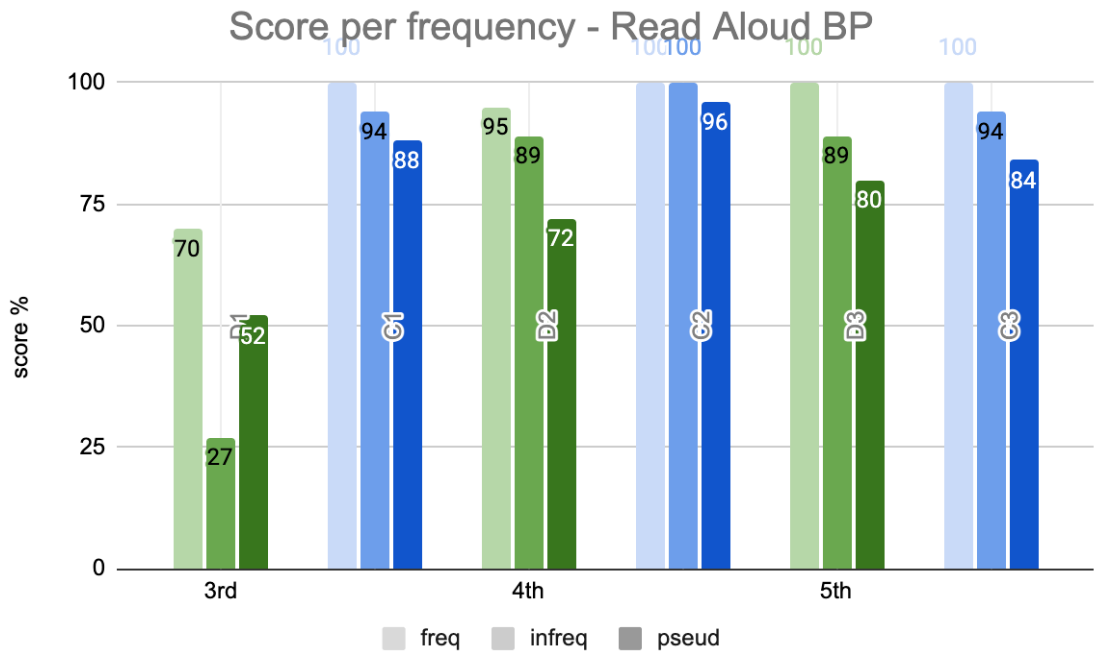
	FELINO		FARELO	GOSMA
Pseudowords	DIVAIRO	TILHU	MARALO	LAJAU
	ETICHÊRO	VARTE	CHÔNILE	SENJO
	JENALA	TEILE	BOLEFU	MÊSLA
	RO[x]OLA (roróla)	TISSO	FO[z]ASSONE (foxasone)	[dag]RA (gadra)
	TASBOPE	ZA[xe]O (zarreo)	ZARRONTE	NURTO
	CAVERMO	BAFAU	TOMENFO	MOXE

Table 42

In Graph 25, we can see the scores for accuracy per word type. The maximum score is 63 and the accuracy is verified through participants' voice recordings during their production. There is a difference for dyslexics, but that difference seems to be relatively low. Broadly, controls are better at pseudowords than dyslexics. However, D3 and C3's results present a small difference. Pseudowords creation tend to follow a regular phonological pattern of a language, irregular words do not necessarily. This may explain why D1 was better at pseudowords than infrequent words. Pseudowords was easier to D1 probably because, for him, pseudowords and infrequent words are in the same category (unknown words). The participants that have more knowledge (older participants) will have more ease with infrequent words probably because they already know those words differently from pseudowords. I observed that dyslexic participants produced similar words in their graphic and phonological form to the target word when they did not know the word, produced real words from the exposed grapheme and phoneme stimuli and also produced, at some points, only part of the word, such as "nurto" > "naruto" (D3).

In terms of score per frequency, comparing C2 and D2, the differences are 100x95, 100x89, 96x72. By doing the same with D1 and C1 and D3 and C3, it is possible to conclude that the trends are similar, that is, always lower hits for infrequent words and pseudowords, with the exception of D1, who had the lowest scores (see Graph 26 below).

Graph 25 - Score BP per frequency



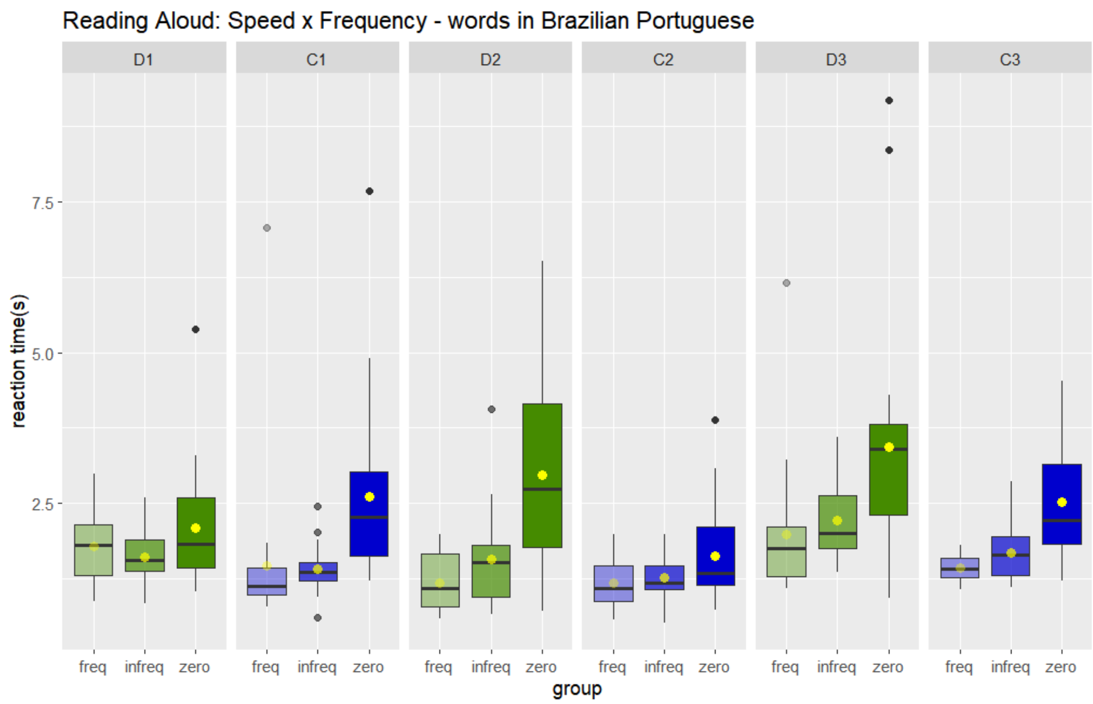
Graph 25

In the graphs below, the dyslexic participants are in green, and the control participants are in blue, the y axis is the reaction time, the x axis is the group, the yellow dot is the average response time (mean and standard deviation are also reported in Table 43). In Graph 26 (average reading time in seconds per frequency), it is possible to see that all the participants took longer to read pseudowords than infrequent words and took longer to read infrequent words than frequent words, except for D1. If you compare the longer reaction times of words in BP, most of them were pseudowords.

Also, the dyslexic group took longer to complete the tasks compared to the control group, especially for D3, who was the slowest of all. Another interesting thing that we can observe from the graph is that the distribution of times is more centered around the median and mean for those in group C, while those in group D have a more 'stretched' distribution (the box is more stretched). That is, they varied much more in time between different items than did the controls. The controls answered more or less consistently in all words, with a few exceptions, as can be seen in the outliers. In contrast, dyslexics took varied time to frequent and infrequent words and even more for pseudowords. This is important complementary data because the participants' time spent on answering reveals the difficulties they faced with different types of words, even when they eventually achieved accuracy. We can see this reflected in the standard deviation values in Table 43. That is, a person who responds consistently will have a low SD, as all their responses will be close to the average value. A person who varies a lot between items (that is, who shows some inconsistency in performance) is likely to show a high SD because the values between items vary a lot and are farther away from the mean value. So, we see that in general, dyslexics have a higher SD than their control counterparts, except for D1 compared to C1 for frequent words and pseudowords.

Besides difficulty, longer response times may also reflect the attention and careful consideration of the answer. For example, for pseudowords, even though D1 took less time to complete the task than C1, the accuracy of C1 was higher than D1 (see Graph 25), which can be interpreted as D1 guessed some words during the task. Increasingly longer times for older participants also seem to point to more engagement, yielding relatively higher accuracy, perhaps due to having more attention and responsibility with the task.

Graph 26 - Average Reading Time BP per frequency



Graph 26

Table 43 – mean and SD value according to frequency for the Reading Words and Pseudowords Aloud in BP test.

Reading words aloud in BP: frequency			
Freq	**Participants**	**Dyslexics (means + SD)**	**Controls (means + SD)**
Freq	1	1,78 (0,62)	1,47 (1,35)
	2	1,17 (0,48)	1,16 (0,37)
	3	1,99 (1,11)	1,42 (0,20)
infreq	1	1,60 (0,45)	1,41 (0,42)
	2	1,57 (0,42)	1,26 (0,41)
	3	2,21 (0,65)	1,67 (0,45)
Zero	1	2,08 (0,96)	2,61 (1,43)
	2	2,96 (1,57)	1,62 (0,77)
	3	3,44 (1,86)	2,51 (0,90)

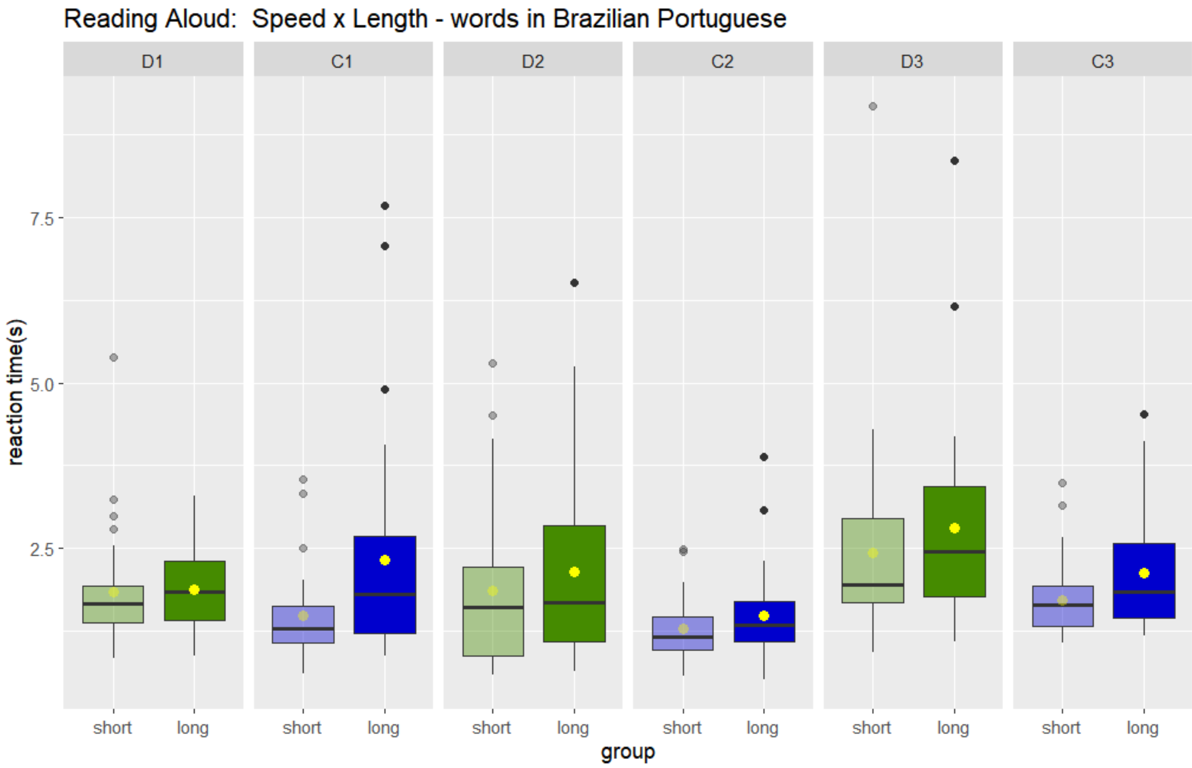
Table 43

That being said, if we look at the length of words (irrespective of type), shown Graph 27, we can see that all participants took longer to read longer words, as expected, and the control group scored better (D1xC1: short: 72x97, long: 29x97 / D2xC2: short: 84x100, long: 84x97 / D3xC3: short: 87x94, long: 78x90, max. score =100) than the dyslexic group when comparing the length of words, as expected (see Graph 27).

D1's average response time to read short words was 1.8 seconds and 1.8 seconds to long words, which may reflect a certain impulsiveness in his answering. C1's average response time to read short words was 1.4 seconds and 2.3 seconds to long words. D2's average response time to read short words was 1.8 seconds and 2.1 seconds to long words. C2's average response time to read short words was 1.2 seconds and 1.4 seconds to long words. D3's average response time to read short words was 2.4 seconds and 2.8 seconds to long words. C3's average response time to read short words was 1.7 seconds and 2.1 seconds to long words (see Table 44).

Although the same tendencies are observed in all groups, dyslexics are slower and vary more in time.

Graph 27 - Average Reading Time BP per length



Graph 27

Table 44 – mean and SD value according to length for the Reading Words and Pseudowords Aloud in BP test.

Reading words aloud in BP: length			
Length	**Participant**	**Dyslexics (means + SD)**	**Controls (means + SD)**
short	1	1,83 (0,87)	1,48 (0,67)
	2	1,85 (1,22)	1,27 (0,46)
	3	2,43 (1,53)	1,72 (0,57)
long	1	1,86 (0,64)	2,31 (1,64)
	2	2,14 (1,49)	1,47 (0,70)
	3	2,81 (1,49)	2,13 (0,92)

Table 44

Graph 28 - Score BP per length

Graph 28

Overall, the results show that although dyslexics' scores and response times approach those of controls, dyslexic participants present lower, albeit good scores, especially D2 and D3 whose scores are ≥89 for frequent and infrequent words, while pseudowords yield lower scores, they are still 72 (D2) and 80 (D3), that is above inadequate (<50). D1 seems to show more difficulty, especially if we consider the type of mistakes made and the scores for infrequent words and pseudowords, but even his score for frequent words is around average (70).

11.11 READING WORDS AND PSEUDOWORDS ALOUD IN ENGLISH

In this test, participants saw words (frequent, infrequent and pseudowords) in English on a computer screen and had to read them out loud and push the spacebar on the keyboard to go to the next word, both accuracy and reaction time were recorded.

In the following tables, participant's production will be described. In green are the words which the participant scored 1 point and in red the words which the participant scored 0 points.

Only parts of the word that contained the mispronunciation are transcribed phonetically. When participants produced a different word (ex. "México" for "exército" (D1), the word is written in graphemes.

D1 had 6 mistakes for frequent words, 12 for infrequent words and 13 for pseudowords. C1 had no mistakes, but he read the word "coundung" 3 times. D2 had 1 mistake for frequent words, 2 for infrequent words and 5 for pseudowords. C2 had no mistakes. D3 had 1 mistake for infrequent words and 6 for pseudowords. C3 had 1 mistake for frequent words and 2 for pseudowords.

It is interesting to note that D1 seemed to have a lot of difficulties in reading out loud in English, as he did in the English dictation test, but in this test we see that the strategy of replacing the target word with another existing word is more recurrent in all categories, as in "party" for "property", "play" for "pineapple", or "science" for "seans". There is also some use of parts of words, such as in "hurbance" for "hurricane", and quite a lot of deletion, as in "over" for "overcoat. Both D2 and D3 also apply word substitution, but less frequently; for example, both of them switched "bunding" for "building". In a few other instances they changed or deleted one segment, such as in "sali[k]ous" for "salicious" or "heding" for "hending". However, their difficulties were mostly restricted to pseudowords, as was the case for C3.

Table 45 - D1's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	[ʒeniva] (government)	BOOK	MORNING	ROAD
	PARTY (property)	LAND	HUSBAND	[kaI]TY (city)
	SECRETARY	FREE (fire)	PICTURE	HOUSE

	UNIVERSITY	HEAD	CHILD (children)	PAPER
	OFFICER	BILL	[əns]DISTANCE (audience)	RIVER
Infrequent words	[brəvẽʒ] (beverage)	SEAM	PLAY (pineapple)	LUNG
	UMBRELLA	TACK	GENTLE (gentlemen)	GOAT
	HURBANCE (hurricane)	PILE	ALLAT (alligator)	NOOSE
	OVER (overcoat)	BRA (bark)	BUTTERFø (butterfly)	BASIC (basin)
	[rispɛtəɹ] (raspberry)	WIND	FUTURE (furniture)	[tɹɛt] (straw)
Pseudowords	BUNDING	FORN	[lɛn] (lankers)	DESS
	[god] (goanded)	GOOT	MOLDEST	FRUG
	[sʌltI] (slatter)	CASTS (cates)	DEVE[ɹʒ] (deverage)	MACT
	C[o]DING (counding)	SCIENCE (seans)	GISC (giscout)	AM[ad] (amude)
	MITTERS	DAKE	MEN[t] (meneration)	SMILE (smill)
	HEN	PANK	LISCI	TUZZLE

	(hending)		(saliscious)	

Table 45

Table 46 - C1's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECRETARY	FIRE	PICTURE	HOUSE
	UNIVERSITY	HEAD	CHILDREN	PAPER
	OFFICER	BILL	AUDIENCE	RIVER
Infrequent words	BEVERAGE	SEAM	PINEAPPLE	LUNG
	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILE	ALLIGATOR	NOOSE
	OVERCOAT	BARK	BUTTERFLY	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW
Pseudowords	BUNDING	FORN	LANKERS	DESS
	GOUNDED	GOOT	MOLDEST	FRUG
	SLATTER	CATES	DEVERAGE	MACT
	COUNDING (3X)	SEANS	GISCOUT	AMUDE
	MITTERS	DAKE	MENERATION	SMILL

	HENDING	PANK	SALICIOUS	TUZZLE

Table 46

Table 47 - D2's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECURITY (secretary)	FIRE	PICTURE	HOUSE
	UNIVERSITY	HEAD	CHILDREN	PAPER
	OFFICER	BILL	AUDIENCE	RIVER
Infrequent words	B[I]VERAGE (beverage)	SEAM	PINEAPPLE	LUNG
	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILL (pile)	ALLIGATOR	NOOSE
	OVERCOAT	BARK	BUTTERFLY	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW
	BUILDING (bunding)	FORN	LANKERS	DESS
	GOUNDED	GOOT	MOLDEST	FRUG
	SALTER	C[a]TES	D[I]VERAGE	MACT

Pseudowords	(slatter)	(cates)	(deverage)	
	C[oU]NDING (counding)	SEANS	GISCOUT	AMUDE
	MITTERS	DAKE	MENERATION	SMILL
	HENDING	PANK	SALICIOUS	TUZZLE

Table 47

Table 48 - C2's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECRETARY	FIRE	PICTURE	HOUSE
	UNIVERSITY	HEAD	CHILDREN	PAPER
	OFFICER	BILL	AUDIENCE	RIVER
Infrequent words	BEVERAGE	SEAM	PINEAPPLE	LUNG
	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILE	ALLIGATOR	NOOSE
	OVERCOAT	BARK	BUTTERFLY	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW
	BUNDING	FORN	LANKERS	DESS

Pseudowords	GOUNDED	GOOT	MOLDEST	FRUG
	SLATTER	CATES	DEVERAGE	MACT
	COUNDING	SEANS	GISCOUT	AMUDE
	MITTERS	DAKE	MENERATION	SMILL
	HENDING	PANK	SALICIOUS	TUZZLE

Table 48

Table 49 - D3's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECRETARY	FIRE	PICTURE	HOUSE
	UNIVERSITY	HEAD	CHILDREN	PAPER
	OFFICER	BILL	AUDIENCE	RIVER
Infrequent words	BEVERAGE	SEAM	PINEAPPLE	LUNG
	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILE	ALLIGATOR	NOOSE
	OVERCOAT	BARK	BUTTERFL[U]/[I] (butterfly)	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW

Pseudowords	BUILDING (bunding)	FORN	LANKERS	DESS
	GROUNDED (gounded)	GOOT	MOLDEST	FRUG
	SLATTER*	CATES	DEVERAGE	MACT
	COUNDING	SEANS	GISC[u]NT (giscout)	AMUDE
	MITTERS	DAKE	MENERATION	SMILL
	HEDING (hending)	PANK	SALI[k]OUS (salicious)	TUZZLE

Table 49

*: time was up, and the participant could not read this word aloud

Table 50 - C3's performance on Reading Words and Pseudowords aloud in EN

Orthographic Neighborhood	**-**	**High**	**-**	**Low**
Length	**Long**	**Short**	**Long**	**Short**
Frequent Words	GOVERNMENT	BOOK	MORNING	ROAD
	PROPERTY	LAND	HUSBAND	CITY
	SECURITY (secretary)	FIRE	PICTURE	HOUSE
	UNIVERSITY	HEAD	CHILDREN	PAPER
	OFFICER	BILL	AUDIENCE	RIVER
	BEVERAGE	SEAM	PINEAPPLE	LUNG

Infrequent words	UMBRELLA	TACK	GENTLEMEN	GOAT
	HURRICANE	PILE	ALLIGATOR	NOOSE
	OVERCOAT	BARK	BUTTERFLY	BASIN
	RASPBERRY	WIND	FURNITURE	STRAW
Pseudowords	BUNDING	FORN	LANKERS	DESS
	GOUNDED	GOOT	MOLDEST	FRUG
	SLATTER	CATES	DEVERAGE	MACT
	COUNDING	SEANS	DISCOUNT (giscout)	AMUDE
	MITTERS	DAKE	MENERATION	SMILL
	HEDING (hending)	PANK	SALICIOUS	TUZZLE

Table 50

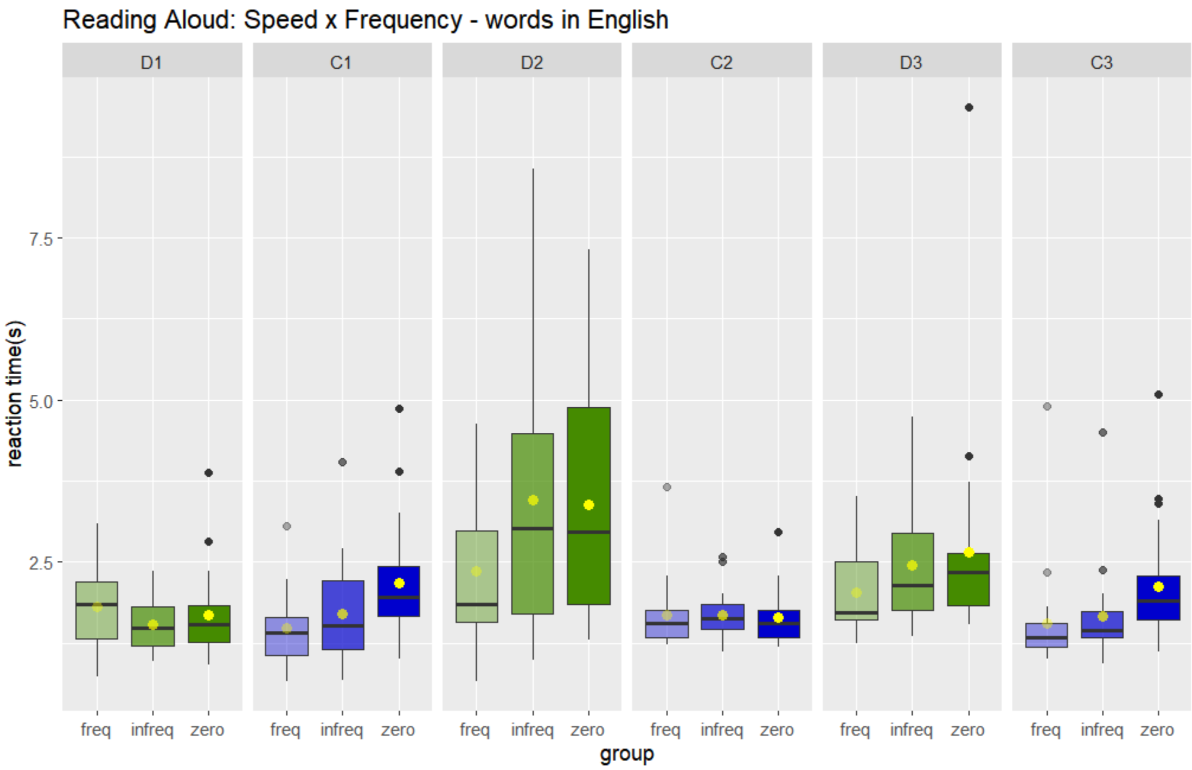
In the graphs below, reaction times are shown. The dyslexic participants are in green and the control participants are in blue, the y axis shows the reaction time, the x axis the age group, the yellow dot is the average response time. In Graph 29 (average reading time in seconds per word type), it is possible to see that the participants took longer to read different types of words. When it comes to reading time, dyslexic participants took longer to read (see Graph 29). Comparing time spent for words in BP to EN, in BP most of them were pseudowords that is a different result compared to EN, which seems to have been more of a mix of word types (frequent, infrequent and pseudowords).

Another interesting thing that we can observe from the graph is that the distribution of data is more centered around the median and mean for those in group C, while those in group D have a more 'stretched' distribution (the box is more stretched), with the exception of D1. That is, they varied much more in time between different items than did the controls. The controls answered more or less consistently in all words, with a few exceptions as reflected in outliers. Even though D1 took less time to complete the task than C1, the accuracy of C1 was higher than D1 (see graph 21), which might be caused by the fact that D1 guessed some words (incorrectly) during the task.

Of all participants, D2 was the slowest, spending 2.3 seconds to read frequent words, 3.4 seconds to read infrequent words, 3.3 seconds to read pseudowords; while C2 was the fastest and most consistent, with 1.68 seconds to read frequent words, 1.69 seconds to read infrequent words, 1.65 seconds to read pseudowords (for all mean and SD values see Table 51)

When it comes to reading time, for both frequency (see Graph 29) and length (see Graph 30), the dyslexic group took longer to complete the task. During the task, D2 took a longer time to pronounce the word orally after looking at it.

Graph 29 – Average Reading Time EN per frequency



Graph 29

Table 51 - SD value according to frequency for the Reading Words and Pseudowords Aloud in EN test.

Reading words aloud in EN: frequency			
Freq	**Participants**	**Dyslexics (means + SD)**	**Controls (means + SD)**
freq	1	1,81 (0,63)	1,48 (0,56)
	2	2,35 (1,17)	1,68 (0,53)
	3	2,03 (0,67)	1,55 (0,85)
infreq	1	1,54 (0,37)	1,70 (0,81)
	2	3,45 (2,28)	1,69 (0,37)
	3	2,46 (0,94)	1,66 (0,75)
zero	1	1,68 (0,66)	2,18 (0,92)
	2	3,38 (1,83)	1,65 (0,43)
	3	2,65 (1,61)	2,13 (0,92)

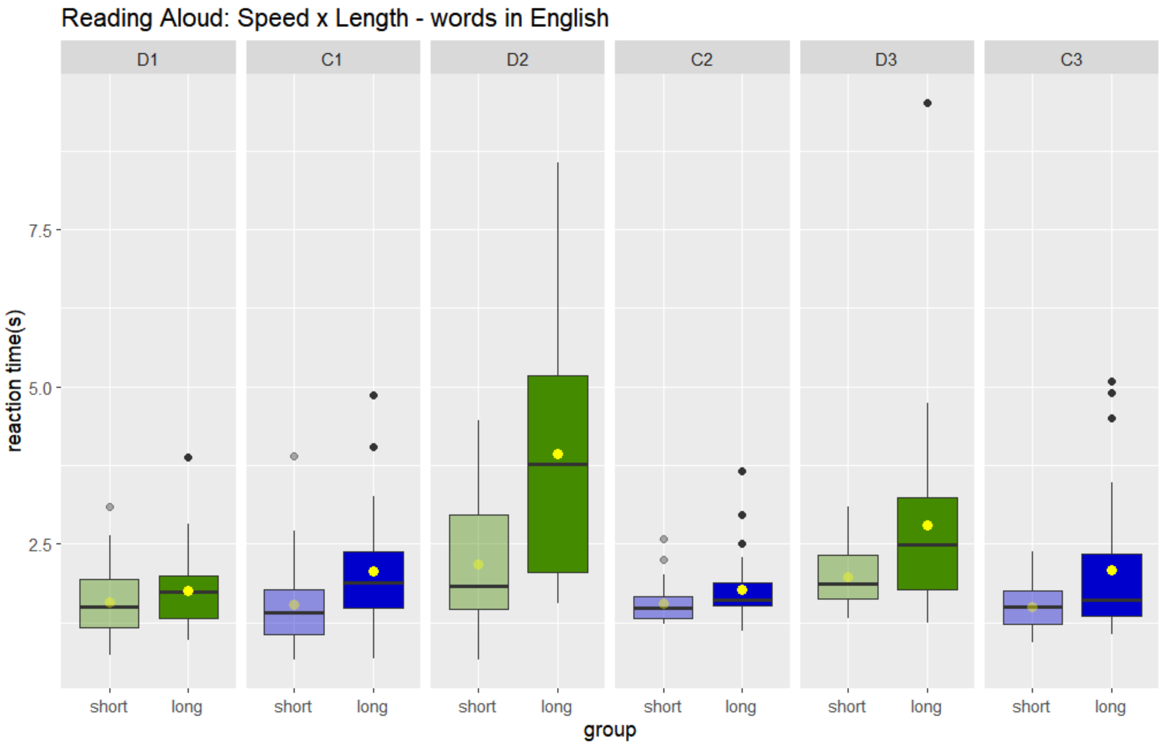
Table 51

D1 showed a tradeoff between speed and score. Older participants took longer to complete the task, which may have led to more attention and higher scores. The tradeoff between speed and accuracy seems to be more pronounced in dyslexics than controls. Controls develop both accuracy and speed, whereas dyslexics take longer to read infrequent words, which yield correct answers, and even longer for pseudowords, which still leads to relatively low scores.

That being said, in terms of length, by looking at Graph 30, the participants took longer to read longer words and were more inconsistent (greater variability in reaction times), as was expected, and, by looking at Graph 31, the control group scored better (D1xC1: short:72x100, long: 31x100 / D2xC2: short: 94x100, long: 81x100 / D3xC3: short: 100x100, long: 78x91) than the dyslexic group when comparing the length of words, as expected.

D1's average response time to read short words was 1.5 seconds and 1.7 seconds to long words. C1's average response time to read short words was 1.5 seconds and 2 seconds to long words. D2's average response time to read short words was 2.1 seconds and 3.9 seconds to long words. C2's average response time to read short words was 1.5 seconds and 1.7 seconds to long words. D3's average response time to read short words was 1.9 seconds and 2.7 seconds to long words. C3's average response time to read short words was 1.5 seconds and 2 seconds to long words (see Table 52).

Graph 30 - Average Reading Time EN per length



Graph 30

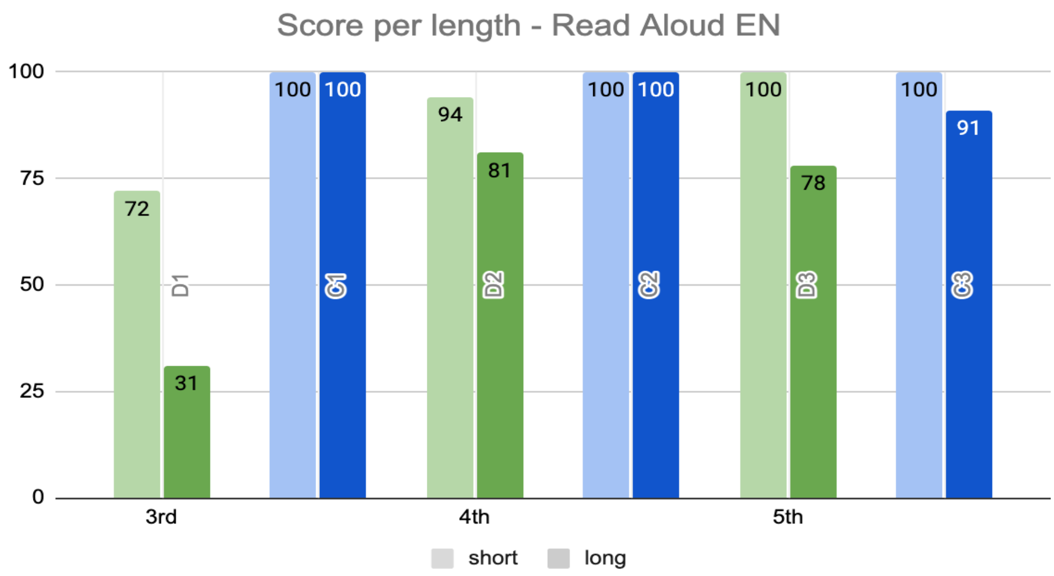
Table 52 - SD value according to length for the Reading Words and Pseudowords Aloud EN test.

Reading words aloud in EN: length			
Length	**Participants**	**Dyslexics (means + SD)**	**Controls (means + SD)**
short	1	1,58 (0,55)	1,54 (0,65)
	2	2,18 (0,96)	1,56 (0,33)
	3	1,97 (0,46)	1,51 (0,34)
long	1	1,76 (0,59)	2,07 (0,91)
	2	3,93 (2,09)	1,78 (0,51)
	3	2,27 (1,50)	2,08 (1,11)

Table 52

There is a similar tendency here but an extreme effect for dyslexics. Controls (mainly C2) do not vary much in terms of performance depending on the item, they read all items consistently with roughly the same reading time. This might be explained by the fact that C2 was diagnosed with high abilities and there is a suspicion that it is for language. Conversely, dyslexics have a much bigger variability, they take longer to some items than others which is a sign of performance variability. Any cognitive pressure on dyslexics will reveal more difficulty and longer times in their performances.

Graph 31 - Score EN per length



Graph 31

Overall, these results confirm that dyslexics have less success with pseudowords compared to controls, however for D2 and D3 their scores are still 75. For D2 and D3, their performance for frequent and infrequent words approaches controls' scores – indeed for frequent words D3 achieved the maximum score. However, D1's performance is still much below that of older dyslexics.

In the test, D1 produced similar words in their graphic and phonological form to the target word, produced real words from the exposed grapheme and phoneme stimuli and also produced, at some points, only part of the word, such as: smill > smile / basin > basic / property > party / pineapple > play / children > child / gentleman > gentle / overcoat > over / fire > free / furniture > future / bark > bra / seans > science / hending > hen. This strongly suggests that D1 was aiming at a lexical mapping.

In our view, this result reveals that D1 used the lexical route to produce these words, making use of the word form and not the grapheme X phoneme transcription (phonological route), that is, at that moment, D1 applies different reading strategies in Portuguese and English, that is, so far, different from other participants that seem to have a more structured reading. This difference can also be explained by the context in which it is inserted and his age, once he is the youngest participant. At school, he is more exposed to English than Portuguese, which is to say that he has more access to English words than Portuguese words in this context, practices whole-word reading more as well as writing. Participants D2 and D3 may have reached their current more successful reading performance by way of direct lexical mapping; the fact that they also produced word substitutes for target words seems to suggest that.

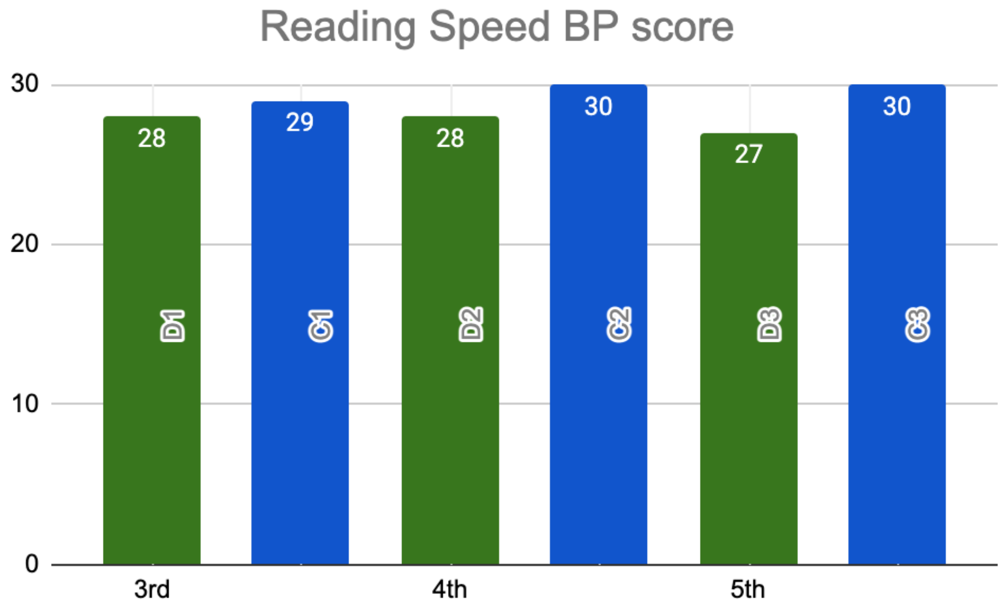
11.12 READING SPEED OF SENTENCES IN BRAZILIAN PORTUGUESE

In this test, participants had to read sentences and judge their truth value. Better results were expected from the control group for both time and accuracy, with faster reading and decreasing reading time with age, as well as a slower reading of long sentences and faster reading of short sentences. It is expected that the control group scores better than the dyslexic group and reads faster than them. The control group took less time to complete the task than the dyslexic group.

In terms of accuracy, all the participants had similar scores, meaning that they were decoding not only the letters but also the meaning of the sentences (see Graph 32). The maximum score is 30 points. However, it is possible to see that the control group got slightly higher scores (varying from 29 to 30) than the dyslexic group (varying from 27 to 28). Also, C1's ‘wrong’ answer was the sentence "O CORAÇÃO É VERMELHO" in which he disputed was purple, therefore, it is safe to say that all participants from the control group scored 30 points, the maximum score.

As the task of judging the truth value of the sentences is subject to interpretations that may vary, the reason for incorrect answers may vary, and, thus, not always reflect a lack of comprehension. D1 marked wrong answers for the sentences "O CACHORRO LATE" and "EU VARRO A CASA COM A VASSOURA", which seem to be pretty much objectively true. Both D2 and D3 answered incorrectly with the sentence "EU USO AS MÃOS PARA TOCAR". For example, they may have considered that the alien monster (the supposed speaker of the experiment) does not have ‘hands’ exactly, but because they didn’t mention anything explicitly to suggest so, we considered their answers incorrect. When C1 read the sentence "O CORAÇÃO É VERMELHO", he asked me if he was supposed to answer that it was a true answer even though it is not, because he mentioned that the heart is purple and not red, the software read this answer as wrong but, as it is open to interpretation, I have considered it a right one. D2 also wrongly answered the somewhat poetic sentence "AS NUVENS FICAM NO MAR". D3's incorrect answer was also to a possibly fantastical sentence "AS ÁRVORES FICAM NO CÉU". He also answered "NA PRAIA NÃO TEM AREIA" wrong, whose negative operator may have slipped by him. C1 and C3 scored right answers for all sentences.

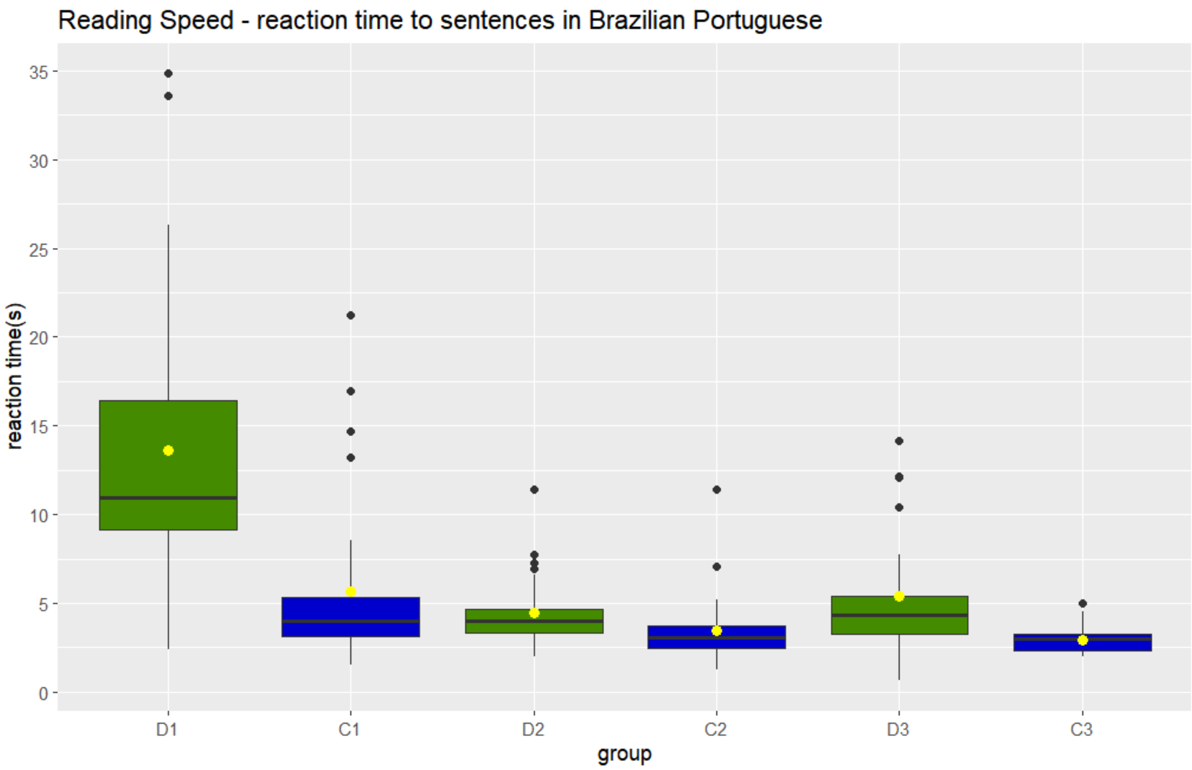
Graph 32 - Reading Speed of Sentences BP score



Graph 32

Graph 33 shows median, the distribution of reaction times and mean (yellow dot). In general, results are remarkably similar but faster for controls. There is evidently an age effect for dyslexics perhaps due to the fact that older participants did not get lost in the task's lucidity. D1 constantly made comments on the content of sentences and the hypothetical situation, for example "why is he asking if white is a dark color if his teeth are white?". Possibly because D1 is the youngest participant (8 years old) he was curious about the story and that's why he stopped a few times to comment on what the alien was asking. Older participants know the pretext of this task, for example, C1 in the "O CORAÇÃO É VERMELHO" sentence told me "You know that the heart is not red, right? But do you want me to answer that it is?".

Graph 33 - Reading Speed of Sentences BP average response time



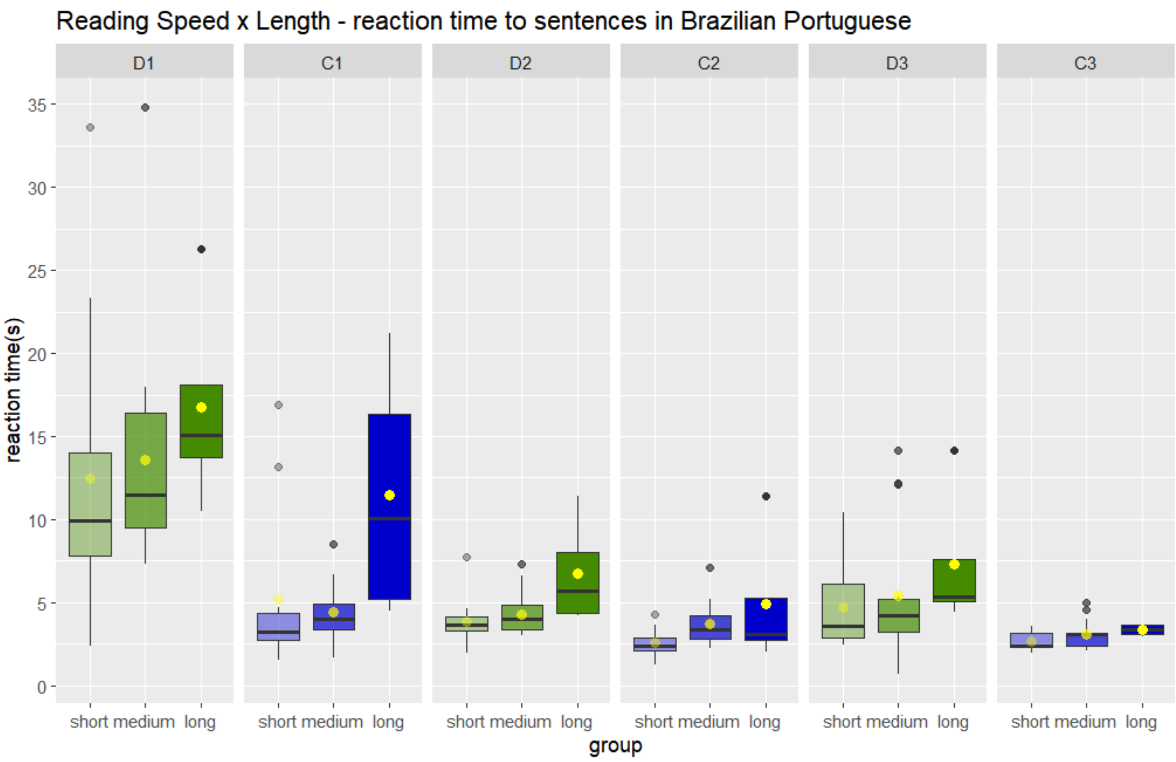
Graph 33

Based on Graph 34, it is possible to state that all the participants took longer to complete the task for long sentences, especially C1, D2 and C2. It is also possible to see that the response time decreases as age increases (see Table 53).

D1's average response time was the longest, with 12.4 seconds for short sentences, 13.5 seconds for medium sentences, 16.7 seconds for long sentences, and in general, his average response time was 14.2 seconds. However, these numbers may not portray D1's Reading Speed of Sentences very accurately, once D1 was very easily distracted throughout the test, taking longer to complete the task. On the other hand, we might consider that D1 has probably just finished his reading instruction process. C1 average response time to short sentences was 5.1 seconds, to medium sentences was 4.4 seconds, to long sentences was 11.1 seconds (not a trusted data, once the time spent with the sentence "o coração é vermelho" is being added) and in general, his average response time was 7 seconds. D2 average response time to short sentences was 3.8 seconds, to medium sentences was 4.2 seconds, to long sentences was 6.7 seconds and in general, his average response time was 4.9 seconds. C2 average response time to short sentences was 2.5 seconds, to medium sentences was 3.7 seconds, to long sentences was 4.8 seconds and in general, his average response time was 3.7 seconds. D3 average response time to short sentences was 4.7 seconds, to medium sentences was 5.3 seconds, to long sentences was 7.3 seconds and in general, his average response time was 5.8 seconds. C3 average response time to short sentences was 2.6 seconds, to medium sentences was 3 seconds, to long sentences was 3.3 seconds and in general, his average response time was 3 seconds.

If we look at the distribution of the data in the graph, as well as standard deviation values in Table 53, we see that overall dyslexics vary more in their answers, showing thus less consistency than controls; with the exception of C1 whose data may be a bit skewed as mentioned before.

Graph 34 - Reading Speed of Sentences BP average response time per length



Graph 34

Table 53 – mean and SD values according to length for the Reading Speed of Sentences BP test.

Reading sentences in BP: length			
Length	**Participant**	**Dyslexics (means + SD)**	**Controls (means + SD)**
short	1	5,18 (5,03)	2,56 (0,86)
	2	2,65 (0,56)	12,46 (9,98)
	3	3,88 (1,49)	4,74 (2,65)
medium	1	4,42 (1,66)	3,72 (1,30)
	2	3,05 (0,86)	13,58 (6,98)
	3	4,30 (1,27)	5,38 (4,12)
long	1	11,45 (7,99)	4,89 (4,37)
	2	3,34 (0,36)	16, 75 (6,73)
	3	6,75 (3,35)	7,33 (4,56)

Table 53

Broadly, dyslexics are slower, however, the differences between controls and dyslexics seem less expressive for this task. What calls attention to this analysis is the age difference, younger participants engaged more in this task (due to their maturity and to the task's lucidity), whereas older participants get a lot faster. This is contrary to the reading aloud task for words, for which older participants took more time. This may mean that the degree of difficulty of the word reading task is higher and that participants are relatively unfamiliar with it, compared to reading sentences. Syntactic and semantic context may help participants' reading process. Also, no infrequent or pseudowords were used for the sentence task, which may also explain participants' more homogeneous behavior.

11.13 READING SPEED OF SENTENCES IN ENGLISH

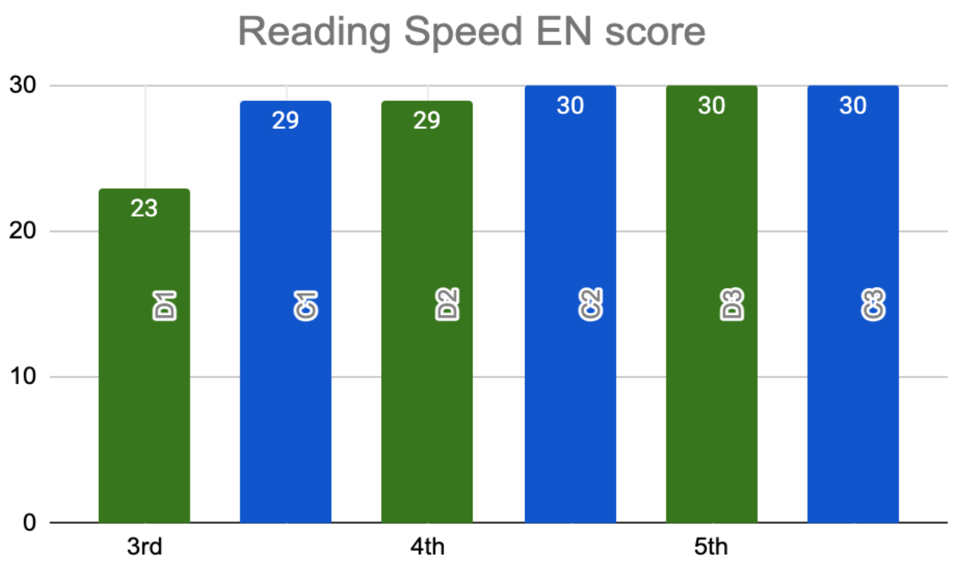
In this test, participants had to read sentences and judge their truth value. Better results were expected from the control group for both time and accuracy, with faster reading and decreasing reading time with age (and with schooling), as well as a slower reading of long sentences and faster reading of short sentences. We expected the control group to achieve higher scores than the dyslexic group and to read faster than them.

In terms of accuracy, all the participants had similar scores (from 29 to 30 out of a maximum of 30), D2, D3 and C3 scored 100% of right answers, meaning that they were decoding not only the letters but also the meaning of the sentences (see Graph 35).

However, D1 showed more difficulty, with 23 out of 30 correctly answered, or 76,6%, which is still generously above chance.

Reasons for not getting the target answer may not always be a lack of comprehension. Both C1 and C2 wrongly answered the sentence "ALICE IS A GIRL'S NAME". D1 wrongly answered the sentences: "I AM A GIRL", "I CAN PLAY GAMES ON MY PHONE", "THE AIRPLANE CAN NOT FLY", "BIRDS CAN'T FLY", "THERE ISN'T MONEY IN THE BANK", "I USE A PEN TO WRITE" and "WE WEAR SOCKS IN OUR NOSES". Some of these seem objectively true or false (ex. “Birds can’t fly”), others may not. We speculate that D1's problem was interpretation and content questioning, not necessarily comprehension in all cases. D1 constantly made comments on the content of sentences and the hypothetical situation, for example "why is he asking if white is a dark color if his teeth are white?". Therefore, D1 probably dove into the story while reading.

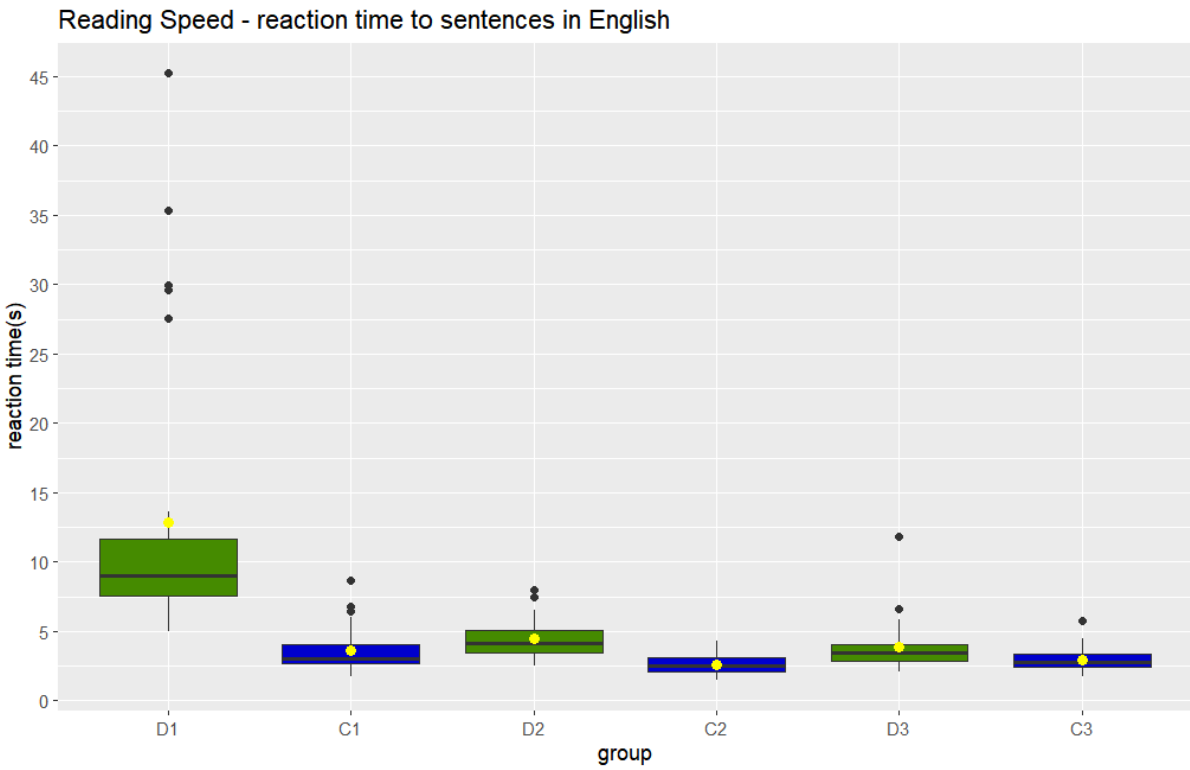
Graph 35 - Reading Speed of Sentences EN score.



Graph 35

Graph 36 represents the median, the distribution of reaction times and mean (yellow dot). The control group responded faster than the dyslexic group, also, there is a slight difference between age groups: older participants' response time is faster than young ones. Yet, it seems that the difference was not that big, with the exception of D1 that probably has just finished his reading instruction process and was the most engaged participant, which distracted him from completing the task in a swift manner. He was curious about the story and that's why he stopped a few times to comment on what the alien was asking. The results are remarkably similar among the older participants and there is the same effect of BP. For control participants, there seems to be a ceiling effect, the maximum speed is conquered for both C2 and C3. For dyslexics, there is a stair effect (lower times for older participants).

Graph 36 - Reading Speed of Sentences EN average response time.



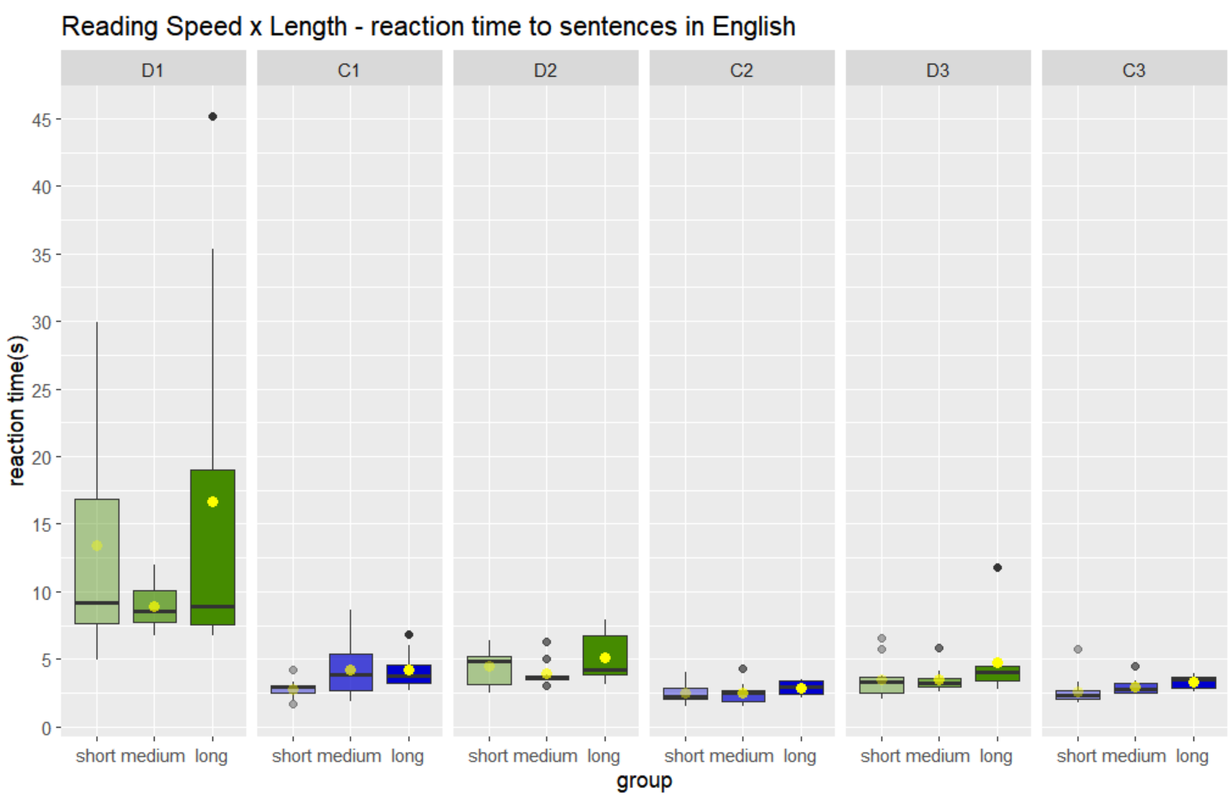
Graph 36

Based on Graph 37, it is possible to state that all the participants took longer time to complete the task for long sentences, with the exception of C1 that took longer to complete the task of medium sentences. Also, there is a slight difference between age groups: older participants' response time is smaller than young ones. Likewise, older dyslexics answered faster than young ones (D3's response time is smaller than D2's, which is smaller than D1's response time) (see Graph 37).

D1 average response time to short sentences was 13.4 seconds, to medium sentences was 8.9 seconds, to long sentences was 16.7 seconds and in general, his average response time was 13 seconds. However, these numbers might be more representative of D1’s distraction than of his Reading Speed of Sentences. C1 average response time to short sentences was 2.8 seconds, to medium sentences was 4.2 seconds, to long sentences was 4.1 seconds and in general, his average response time was 3.7 seconds. D2 average response time to short sentences was 4.4 seconds, to medium sentences was 3.9 seconds, to long sentences was 5 seconds and in general, his average response time was 4.5 seconds. C2 average response time to short sentences was 2.5 seconds, to medium sentences was 2.5 seconds, to long sentences was 2.8 seconds and in general, his average response time was 2.6 seconds. D3 average response time to short sentences was 3.5 seconds, to medium sentences was 3.4 seconds, to long sentences was 4.7 seconds and in general, his average response time was 3.9 seconds. C3 average response time to short sentences was 2.6 seconds, to medium sentences was 2.9 seconds, to long sentences was 3.3 seconds and in general, his average response time was 2.9 seconds.

If we look at the distribution of the data in the graph, as well as standard deviation values in Table 54, we see that overall dyslexics vary a little more in their answers, showing thus less consistency than controls. D1 shows most variability, and of controls. C1 is still a little less consistent.

Graph 37 - Reading Speed of Sentences EN average response time per length



Graph 37

Table 54 – mean and SD values according to length for the Reading Speed of Sentences EN test.

Reading sentences in EN: length			
Length	**Participant**	**Dyslexics (means + SD)**	**Controls (means + SD)**
short	1	2,81 (0,68)	2,52 (0,81)
	2	2,62 (1,06)	13,5 (9,66)
	3	4,46 (1,23)	3,50 (1,37)
medium	1	4,25 (2,14)	2,50 (0,82)
	2	2,96 (0,65)	8,92 (1,69)
	3	3,98 (0,97)	3,48 (0,92)
long	1	4,17 (1,49)	2,88 (0,53)
	2	3,31 (0,50)	16,70 (14,94)
	3	5,10 (1,93)	4,80 (2,91)

Table 54

Apparently, there is a bit of increase in time for longer sentences but not so much. D1 is the exception. This task is more ludic than the others, which may have affected D1's time response along with his relative inexperience in reading.

To sum up, all the participants had roughly similar accuracy scores, having slight differences between them, meaning that they were decoding not only the letters and words, but also the meaning of the sentences (see graph 38). However, participant D1 scored worse, possibly due to less time being in contact with the English language and due to being the most distracted participant during the tasks.

We speculate that, in part, D1's mistakes were not due to not understanding, but due to the ease in which he believed the background story (an alien that had just arrived on earth and needed to learn about our planet, needing his help).

Besides measuring Reading Speed of Sentences, this test also measures proficiency, once the reader is not guessing the meaning but understanding what is written (accuracy results in Table 55). Along with the proficiency test based on vocabulary this test seems to complement proficiency measures in an interesting way, based on the scores achieved.

Reading words in English is different from reading sentences in English. The advantage of reading tasks in English compared to Portuguese for dyslexics is seen mainly in sentence reading because it has more context, semantics and logic (compared to section 11.10 and 11.11). In the pseudoword reading, nothing helps you, you see an isolated word and have to decode it. Context helps the reader to predict lexical content.

Table 55 - Reading Speed of Sentences EN accuracy (in %).

Reading sentences in EN: accuracy (in %)		
Participant	**Dyslexics**	**Controls**
1	77	97
2	97	100
3	100	100

Table 55

12 COMPARING AND DISCUSSING THE RESULTS BETWEEN BRAZILIAN PORTUGUESE AND ENGLISH

In this section I will compare participants' performance for those assessments that were done in both languages, which are dictation, reading speed of sentences and reading words and pseudowords aloud tasks. The main objective of this section is to assess participant's performance in both languages, making a comparison between them.

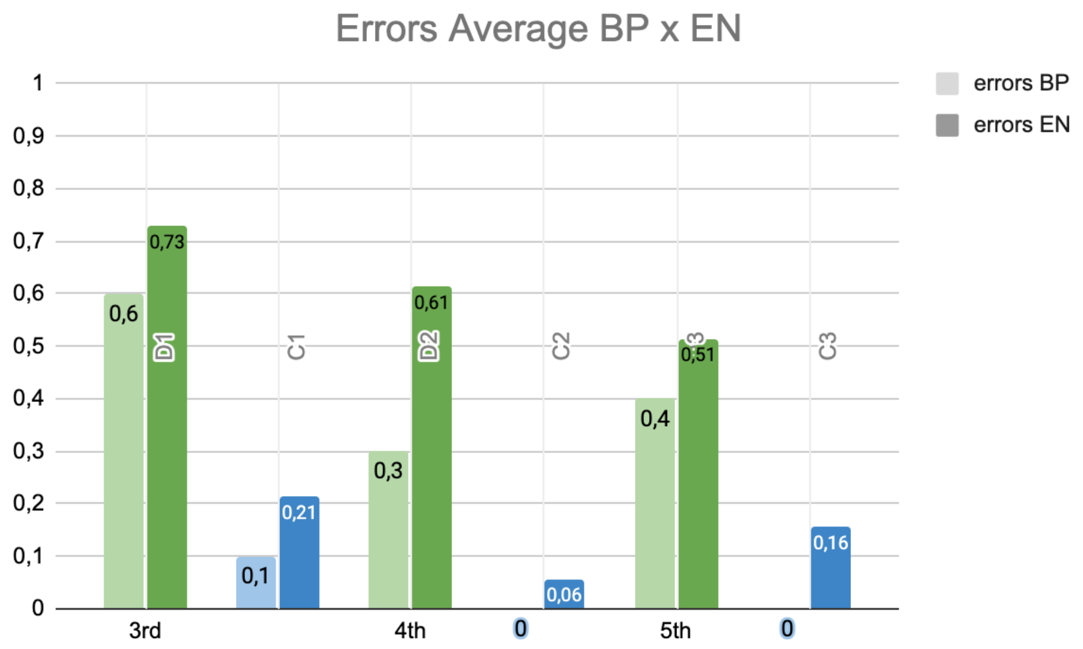
12.1 DICTATION BP x EN

Starting with the comparison between dictation tests in both languages, better results in BP than in EN were expected given that BP is their first language (L1). On the other hand, even though their language of instruction and literacy is in English, the expectancy of better results in BP is due to greater lexical knowledge and greater grapheme-phoneme correspondence intuition.

By looking at Graph 38, as a result, by counting the number of errors per word and comparing BP to EN, participants scored better (shorter bars) in BP than EN: D1 scored 0.6 in BP and 0.73 in EN, D2 scored 0.3 in BP and 0.21 in EN, D3 scored 0.4 in BP and 0.51 in EN, C1 scored 0.1 in BP and 0,21 in EN, C2 scored 0 in BP and 0,06 in EN and C3 scored 0 in BP and 0.16 in EN. Also, controls scored better than dyslexics. In Graph 38, the control group is in blue and the dyslexic group in green.

Nevertheless, in the qualitative analysis (see Graph 22), although the control group scored better than the dyslexic group (C1 scores 59 whereas D1 scored 31, C2 scores 67.5 whereas D2 scored 37.5, C3 scores 62 whereas D3 scored 45.5), there is a significant improvement of the dyslexic group as the school years pass, perhaps due to reading/writing exposition in English. The quantitative analysis has the maximum score of 70 points (1 point per word). Indeed, regarding participants from the control group, C2 is the one that prefers English for reading and writing (see Graph 5), therefore, this can explain the short difference between controls.

Graph 38 - Dictation score BP x EN



Graph 38

Table 56 - Dictation BP x EN errors average

Dictation BP x EN: errors average			
Language	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	1	0,6	0,1
	2	0,3	0
	3	0,4	0
English	1	0,73	0,21
	2	0,61	0,06
	3	0,51	0,16

Table 56

The data seem to confirm the difference between cognitive processes involved in reading and writing. In writing, the transparency of a language seems to help as we can see that the scores in BP were greater than in EN (D1 scored 0.6 in BP and 0.73 in EN, D2 scored 0.3 in BP and 0.21 in EN, D3 scored 0.4 in BP and 0.51 in EN, C1 scored 0.1 in BP and 0,21 in EN, C2 scored 0 in BP and 0,06 in EN and C3 scored 0 in BP and 0.16

in EN). This result is not replicated in reading (see section 11.10 and 11.11). In reading, better results occur in English.

The advantage of English is not that highlighted in writing compared to reading. Maybe there is no advantage. All participants were better in the BP Dictation test than EN. Perhaps those transference of strategy effects do not have the same effects, at least in my study.

12.3 READING WORDS AND PSEUDOWORDS ALOUD BP x EN

In Graph 32, we can see the scores for reading words aloud in both BP and EN, with lighter tones for BP and distinct colors marking the category of the words (frequent, infrequent, pseudoword – or zero for frequency). In terms of score per frequency, by comparing the two languages, results show that the scores are the same between languages for frequent words (represented in blue) for all participants (C1, C2 and D3 scored 100% for both, D2 95% for both, D1 70% for both) with the exception of C3 take scored higher for BP than EN frequent words (100% for BP and 95% for EN). For infrequent words (represented in green), EN scores were greater than BP in both groups (D1 scored 40% for EN and 25% for BP, C1 scored 100% for EN and 95% for BP, D2 scored 90% for EN and 88% for BP, C2 scored 100% for both, D3 scored 95% for EN and 88% for BP, C3 scored 100% for EN and 95% for BP), perhaps due to their reading instruction in English. It really seems to make sense that reading expands our vocabulary knowledge (and especially about its spelling form), so, as they have more contact with English reading and writing, they will be increasing their knowledge on spelling forms and vocabulary. This seems to be true for D3 who scores better than C3, but only for frequent words in English, which seems to prove the hypothesis that dyslexics' success does depend more on a direct lexical mapping, which might be favored in the case of frequent words.

For pseudowords (represented in purple), the control group scored better in EN than in BP (C1 scored 87% for BP and 100% for BP, C2 scored 95% for BP and 100% for EN, C3 scored 83% for BP and 91% for EN). It seems that C group has improved for English because it seems that they better internalized the relationships between graphemic segments and patterns and their phonological mapping. Differently, D group had overall lower and mixed results (D1 and D3 scored better in BP than EN, D2 scored better in EN than BP, D1 scored 52% for BP and 45% for EN, D2 scored 71% for BP and 78% for

EN, D3 scored 80% for BP and 75% for EN), it seems that they were not able to employ the same strategy as the C group so easily.

For pseudowords in BP and EN, dyslexics got the lowest scores.

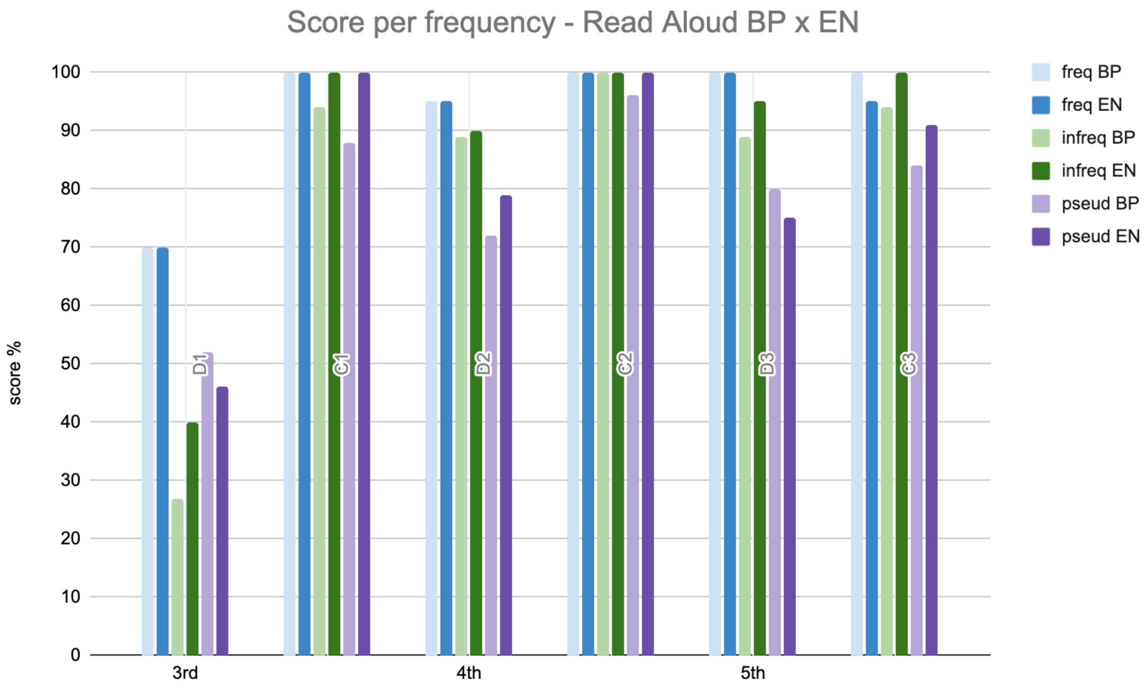
Last but not least, for pseudowords, we see that a language like BP facilitates phonological reading. This is because BP is a highly regular language in terms of its letter to sound mapping, which means that there is a strong correspondence between the letters of the alphabet and their corresponding sounds.

In languages that are not very regular, such as English, it can be more difficult to read pseudowords because the spelling does not always accurately reflect the sounds of the language. However, in languages with more predictable spelling patterns, like BP, readers can use their knowledge of the sound-letter correspondences to decode unfamiliar words and accurately pronounce them.

Overall, the degree to which a language facilitates phonological reading of pseudowords depends on the phonetic complexity of the language and the consistency of its spelling system. For example, the word "TASBOPE" facilitates phonological mapping, the graphemes have a direct relation to the phonemes: /tasˈbɔpi/.

Besides, reading words in English is different from reading sentences in English. Dyslexics have had a lower performance in reading words compared to reading sentences. The advantage of reading tasks in English for dyslexics is seen mainly in sentence reading because it has more context, semantics and logic (compared to section 11.10 and 11.11). In the pseudoword reading, nothing helps you, you see an isolated word and have to decode it. Context helps, the reader can predict lexical content. It seems that dyslexics do not have specific difficulties with English, but with pseudowords, which is typical of dyslexia.

Graph 39 - Reading words and pseudowords aloud BP x EN score per frequency.



Graph 39

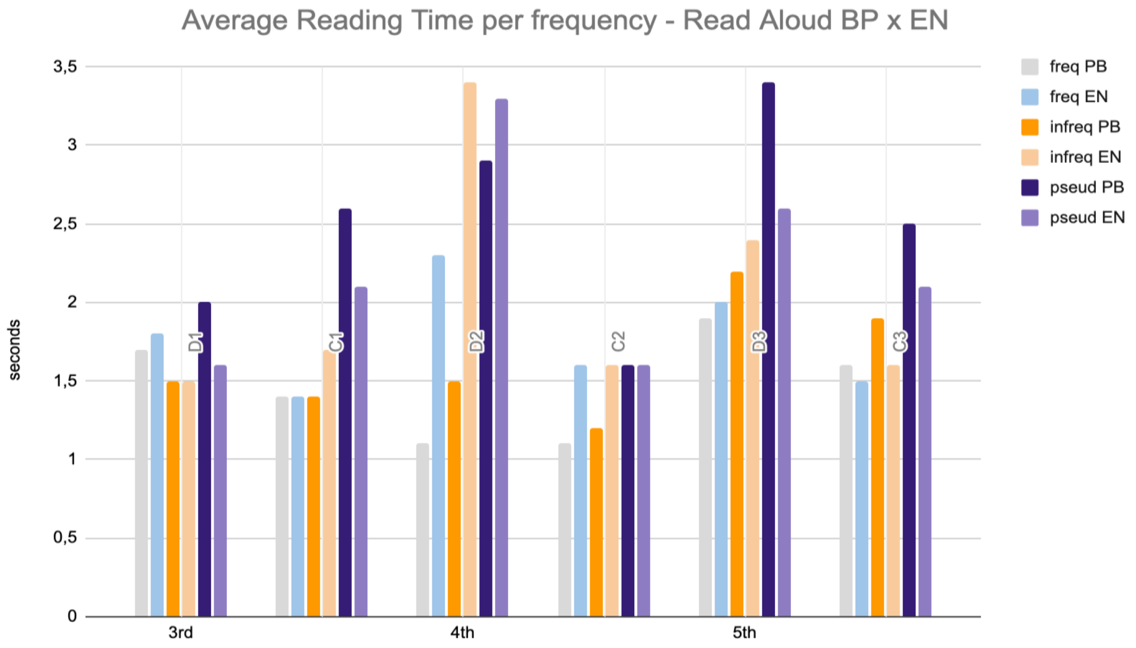
Table 57 - Reading words and pseudowords aloud BP x EN score per frequency.

Reading words and pseudowords aloud BP x EN score per frequency				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Frequent	1	70	100
		2	95	100
		3	100	100
	Infrequent	1	27	94
		2	95	100
		3	100	95
	Pseudowords	1	52	88
		2	89	100
		3	89	94
English	Frequent	1	70	100
		2	90	100
		3	95	100
	Infrequent	1	40	100
		2	72	96
		3	80	84
	Pseudowords	1	46	100
		2	79	100
		3	75	91

Table 57

Apart from the score, the average response time was also quicker for English than for Portuguese in most of the participants (see Graph 40). D1's average response time to read frequent words was 1.7 seconds for BP and 1.8 seconds for EN, 1.5 seconds to read infrequent words for BP and EN, 2 seconds to read pseudowords in BP and 1.6 seconds for EN. C1's average response time to read frequent words was 1.4 seconds for BP and EN, 1.4 seconds to read infrequent words in BP and 1.7 seconds for EN, 2.6 seconds to read pseudowords in BP and 2.1 seconds for EN. D2's average response time to read frequent words was 1.1 seconds for BP and 2.3 seconds for EN, 1.5 seconds to read infrequent words for BP and 3.4 seconds for EN, 2.9 seconds to read pseudowords and 3.3 seconds for EN. C2's average response time to read frequent words was 1.1 seconds for BP and 1.6 seconds for EN, 1.2 seconds to read infrequent words for BP and 1.6 seconds for EN, 1.6 seconds to read pseudowords for both BP and EN. D3's average response time to read frequent words was 1.9 seconds for BP and 2 seconds for EN, 2.2 seconds to read infrequent words for BP and 2.4 seconds for EN, 3.4 seconds to read pseudowords for BP and 2.6 seconds for EN. C3's average response time to read frequent words was 1.6 seconds for BP and 1.5 seconds for EN, 1.9 seconds to read infrequent words for BP and 1.6 seconds for EN, 2.5 seconds to read pseudowords in BP and 2.1 seconds for EN. Although there are varied results in terms of time per type of word, what calls attention in Graph 45 is the result on pseudowords, all participants read pseudowords faster in EN than BP with the exception of D2 (faster in BP than EN) and C2 (same time per both).

Graph 40 - Reading words and pseudowords aloud BP x EN average reading time per frequency (in seconds).



Graph 40

Table 58 - Reading words and pseudowords aloud BP x EN average reading time per frequency (in seconds)

Reading words and pseudowords aloud BP x EN average reading time per frequency				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Frequent	1	1,7	1,4
		2	1,1	1,1
		3	1,9	1,6
	Infrequent	1	1,8	1,4
		2	2,3	1,6
		3	2,0	1,5
	Pseudowords	1	1,5	1,4
		2	1,5	1,2
		3	2,2	1,9
English	Frequent	1	1,5	1,7
		2	3,4	1,6
		3	2,4	1,6
	Infrequent	1	2	2,6
		2	2,9	1,6
		3	3,4	2,5
	Pseudowords	1	1,6	2,1
		2	3,3	1,6
		3	2,6	2,1

Table 58

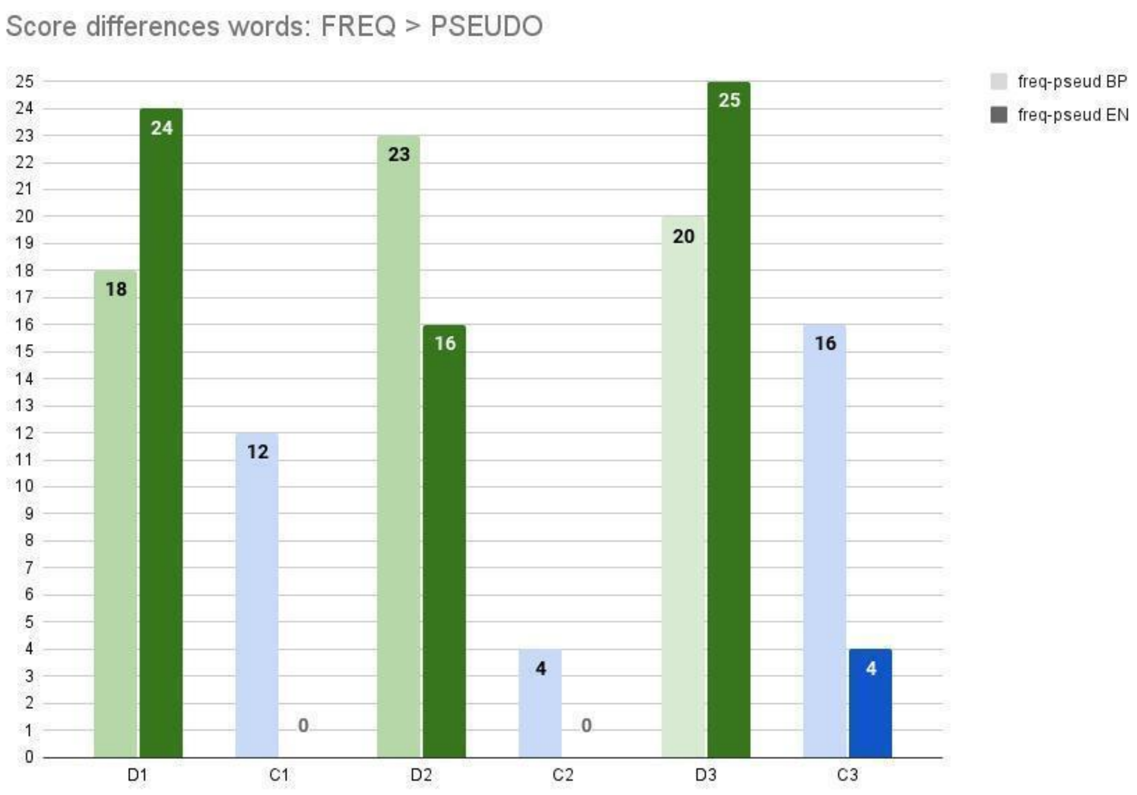
It is expected to have a growing effect, which is what we see on dyslexics. D2 treats infrequent words in English as pseudowords (very similar results). D3 and D1 are worse in BP pseudowords.

Overall, dyslexics are worse in pseudowords, according to the hypothesis.

In general, dyslexics read faster in EN pseudowords than BP, perhaps because they know more phoneme grapheme correspondences in English than in Portuguese for having more practice with English. However, it is important to take accuracy into consideration, they may be faster, but the answers are not separated for the correct answer, that is, faster is not always better.

Graph 41 shows the difference between frequent and pseudoword score, i.e., it shows how much the score for frequent words increases compared to reading pseudowords. For all dyslexics, this difference (hit between frequent and pseudowords) is always big, both in BP and in EN. Whereas for the controls, this difference will be much less for dyslexics. It is even zero or near to zero in English. This gives evidence for the difficulty for pseudo in both languages for dyslexics, and the relative advantage for high frequency words, especially in English (at least for D1 and D3); whereas for controls they can successfully generalize pronunciation patterns for all categories, although they seem to do relatively a little better in English than in Portuguese.

Graph 41 - Score differences BP x EN for frequent and pseudowords.



Graph 41

Table 59 - Score differences BP x EN for frequent and pseudowords.

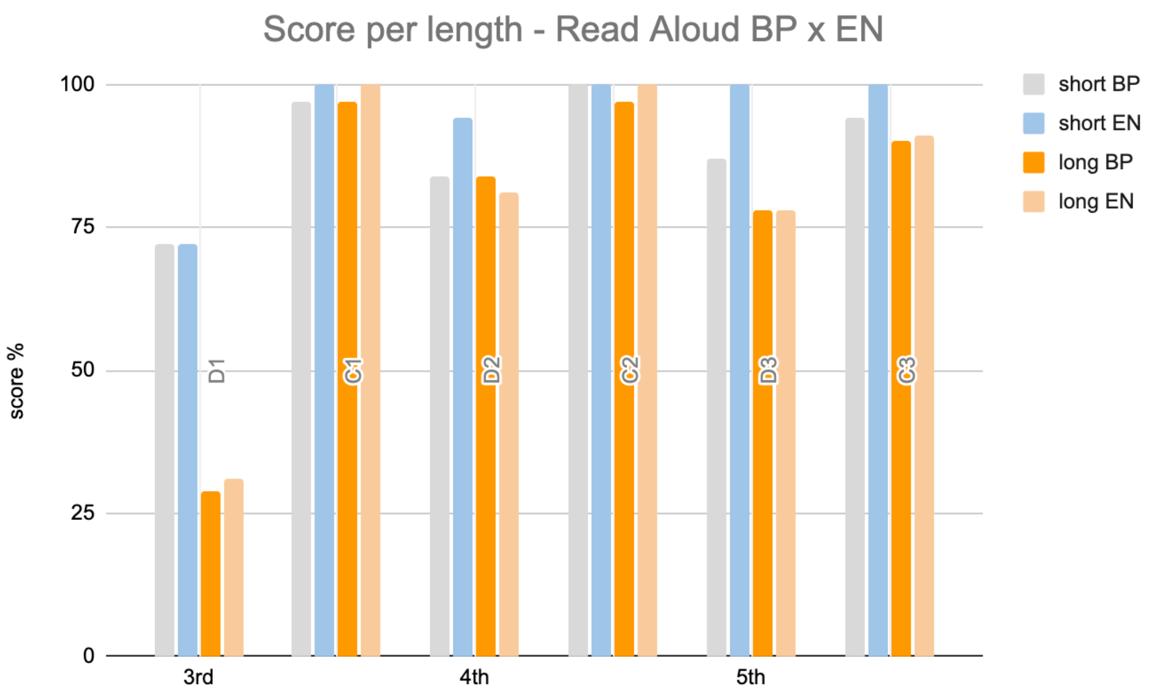
Score differences BP x EN for frequent and pseudowords				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Frequent > Pseudowords	1	18	12
		2	23	4
		3	20	16
English	Frequent > Pseudowords	1	24	0
		2	16	0
		3	25	4

Table 59

When it comes to the score per length, most of the participants scored better for both short and long words in English (see Graph 42 below). D1 scored 72% for both short BP and EN words (in blue and gray tones) and 29% for long BP and 31% for long EN (in orange tones). C1 scored 97% for short BP words and 100% for short EN words, 97% for long BP words and 100% for long EN words. D2 scored 84% for short BP words and

94% for short EN words, 84% for long BP words and 81% for long EN words. C2 scored 97% for short both BP and EN words, 97% for long BP words and 100% for long EN words. D3 scored 87% for short BP words and 100% for short EN words, 78% for long BP words and for long EN words. C3 scored 94% for short BP words and 100% for short EN words, 90% for long BP words and 91% for long EN words.

Graph 42 - Reading words and pseudowords aloud BP x EN score per length.



Graph 42

Table 60 - Reading words and pseudowords aloud BP x EN score per length.

Reading words and pseudowords aloud BP x EN score per length				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Short	1	72	97
		2	84	100
		3	87	94
	Long	1	29	100
		2	94	97
		3	78	90
English	Short	1	72	97
		2	84	100
		3	100	100
	Long	1	31	100

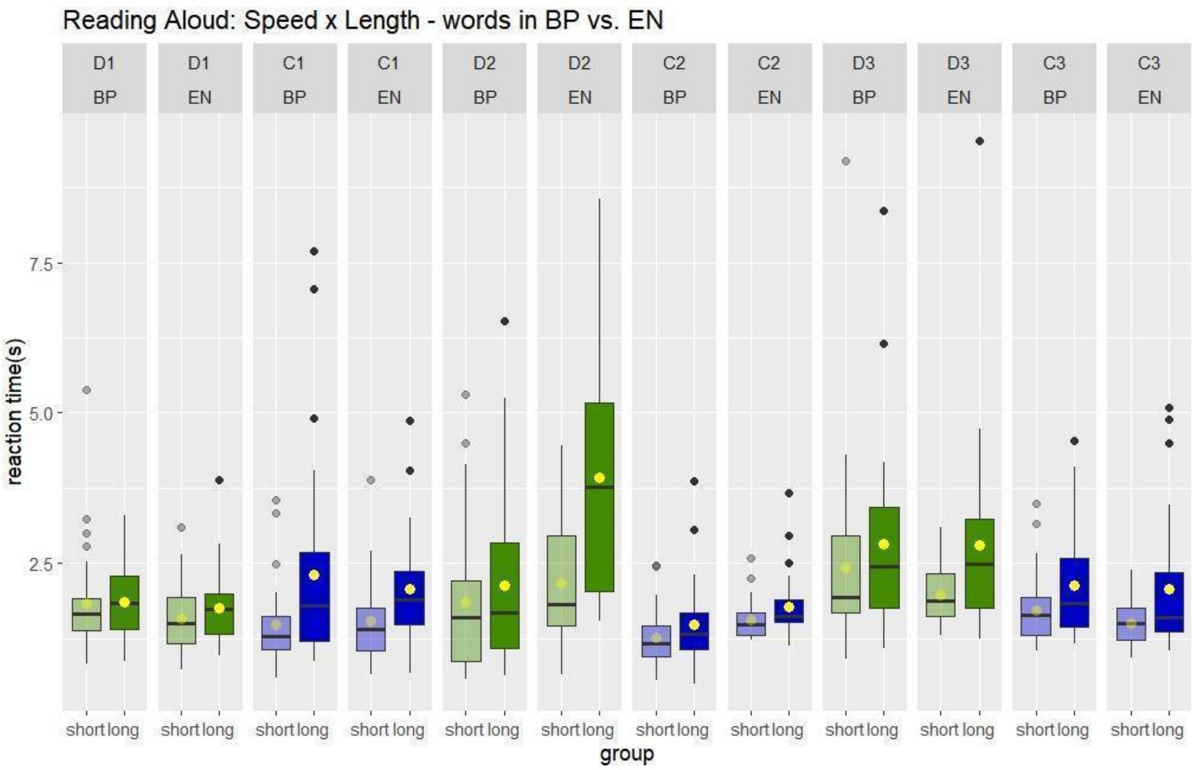
		2	81	100
		3	78	91

Table 60

Dyslexics clearly have an advantage for English than Portuguese, which is less pronounced when the word is long. When the word is long it is the same result for EN and BP. This seems to point to a lexical effect for short words. Lexical effects refer to how the frequency or commonness of a word influences its processing and interpretation. Words that are used more frequently tend to be processed more quickly and easily and may be more likely to be recalled from memory (BAAYEN, 2001).

In terms of average response time per length, the results varied (see Graph 43). The participants took longer to read longer words (more stretched boxes), as expected. D1's average response time to read short words was 1.8 seconds for BP and 1.5 for EN, 1.8 seconds for long words in BP and 1.7 in EN. C1's average response time to read short words was 1.4 seconds for BP and 1.5 for EN, 2.3 seconds for long words in BP and 2 seconds for EN. D2's average response time to read short words was 1.8 seconds for BP and 2.1 for EN, 2.1 seconds for long words in BP and 3.9 in EN. C2's average response time to read short words was 1.2 seconds in BP and 1.5 in EN, 1.4 seconds to long words in BP and 1.7 in EN. D3's average response time to read short words was 2.4 seconds in BP and 1.9 in EN, 2.8 seconds for long words in BP and 2.7 for EN. C3's average response time to read short words was 1.7 seconds for BP and 1.5 seconds for EN, 2.1 seconds for long words in BP and 2 seconds for EN.

Graph 43 - Reading words and pseudowords aloud BP x EN average reading time per length (in seconds).



Graph 43

Table 61 - Reading words and pseudowords aloud BP x EN average reading time per length (in seconds).

Reading words and pseudowords aloud BP x EN average reading time per length				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Short	1	1,8	1,4
		2	1,8	1,2
		3	2,4	1,7
	Long	1	1,8	2,3
		2	2,1	1,5
		3	2,8	2,1
English	Short	1	1,5	1,5
		2	2,1	1,4
		3	1,9	1,5
	Long	1	1,7	2
		2	3,9	1,7
		3	2,7	2,0

Table 61

Overall, dyslexics are slower than controls. However, dyslexics read faster and English than Portuguese and are slower for longer words, mainly D2 that shows a great difference. Also, dyslexics have more variances (differences of the box sizes in the graph), especially to longer words. Although D1 was fast, the accuracy was low.

12.2 READING SPEED OF SENTENCES BP x EN

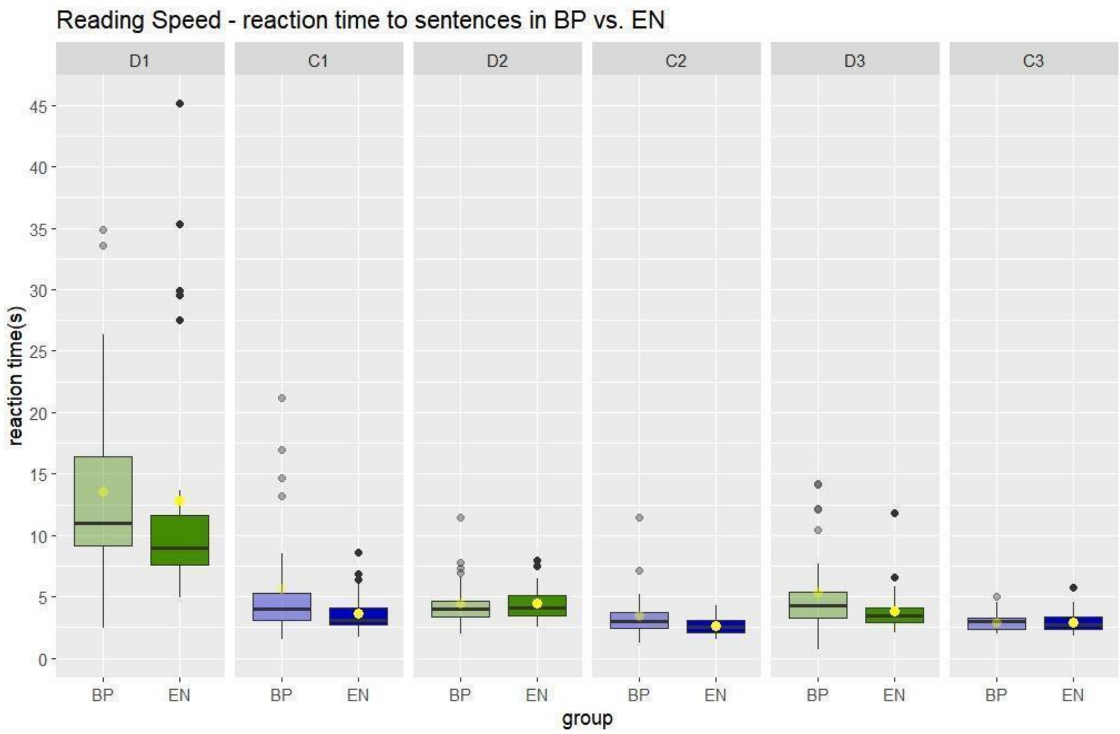
Reading in BP was expected to be faster than reading in EN because BP is their L1 for the similar reasons cited in 12.1. Surprisingly, results revealed a more fluid reading of EN (see Graph 45), which can be explained by the EN reading strategy (the use of the lexical route). Taking into account the average response time for each participant excluding D1 and C1 (due to this data being compromised once participants made comments during the task), D2 average response time was 4.9 seconds in BP and 4.5 seconds in EN, C2 average response time was 3.7 seconds in BP and 2.6 seconds in EN, D3 average response time was 5.8 seconds in BP and 3.9 seconds in EN. C3 average response time was 3 seconds in BP and 2.9 seconds in EN.

It is no coincidence that the difference (both for average response time and score) is greater in the 3rd year, which is the year the child would be expected to have mastered basic reading skills in English. In Brazil, the 3rd grade is considered the last year of reading instruction. Therefore, D1 probably didn't finish the reading instruction process by the time of the study whereas C1 did due to his dyslexia. Also, D1 is the participant with the shortest enrollment in the school.

Likewise, this test also measures proficiency, once the reader is not guessing the meaning but understanding what is written (see Table 55 with the accuracy results). This means that participants have had a clear understanding for both languages, revealing a familiarity with both English and Portuguese.

In general, some participants took longer for EN (D2 and C3), others took longer for BP (D1, C1, C2 and D3). D1 was the slowest participant in this task for both languages. In the control group, time decreases as school years pass by (see Graph 44).

Graph 44 - Reading Speed of Sentences BP x EN average response time (in seconds).



Graph 44

Table 62 - Reading Speed of Sentences BP x EN average response time (in seconds)

Reading Speed of Sentences BP x EN average response time			
Language	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	1	14,2	7,0
	2	4,9	3,7
	3	5,8	3,0
English	1	13,0	3,7
	2	4,5	2,6
	3	3,9	2,9

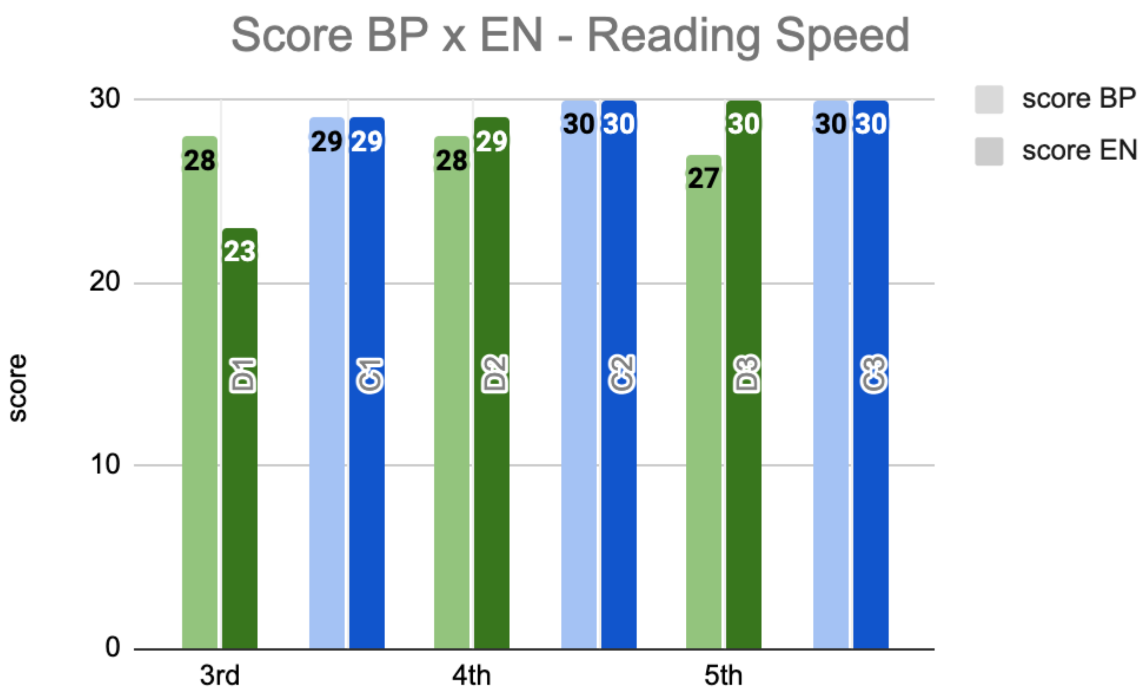
Table 62

Participants were reading faster in English than in Portuguese (see Graph 44), this might be explained by their reading instruction and school environment (immersive). They spend 8 hours per day in a full immersive English environment, having 50 minutes of Portuguese class per day.

Broadly, there is a faster reading of English for both groups. Older participants read faster than young ones.

In terms of score, participants scored better in English than in Portuguese or had the same score results for both languages, with the exception of D1 that scored better in Portuguese (see Graph 46). D1 scored 28 for BP and 23, being the exception of the participants, for EN whereas C1 scored 29 for both. D2 scored 28 for BP and 29 for EN whereas C2 scored 30 for both. D3 scored 27 for BP and 30 for EN whereas C3 scored 30 for both. It is also possible to see that the scores get higher as school years pass by, due to time of exposition and practice in reading and writing, as well as better metacognitive skills to deal with the specifics of the task at hand.

Graph 45 - Reading Speed of Sentences BP x EN score.



Graph 45

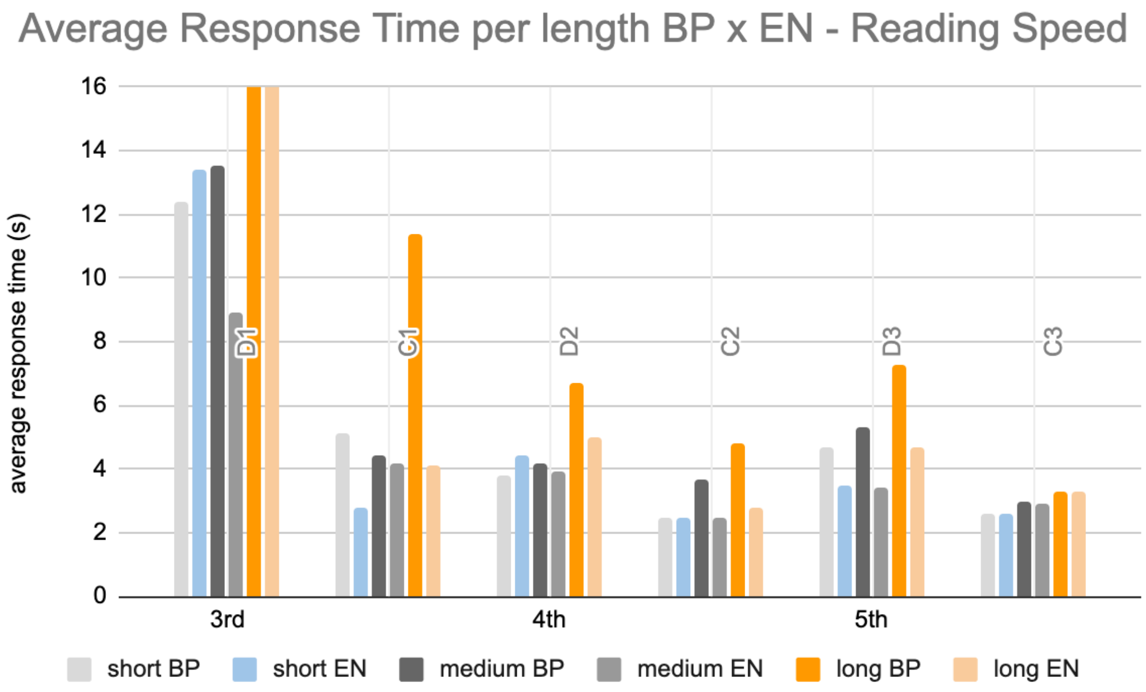
There are higher scores in English, very small difference between BP and EN. Reading sentences is different from reading words. This result confirms the hypothesis that they are better in English reading and that there is a positive effect on Portuguese reading (the results were very close).

In terms of the length of the sentences, most of the participants had quicker response times to EN no matter the length of the sentence (see Graph 47). D1 average response time to short sentences (in light gray and blue) was 12.4 seconds for BP and 13.4 seconds for EN, to medium sentences (in darker gray) was 13.5 seconds for BP and

8.9 seconds for EN, to long sentences (in orange tones) was 16.7 seconds for both BP and EN. However, these numbers may not portray D1's reading time effectively, once D1 was very easily distracted throughout the test, taking longer to complete the task. C1 average response time to short sentences was 5.1 seconds for BP and 2.8 seconds for EN, to medium sentences was 4.4 seconds for BP and 4.2 seconds for EN, to long sentences was 11.1 seconds to BP (not a trusted data once the time spent with the sentence "o coração é vermelho" is being added) and 4.1 seconds for EN. D2 average response time to short sentences was 3.8 seconds for BP and 4.4 seconds for EN, to medium sentences was 4.2 seconds for BP and 3.9 seconds for EN, to long sentences was 6.7 seconds for BP and 5 seconds for EN. C2 average response time to short sentences was 2.5 seconds for BP and 2.5 seconds for EN, to medium sentences was 3.7 seconds for BP and 2.5 seconds for EN, to long sentences was 4.8 seconds for BP and 2.8 seconds for EN. D3 average response time to short sentences was 4.7 seconds for BP and 3.5 seconds for EN, to medium sentences was 5.3 seconds for BP and 3.4 seconds for EN, to long sentences was 7.3 seconds for BP and 4.7 seconds for EN. C3 average response time to short sentences was 2.6 seconds for both BP and EN, to medium sentences was 3 seconds for BP and 2.9 seconds for EN, to long sentences was 3.3 seconds for both BP and EN.

Thus, for short sentences, C1 and D3 read faster in BP than in EN, D1 and D2 read faster in EN than BP and C2 and C3 took the same time for both. For medium sentences, all participants read faster in BP than EN. For long sentences, C1, D2, C2 and D3 read faster in EN than BP.

Graph 46 - Reading Speed of Sentences BP x EN average response time per length (in seconds).



Graph 46

Table 63 - Reading Speed of Sentences BP x EN average response time per length (in seconds).

Reading Speed of Sentences BP x EN average response time per length				
Language	**Frequency**	**Participant**	**Dyslexics**	**Controls**
Brazilian Portuguese	Short	1	12,4	5,1
		2	3,8	2,5
		3	4,7	2,6
	Medium	1	13,5	4,4
		2	4,2	3,7
		3	5,3	3,0
	Long	1	16,7	11,4
		2	6,7	4,8
		3	7,3	3,3
English	Short	1	13,4	2,8
		2	4,4	2,5
		3	3,5	2,6
	Medium	1	8,9	4,2
		2	3,9	2,5
		3	3,4	3,0

	Long	1	16,7	4,1
		2	5,0	2,9
		3	4,7	3,3

Table 63

Long sentences in BP took longer than long sentences in EN, even more for dyslexics. For medium sentences, BP took longer than EN. For short sentences, it varied. Broadly, participants have read faster in English than in Portuguese. This may be because English forces the use of lexical route, Portuguese reading forces the use of phonological route. Also, participants are more used to reading in English than Portuguese.

13 DISCUSSION

The Granularity and Transparency Hypothesis suggests that reading acquisition is influenced by the transparency of the orthography, as well as the grain size of the phonological units used in the orthography. (WYDELL;BUTTERWORTH, 1999).

The Dual Route Model (ELLIS, 1995) foresees the existence of two routes: the Phonological Route or Indirect Route (also called Non-lexical Route, see Coltheart *et al.*, 2001) and the Lexical or Direct Route. The Lexical Route is often referred to as the direct route, whereby sublexical orthographic information makes direct contact with whole-word orthographic representations, which then provide access to whole-word phonology on the one hand, and higher-level semantic information on the other (COLTHEART *et al.*, 2001).

In typical readers, the phonological route is used to decode unfamiliar words by breaking them down into their individual sounds (phonemes) and then blending the sounds together to form a word. However, dyslexics may struggle with this process, making it difficult for them to sound out words they have never seen before. They may also have difficulty recognizing familiar words by their sound, which can lead to poor spelling and reading fluency. While the lexical route can be an effective strategy for reading familiar words, it may not be as helpful for decoding unfamiliar words or for developing strong phonological skills (SNOWLING, 2000; RAMUS, 2003).

In this study, I wanted to show that a high exposure to an opaquer language like English at a very young age (8 to 10), in an L2 immersive environment and through a flexible and individualized student-centered approach, like the Montessori method, may influence dyslexics' reading positively, both in English and Portuguese. One important factor in this positive influence may be that the English language, as being more opaque and presenting a thin granularity, forces the reader to engage in the lexical route, recognizing words by accessing their stored representations in our mental lexicon via direct mapping of a full phonological (or orthographic) word form onto the lexical representation, rather than going through a phonological segment-by-segment mapping (ELLIS, 1995). The claim is that this is a more appropriate reading strategy for dyslexics due to their innate difficulties with reading engaging the phonological route. As dyslexics train using the lexical route to read, this may help them in reading by applying direct lexical mapping even to the more transparent words in Brazilian Portuguese, which may allow them to automate their reading and ease this arduous task for them.

Difficulties in engaging in the phonological route, which involves segmenting and mapping onto segmental and sublexical phonological units before accessing lexical entries, are evidenced by difficulties in reading and writing pseudowords (non-existing, but phonologically legitimate sequences). Therefore, weak results in pseudowords reading for both languages were expected, if dyslexics of this study did adapt to using the lexical route more than the phonological one, we expect to have a weak performance on EN and BP pseudowords compared to controls. For all word reading tasks, we expected the dyslexic group to be weaker in relation to control, but greater differences were expected for pseudowords.

Indeed, in the reading aloud task for words and pseudowords task, the hypothesis that dyslexics would struggle with pseudowords in both languages was confirmed. During this task, it was clear that dyslexics were using the lexical route as a strategy in reading for both languages, dyslexic participants, when facing an unknown word, placed similar words based on form, for example, D3 in the pseudoword "nurto" he read "naruto" due to the familiarity with the word, D2 read "janela" in the pseudoword "jenala", D1 read "nutro" in the pseudoword "nurto", D3 read "grounded" in the pseudoword "gounded", D2 read "building" in the pseudoword "bunding", D1 read "smile" in the pseudoword "smill". Additionally, it was common to see D1 reading the beginning and end of the word and guessing the middle or reading the beginning and end of the words and misplacing its parts. This confirms both their specific difficulty with grapheme to phoneme mapping, as well as the hypothesis that they are making use of the lexical route for both English and Portuguese, meaning that it is a compatible strategy to their reading difficulties. Also, in this task, although there are varied results in terms of time per type of word, what calls attention in Graph 45 is the result on pseudowords, all participants read pseudowords faster in EN than BP with the exception of D2 (faster in BP than EN) and C2 (same time per both).

For pseudowords only D2 has an advantage for EN, and none of the other dyslexics, nor the controls, which probably also reflect the opaque and unpredictable nature of English spelling to sound mapping. There is a lexical effect for short words. Lexical effects refer to how the frequency or commonness of a word influences its processing and interpretation. Words that are used more frequently tend to be processed more quickly and easily and may be more likely to be recalled from memory (BAAYEN, 2001). It also revealed that dyslexics have more development for English because it is their instruction language. The English language seems to force a reading that is more suitable for their difficulties, which goes against common sense because it would be expected that this would be the context in which they would have more difficulty once people may think they would have more difficulty with the phonological processing necessary for learning a new language like English, and they performed greatly.

All participants read pseudowords faster in EN than in BP, however, this was associated with poor accuracy, with the exception of D2 that read faster in BP than in EN and C2 that took the same time for both. My interpretation of this data is that they were using the lexical form of EN words to ease reading (for example: the word was "smill" and the participant reads "smile"), which is a strong indicator of the lexical route use. The idea that dyslexics are favored by the use of the Lexical Route by its strengthening when facing more opaque spellings contributes to the view that we cannot impose reading instruction methods once the best will depend on the group.

In terms of sentence reading, we expected no significant difference between groups once sentence reading requires little on the phonological route, differently from pseudowords.

The successful and rapid reading of sentences for comprehension shows students have managed to automatize their reading.

When it comes to Reading Speed of Sentences, there are higher scores in English, a very small difference between BP and EN. Reading sentences is different from reading words. This result confirms the hypothesis that they are better in English reading and that there is a positive effect on Portuguese reading (the results were very close). Broadly, participants have read faster in English than in Portuguese. It is important to remember that participants have become literate recently through the Reading & Writing Workshop

(ATWELL, 1988), additional phonics supplements and word work/vocabulary lessons based on the Primary Years Programme from the International Baccalaureate scope and sequence for language (2018), reading and writing. Additionally, it is important to remember that one of the hypotheses was that immersion is beneficial to dyslexics. The fact that they show relatively little difference in speed and, mainly, score with control, as well as between languages in the sentence reading task, shows that they manage to automate the reading that should be facilitated by the engagement of the lexical route. Reading words in English is different from reading sentences in English. The advantage of reading tasks in English compared to Portuguese for dyslexics is seen mainly in sentence reading because it has more context, semantics and logic. In the pseudoword reading, nothing helps you, you see an isolated word and have to decode it. Context helps, the reader can predict lexical content. Dyslexics scored better in sentence reading than pseudoword reading and better in word reading than pseudoword reading, confirming the hypothesis that they would struggle with pseudowords reading and that the lexical route strategy benefits their reading in English in comparison to Portuguese. In the next work, we will control the presence of negative and positive marks in the sentences.

The dictation data seem to confirm the difference between cognitive processes involved in reading and writing. In writing, the transparency of a language seems to help as we can see that the scores in BP were greater than in EN. The English advantage is not as stressed in writing as in reading, maybe it doesn't have advantage at all in reading, once they were better in BP Dictation than EN Dictation. It seems to me that the dual route model did not predict the result in the writing so well (did not apply to writing) but maybe a more specific model is missing for the writing, perhaps it would be something to be deeper developed in my doctorate. Frequency is still a strong factor, they are probably better at frequent words probably, which is a data that I will check in my doctorate after validating this EN Dictation test. Overall, dyslexic participants have greater difficulty with infrequent words and pseudowords, except D3 that has managed to develop some skill in predicting possible spelling forms.

That being said, another objective of this study was to investigate to what extent these participants have difficulty in rapid naming, which could point to a difficulty underlying the dyslexia condition suggesting that what is underlying this dyslexia picture is something that is more complex as suggested by the Double Deficit Hypothesis (WOLF;BOWERS, 1999).

In RAN tasks, dyslexics show difficulties, as expected. This result shows that the participants are comparable (controls and dyslexics). Globally, dyslexics have the lowest scores, however, the difficulty proportion is similar (all participants are better in numbers and letters). This result can be explained by the double-deficit hypothesis once it attributes the naming process as a type of weakness in dyslexia. Importantly, we must take into account that this test was not developed for bilinguals, bilinguals spend more time on this task due to lexical choice. During the object and color naming, participants named the items sometimes in English and sometimes in Portuguese, showing that they were choosing one over the other.

Also, we expected to expand and complement the effects of Azevedo (2016). Azevedo studied bilingual participants who were 13-18 year-olds and only 1 of them was in a school that is a full-immersive English environment, while other participants had English classes every day, also, the learning environment was not the main focus, that is to say that the methodology was not the focus in her study. Differently from Azevedo, the context of our study is 8-11 years old participants, whose school is a full-immersive English environment and follows a Montessorian pedagogy. Thus, our results may expand and complement Azevedo's (2016) results by postulating that a prominent level of English exposure through immersive teaching has an influence on reading performance in Brazilian Portuguese even for young bilingual pupils. Thus, the main difference between the context of our studies is the immersive teaching, importance of school methodology and participants' age. This study highlights the importance of a teaching method that is more open and flexible, such as the Montessorian method, as well as the high exposure to English in immersive environments, claiming that it is an effective method in acquiring a L2, influencing dyslexics' reading strategies positively for both languages.

One of the methodological difficulties of a study such as this is that the group of participants is small. This is due to the inclusion criteria (i.e., being diagnosed with dyslexia), logistics and ethics (the collaboration of school and parents), as well as the labor intensive nature of the study involving a multidisciplinary team who carried out the tests in multiple sections. The small participant sample makes it difficult to generalize across results. Moreover, participants may differ in the overlap of other developmental issues, and in their cognitive abilities, therapeutic support, preferences, collaborative attitudes, not to mention, importantly for this study, in their exposure and use of English outside of school context. In order to map out these idiosyncrasies, including those of control participants, it is important to test for a series of cognitive aspects as well as obtain a detailed clinical history.

In this study, we applied a WASI IQ test, anamnesis, language proficiency questionnaire (QuExPLi), English language proficiency test, digit span in BP and pseudowords repetition in BP were control measures, to show how similar and/or different participants are.

The WASI IQ test was used as a control measure and we did not expect to find relevant data concerning dyslexia, however, although IQ measure does not identify dyslexia, ADHD/dyslexic participants showed a medium IQ whereas non-ADHD showed a higher IQ (see Graph 2). This measure revealed that C1 and C2 were high ability/super gifted pupils, which justified some unexpected differences. Importantly, according to parents and school, C2's high ability is probably towards language once he is a kid that reads multiple books, fast, and likes writing stories. Therefore, this may explain why he scored best in EN dictation test (see Graph 21) and read faster in comparison to other participants in EN word reading task (see Graph 30) and for EN sentence reading task (see Graph 36). There is also objective data to say that D1 is less functional (compared to D2 and D3, for example). Accordingly, D2 seems to be the most functional of the dyslexic participants. There is a high probability that the contrasts between D1 and C1 are greater due to the fact that both are at more opposite poles, whereas D3 and C3 seem to be more closely matched.

Anamnesis showed that all dyslexic participants were diagnosed around the same age (6, 7 years old). D1 is the participant that receives more learning support out of school (3 times a week), D2 receives 1 time a week and D3 does not receive learning support outside school anymore. All dyslexic participants have individualized learning support at school. D3’s score in BP dictation may be explained by his lack of learning support outside school (see Graph 18) once he has got the worse score.

The experience and linguistic proficiency questionnaire showed that all the dyslexic participants prefer reading and writing in English with the exception of D1 who prefers writing in Portuguese. This might be because he has just finished his reading instruction process in English and is the one that has had less contact with English compared to the other dyslexic participants. The extra questions showed that all participants read in English every day and prefer listening to music in English rather than Portuguese. Out of all participants, D1 is the only one that is not exposed to English out of school. D2 watches videos and plays video games in English every day, whereas D3 does it a few times per week. C1 plays video games in English every day and watches videos in English a few times per week. C2 watches videos in English and plays video games in English a few times per week. C3 watches videos in English a few times per week and never plays video games in English. This shows that all participants have a high exposure to English out of school, with the exception of D1 that does not have any, which may explain the difference in some results. D1 scored worse in the PVST task (see Graph 8), EN sentence reading (see Graph 35), EN word reading (see Graph 31) and in EN dictation task (see Graph 21).

Accordingly, D1 scored less in the language proficiency task, perhaps due to his low level of exposure to English out of school and to his severe symptoms of ADHD. Other dyslexic participants do well in this task, showing a difference between linguistic capacity and specific tasks like reading and writing by the dyslexics, revealing a good linguistic development. The participants from the control group also had good marks in this task. Perhaps there is, at the same time, a dissociation between language ability, but also a difficulty in the learning process (but not an impediment) associated with dyslexia. The sentence reading task in English works in a complementary way once it also measures comprehension (see Table 55).

Although the digit span result was not relevant to the hypothesis, there was a surprising result in which the dyslexic group showed higher recall than the control group, which was not expected once dyslexics show impairment with working memory (SILVA; CRENITTE, 2014; SMITH-SPARK;FISK,2007; MENGHINI et al, 2011). This shows that their cognitive deficit may be dissociated from working memory issues, at least when tasks do not task verbal memory. The fact that this was true for all dyslexics, irrespective of age, may allow some generalizations for the explanation of dyslexics' performance in other tasks.

In the BP pseudowords repetition task, results revealed that dyslexic participants do not struggle with their phonological loop once they achieve high marks in the smaller words and due to the fact that all words require a certain level of phonological analysis. But, when it comes to longer words, their performance is affected, possibly due to the fact that this taxes memory, attention more, and the articulatory planning required for the repetition is also more complex with longer words.

The control measures (RAN, digit span, IQ, repetition of pseudowords in BP, anamnesis, language proficiency test and questionnaire) revealed that D3 is weaker than D2, based on age difference and that C2 is stronger than C3 due to his IQ tendency, revealing that C2 is an unfair control for D2 and still, D2 scored similarly to C2 in multiple tasks.

Owing to the results, being in contact with an opaquer language is clearly important for dyslexics. In many tests, the control group and the dyslexic group showed greater results. This might be an indication that bilingualism has beneficial effects, not only due to the development of suitable reading strategies, but also due to possible general cognitive benefits associated with achieving greater levels of bilingualism, such an enhancement of executive functions or attention more generally (BYALSTOK, 2004).

Herewith, the data of this study truly expands Azevedo's (2016) findings. Bilingual dyslexics that have a great exposure to English have better performance in reading measures in English than Portuguese, even at an early age. The difference between our studies is the immersive teaching, importance of school methodology and participants' age as well as the tests used.

Our results are in accordance with Nijakowska (2008), Ho *et al* (2005), Lallier *et al* (2005), Hedman (2012), Azevedo, (2016), van Setten *et al* (2017) and Vender *et al* (2005) suggesting that bilingualism can have protective effects on phonological processing and reading difficulties in children with dyslexia. Our results seem to confirm that simultaneous exposure to reading different spellings can result in spelling-specific plasticity, meaning that the brain can adapt to process and recognize different spellings of the same sound.

In general, the results partially show this idea that bilingual dyslexics "take advantage" of the English reading strategies to Portuguese, but it is difficult to state that because there are still differences between participants within the dyslexic group, as well as between participants in the control groups, which were not always according to the expected linear development according to age and schooling, which made de dyslexic-control pairing not optimal. However, it seems that the dyslexics were better in English than Portuguese, showing that the exposure to a L2 is not a problem. So far, it seems that dyslexics do not have specific difficulties with English, but with pseudowords, confirming the hypothesis of the lexical route use. The Montessori methodology may have played a key role in enhancing participants' proficiency and performance on tasks. Future comparative studies may explore this question further.

CONCLUSION AND FINAL CONSIDERATIONS

There were 3 main hypotheses:

- Hypothesis 1: is that dyslexics are strengthened in the processing strategy by the lexical route, which at the same time is a strategy more compatible with its deficit, and possibly more adequate to deal with the opacity and irregularity in the granularity of the English spelling system.
- Hypothesis 2: early age, high level of exposure and open and flexible methodology positively affect the reading performance of dyslexics both in Portuguese and in English due to different reading strategies (lexical route or the phonological route) postulated by Elis (1996).
- Hypothesis 3: If dyslexics use the lexical route due to exposure to English, they will have difficulties with pseudowords for both BP and EN compared to the control group. Arguing that the lexical route is beneficial for dyslexics, the use of this route will be evaluated for better results in EN than in BP, by the 2 groups.

In the reading aloud task for words and pseudowords task, the hypothesis that dyslexics would struggle with pseudowords in both languages was confirmed. The successful and rapid reading of sentences for comprehension shows students have managed to automatize their reading. When it comes to Reading Speed of Sentences, there are higher scores in English, a very small difference between BP and EN. Dyslexics scored better in sentence reading than pseudoword reading and better in word reading than pseudoword reading, confirming the hypothesis that they would struggle with pseudowords reading and that the lexical route strategy benefits their reading in English in comparison to Portuguese. The dictation data seem to confirm the difference between cognitive processes involved in reading and writing. In writing, the transparency of a language seems to help as we can see that the scores in BP were greater than in EN.

In this stage of our investigation, we noticed that the immersive contact with the English language seems not to hurt development of dyslexic students and, probably, is even beneficial to it.

On the whole, it is beneficial to dyslexic students to achieve higher levels of bilingualism in which the L2 is an opaquer language than the L1 at a young age. An immersive English environment as well as an open and flexible methodology seems to leave space for personal development and faster language acquisition.

In terms of the number of participants, since it is an extremely specific public, it is hard to find a substantial number of participants. We tried to remedy this methodological weakness with a broad spectrum of tests, but we have to concede that this limits the kind of conclusions and generalizations which can be taken from this research. Other studies faced the same reality, Azevedo's (2016) study had 12 participants in total. In Brazil, bilingualism is at growth and dyslexics' possibility to be bilingual is still a myth. Dyslexic participants' parents shared that they have faced a lot of criticism by their choice of putting their children into an immersive English school. Therefore, this explains the few numbers of participants. It was fundamental to have a wider base of tests to have more information and data from participants.

There is a lack of studies of this kind. Furthermore, it is particularly important for educators, parents, and speech therapists to understand the cognitive impact of L2 exposure on dyslexic reading development as well as teaching methodology.

This study also supports a better understanding of the dyslexia framework, the inclusion of dyslexic students in L2 learning contexts and a demystification of supposed difficulties in L2 learning. The myth turned out to be true: parents and schools demonstrated that this idea of a dyslexic learning a second language as being something bad is still very present. However, this study demystifies this idea, once it leaves space for scientific dissemination and also because it causes provocation of interest, in addition to bringing the scientific world closer to the school universe: the school has asked me to conduct lectures and meetings with parents and employees to spread knowledge on this topic.

Furthermore, although this study data is retrieved from an extremely specific group of participants of very specific reality and social cultural conditions, all pieces of data and information are relevant when it comes to the topic of this research. It is important to articulate with different studies to slowly piece together the parts of a greater puzzle in order to achieve deeper knowledge on the subject.

Finally, this study leaves space for further investigation as an investigation for a model that explains bilingual dyslexics writing, eye-track measures and possible strengthening of executive functions. I intend to complement this study by enlarging the number of participants as well as comparing different educational contexts (methodology). Also, eye-track measures could bring important inferences on reading analysis, once some patterns were observed in dyslexics’ reading by observation. Additionally, there is room for investigation when it comes to dyslexia intervention once speech therapists usually focus on the Phonological Route strengthening. Tests developed for the study (English Dictation for L2 English learners, Reading Speed of Sentences in English for L2 English learners, Reading Speed of Sentences in Portuguese) will be validated and published. On top of that, a booklet for schools and teachers about dyslexia and bilingualism will be created once there is a lack of hands-on material on that subject.

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APPENDIX 1

ANAMNESIS: INTERVIEW WITH THE PARTICIPANTS' GUARDIANS IN PORTUGUESE

ANAMNESE

Dados pessoais

Nome da criança: ____

Nome da mãe: ____

Nome do pai: ____

Data de nascimento: ___/____/____

Idade atual: ______________

Escola: ____

Ano escolar: _____________________________

Naturalidade: ____________________________

História Escolar

Entrou para escola bilíngue com qual idade? ___________________________

Por que a preferência pela escola bilíngue? _____________________________

Em casa é dado preferência ao português ou ao inglês? No caso do inglês, desde quando?

____

Quem escolheu a escola e por quê?

____

____

Como foi essa escolha?

____

____

Já mudou de escola? (de escola bilíngue para outra escola bilíngue ou de escola não bilíngue para escola bilíngue)

____

A criança tem algum auxílio/suporte em sala de aula? Se sim, quantas vezes por semana?

____

Quando recebeu o diagnóstico de dislexia?

____

Quais as principais dificuldades observadas na criança?

____

____

Já repetiu de série na escola? Qual série? Quantas vezes?

____

Realizou ou realiza terapia fonoaudiológica (se faz atualmente, desde quando)?

____

Realizou ou realiza apoio psicopedagógico (se faz atualmente, desde quando)?

____

Realizou ou realiza apoio psicológico (se faz atualmente, desde quando)?

____

Quantas horas por dia a criança permanece na escola?

____

Se realizar alguma terapia, quantas vezes por semana?

____

Qual a disciplina com maior dificuldade?

____

Qual a disciplina com maior facilidade?

____

A escola já chamou você para conversar sobre alguma dificuldade? Quando começaram?

____

Observações:

____

____

____

____

____

APPENDIX 2

LINGUISTIC EXPERIENCE QUESTIONNAIRE APPLIED VIA GOOGLE FORMS

QuExPLi - Questionário de Experiência e Proficiência Linguística baseado em Scholl; Finger (2013): https://forms.gle/wC9L9EwahP5rUbWy5

Nível de escolaridade: Total em anos:________

( ) Fundamental completo
( ) Fundamental incompleto [anos]
( ) Médio completo
( ) Médio incompleto [______anos]
( ) Superior completo
( ) Superior incompleto [______________________________anos]
( ) Pós-graduação

1. Liste todas as línguas que você sabe em ordem de aquisição (sendo 1 a materna/nativa)

Língua 1		Língua 3	
Língua 2		Língua 4	

2. Indique onde você aprendeu as suas línguas (marque as opções que forem necessárias):

Língua 1	**Língua 2**	**Língua 3**	**Língua 4**
( ) Casa	( ) Casa	( ) Casa	( ) Casa
( ) Escola	( ) Escola	( ) Escola	( ) Escola
( ) Cur. línguas	( ) Cur. línguas	( ) Cur. línguas	( ) Cur. línguas
( ) Sozinho/a	( ) Sozinho/a	( ) Sozinho/a	( ) Sozinho/a
( ) Outro:	( ) Outro:	( ) Outro:	( ) Outro:

3. Informe a idade em que você:

	Língua 1	Língua 2	Língua 3	Língua 4
Começou a aprender				
Começou a utilizar ativamente				
Tornou-se fluente				

4. Indique, em uma escala de 0 a 6 (0=nada, 3=razoavelmente, 6=muito), o quanto desses fatores contribuiu para a aprendizagem das suas línguas:

	Língua 1	Língua 2	Língua 3	Língua 4
Interação com a família				
Interação com os amigos				
Leitura geral				
Assistir televisão e filmes				
Ouvir rádio e/ou música				
Uso da internet				
Curso de línguas				
Outro ____________________				

5. Informe o número de anos e meses que você passou em cada um destes ambientes:

	Língua 1	Língua 2	Língua 3	Língua 4
País em que a língua é falada	____anos ____meses	____anos ____meses	____anos ____meses	____anos ____meses
Família em que a língua é falada	____anos ____meses	____anos ____meses	____anos ____meses	____anos ____meses
Escola/Trabalho em que a língua é falada	____anos ____meses	____anos ____meses	____anos ____meses	____anos ____meses

6. Marque com um X em que língua você realiza estas atividades e circule o número correspondente à frequência com que elas acontecem, sendo:

1= algumas vezes por ano 2= uma vez por mês 3= quinzenalmente
4= uma vez por semana 5= + de uma vez por semana 6= diariamente

	Língua 1	Língua 2	Língua 3	Língua 4
Fala com seu pai	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6

Fala com sua mãe	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6
Fala com familiares	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6
Fala com amigos	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6

Fala no trabalho/faculdade	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6
Lê/escreve no trabalho/faculdade	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6	( ) 1 2 3 4 5 6

7. Estime a porcentagem de tempo em que você usa cada língua diariamente (o total deve ser 100%):

	% de tempo
Língua 1	
Língua 2	
Língua 3	
Língua 4	

8. Estime <u>em número de horas</u> o quanto você usa cada língua para as seguintes atividades <u>diariamente</u>:

	Língua 1	Língua 2	Língua 3	Língua 4
Assistir TV/Filmes				
Ouvir música				
Jogar videogames				
Ler (livros, revistas)				

Ler (textos acadêmicos)				
Escrever				
Falar				

9. Circule em uma escala de 1 a 6 seu nível de proficiência nas línguas que conhece, sendo:

1= muito baixo 2= baixo 3= razoável 4= bom 5= muito bom 6= proficiente

	Leitura	Escrita	Compreensão auditiva	Fala
Língua 1	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Língua 2	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Língua 3	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
Língua 4	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6

10. Marque com um X em que língua você se sente mais confiante ao:

	Língua 1	Língua 2	Língua 3	Língua 4
Ler				
Escrever				
Compreender (oral)				
Falar				

11. Caso você já tenha realizado algum teste de proficiência, indique:

Língua	Teste (nome)	Ano	Pontuação

12. Other relevant information

APPENDIX 3

Extra Bilingualism Questions Asked in Person

1. QUANTAS VEZES NA SEMANA VOCÊ ASSISTE VÍDEOS EM INGLÊS NO YOUTUBE?
   a. TODO DIA;
   b. ALGUMAS VEZES NA SEMANA;
   c. RARAMENTE;
   d. NUNCA

1. VOCÊ JOGA JOGOS EM INGLÊS?
   ( ) NÃO ( ) SIM.
   COM QUAL FREQUÊNCIA?
   a. TODO DIA;
   b. ALGUMAS VEZES NA SEMANA;
   c. RARAMENTE;
   d. NUNCA

2. VOCÊ OUVE MAIS MÚSICAS EM INGLÊS OU EM PORTUGUÊS?
   ( ) INGLÊS ( ) PORTUGUÊS ( ) QUANTIDADE
IGUAL

3. VOCÊ LÊ COISAS EM INGLÊS NO SEU DIA-A-DIA?
   ( ) NÃO ( ) SIM.
   COM QUAL FREQUÊNCIA?
   a. TODO DIA;
   b. ALGUMAS VEZES NA SEMANA;
   c. RARAMENTE;
   d. NUNCA

APPENDIX 4

RCLE - REGISTRATION OF FREE AND CLEAR CONSENT

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Informações aos participantes e responsáveis.

1) Título do protocolo do estudo: “Processamento de leitura em crianças portadoras de dislexia aprendizes de inglês como L2 de diferentes níveis de bilinguismo: influência no desempenho de leitura em L1 e L2”

2) Convite
Os alunos portadores de dislexia do quarto ano em diante do ensino fundamental da escola estão sendo convidados a participar da pesquisa “Processamento de leitura e bases neurais em monolíngues e aprendizes de inglês como L2: influência no desempenho de leitura em L1 e L2”. Após explicação e reuniões feitas entre a escola e a pesquisadora, a fim de detalhar a pesquisa, a própria escola, que tem acesso ao diagnóstico fornecido pelas famílias, entrou em contato com os responsáveis para divulgar a pesquisa e compartilhar o contato da pesquisadora caso algum responsável desejasse e consentisse a participação de seu/sua filho/a. Portanto, o contato entre família e pesquisadora deu-se dessa forma. Como são menores de idade, precisam da autorização dos responsáveis para que possam participar. Antes de decidir se o/a aluno/a participará, é importante que você entenda porque o estudo está sendo feito e o que ele envolverá. Reserve um tempo para ler cuidadosamente as informações a seguir e faça perguntas se algo não estiver claro ou se quiser mais informações. Serão formados 3 grupos de 6 integrantes cada. O primeiro grupo em análise será em torno de 6 crianças portadoras de dislexia com diagnóstico prévio de uma escola bilíngue de imersão, um segundo grupo 6 crianças portadoras de dislexia também com diaginóstico prévio de outra escola com programa bilíngue e um grupo de controle pareado em faixa etária, sexo, nível de inteligência não-verbal e ano escolar de não-portadoras de dislexia dessa mesma escola com programa bilíngue.

3) O que é o projeto?

O projeto consiste na aplicação de testes linguísticos, para medirmos o desempenho de leitura dos alunos crianças portadoras de dislexia em língua inglesa e em língua portuguesa bem como as possíveis influências para esse desempenho, e aplicação de testes das chamadas funções executivas (FEs), para analisarmos se as crianças que estudam um idioma estrangeiro no ensino fundamental possuem melhor desempenho na leitura influenciado ou não pelo nível de bilinguismo obtido.

4) Qual é o objetivo do estudo?

Como previamente mencionado, o estudo investiga como os diferentes níveis de bilinguismo influenciam no desempenho da leitura na língua portuguesa e na língua inglesa. Faremos tal investigação aplicando testes de leitura em inglês e português nas crianças, bem como testes das FEs, memória e consciência fonológica. O termo teste é usado pois estamos falando de uma pesquisa científica, mas esse teste é diferente dos aplicados na escola. Esse é apenas um experimento do estudo e não avaliará as crianças com notas e nenhum dado individual será divulgado, pois a análise é baseada no desempenho total do grupo.

5) Por que eu fui escolhido(a)?

Precisamos estudar dois grupos de diferentes níveis de bilinguismo para compararmos os resultados obtidos. Sendo assim, os alunos do ensino fundamental participarão dos dois tipos de estudos: linguístico (testes de leitura em inglês e português), das funções executivas (FEs – para medirmos a performance em ações rotineiras, como por exemplo, concentração durante as aulas, finalizar uma determinada tarefa, tomar decisões e seguir um comportamento positivo na resolução de problemas, memória, QI, velocidade de processamento de informação visual) e consciência fonológica. Só participarão desses testes como voluntários os alunos que tiverem a permissão de seus responsáveis e desejarem participar. Os responsáveis receberão um relatório inteiro sobre o nível de leitura que a criança está, bem como resultados de outros marcadores do teste de funções executivas.

Importante ressaltar que o/a estudante que for alocado para o grupo com dislexia está ciente de sua condição previamente à participação na pesquisa, pois pode acontecer da família ter o diagnóstico, mas o estudante não saber de sua condição ainda ou não compreender, evitando, assim, a geração de sentimentos de ansiedade nos estudantes devido ao desconhecimento de sua condição e revelação no momento de assinatura do Termo de Assentimento Livre e Esclarecido.

6) O aluno/a é obrigado a participar?
O responsável é quem decide se o aluno poderá participar ou não deste estudo/pesquisa. Se decidir a autorizar que o/a aluno/a participe do projeto "Processamento de leitura e bases neurais em monolíngues e aprendizes de inglês como L2: influência no desempenho de leitura em L1 e L2", você deverá assinar este registro e receberá uma via assinada pelo pesquisador, a qual você deverá guardar. Mesmo se você decidir que o/a aluno/a possa participar, você ainda tem a liberdade de retirá-lo/la das atividades a qualquer momento, sem qualquer justificativa.

7) O que acontecerá com o aprendiz que participar? O que o/a aluna deverá fazer?

A participação do/a aluno/a no estudo será no sentido de interagir com o pesquisador e sua equipe enquanto a realização dos testes. O aprendiz participará de 5 sessões de 50 minutos cada (1 com a psicóloga, 2 com a fonoaudióloga e 3 com a pesquisadora) nas quais ele deverá realizar testes de habilidades não verbais e testes de averiguação do perfil linguístico, teste de QI, testes de leitura (compreensão e produção), proficiência em inglês e testes de atenção e funções executivas.

8) O que é exigido do aprendiz nesse estudo além da prática de rotina?

Apenas que interaja com o pesquisador e sua equipe (respondendo perguntas e realizando testes) e computador (no caso do teste das funções executivas), apertando um dos botões quando solicitado. Serão agendadas sessões com o aprendiz na escola fora do horário de aula. Todos os membros da equipe estarão de máscara e será realizado distanciamento físico, sempre que possível para a condução dos experimentos, em toda e qualquer interação com os estudantes.

9) Eu terei alguma despesa ao participar da pesquisa?
Não há nenhum valor econômico, a pagar ou a receber, pela participação.

10) Quais são os eventuais riscos ao participar do estudo?
Os riscos são os mesmos recorrentes do ambiente escolar, como o de conversar, falar, pintar, uma vez que, de acordo com as Resoluções 466 e 510 do Conselho Nacional de

Saúde, todas as pesquisas envolvem riscos, ainda que mínimos. Além disso, esclarecemos que não existe certo ou errado nesse teste, toda resposta será válida. Se mesmo após a autorização dos responsáveis e de seu próprio consentimento, o/a aluno/a ainda se sentir constrangido ou desconfortável, ele poderá escolher se deseja prosseguir no experimento ou não.

Em virtude da pandemia causada pelo coronavírus SARS-CoV-2 (Covid-19) alguns cuidados deverão ser tomados na aplicação do teste. Essa pesquisa só será aplicada após conversa com a direção da escola, para que possamos estar alinhados com as medidas de prevenção adotadas pela Secretaria Municipal de Educação do Rio de Janeiro (SME-RJ) e consequentemente não expor nenhum participante, pesquisador ou membro da comunidade escolar a riscos.

Não haverá perda de confidencialidade em relação aos resultados dos testes realizados para outras pessoas que não os responsáveis. Está garantida a anonimidade dos participantes.

Pode acontecer dos participantes ou responsáveis não se sentirem confortáveis durante as aplicações de testes. Nesse caso, a qualquer momento, o aprendiz que estiver participando do experimento, poderá desistir em qualquer etapa da pesquisa, não havendo obrigatoriedade de terminá-la.

Além disso, antes de todas as etapas de aplicação de testes, o consentimento de participação do participante será verificado e registrado através de gravação de voz, perguntando se ele gostaria de participar do experimento ou não, a fim de garantir uma experiência de confiança. Pode haver recusa à participação no estudo, bem como pode ser retirado o consentimento assinado pelo responsável a qualquer momento, sem precisar haver justificativa.

Além disso, todos os encontros serão previamente agendados de acordo com a disponibilidade dos participantes e da equipe de pesquisa.

Caso ocorram eventuais problemas técnicos, como queda de energia ou problemas no computador, todas as sessões serão reagendadas.

11) Quais são os possíveis benefícios de participar?

Como benefício direto, será disponibilizado um relatório completo com os resultados dos testes para os responsáveis. Entre os benefícios indiretos do presente estudo podemos citar a aproximação da universidade e do ambiente escolar, o que permitirá uma ampliação do repertório cultural e do conhecimento de mundo dos alunos, que terão contato com tal estudo e com a pesquisadora. Além disso, é nosso objetivo que a pesquisa feita na universidade melhore as práticas e os métodos de ensino nas escolas e facilite o processo de aprendizagem dos alunos. Uma outra possibilidade, caso os resultados da pesquisa apontem para um efeito positivo do ensino bilíngue para alunos crianças portadoras de dislexia, esse estudo também poderá contribuir para uma oferta mais ampla do ensino bilíngue.

12) O que acontece quando o estudo termina?

Os dados obtidos nesta pesquisa serão utilizados no projeto de mestrado da mestranda Rebecca Christina Tomaz Reina e na publicação de artigos científicos, não sendo publicado qualquer dado que comprometa o sigilo da participação dos integrantes dessa instituição. A dissertação estará disponível no site do programa de pós-graduação em Linguística da Universidade Federal do Rio de Janeiro.

13) Minha participação neste estudo será mantida em sigilo?

A privacidade dos participantes será respeitada, ou seja, seu nome ou qualquer outro dado ou elemento que possa, de qualquer forma, o(a) identificar, será mantido em sigilo e não será divulgado de forma alguma.

14) Contato para informações adicionais

Dados do(a) pesquisador(a) responsável: Rebecca Christina Tomaz Reina. Email para contato: rebeccareina@letras.ufrj.br

Dados da Instituição Proponente. Faculdade de Letras UFRJ - Programa de Pós-Graduação em Linguística Av. Horácio Macedo, 2151, Cidade Universitária, Ilha do Fundão, Rio de Janeiro RJ – Brasil – CEP 21941-917 / e-mail: ppglinguistica@letras.ufrj.br

Telefone: (21) 3938-9710 (Coordenação)

Dados do CEP: Comitê de Ética em Pesquisa do IESC (Instituto de Estudos em Saúde Coletiva) - Avenida Horácio Macedo s/n. Próximo a Prefeitura Universitária da UFRJ. Ilha do Fundão, Cidade Universitária. CEP: 21941-598 - Rio de Janeiro, RJ. Telefone: 021 973-805-679 - email: cep@iesc.ufrj.br.

O Comitê de Ética em Pesquisa é um colegiado responsável pelo acompanhamento das ações deste projeto em relação a sua participação, a fim de proteger os direitos dos participantes desta pesquisa e prevenir eventuais riscos.

15) Remunerações financeiras

Nenhum incentivo ou recompensa financeira está previsto pela participação nesta pesquisa.

Obrigado por ler estas informações. Se deseja participar deste estudo, assine este Termo de Consentimento Livre e Esclarecido e devolva-o ao(à) pesquisador(a). Você deve guardar uma via deste documento para sua própria garantia. Você também irá receber uma via assinada pela pesquisadora.

1 – Confirmo que li e entendi as informações sobre o estudo acima e que tive a oportunidade de fazer perguntas.

2 – Entendo que minha participação é voluntária e que sou livre para retirar meu consentimento a qualquer momento, sem precisar dar explicações, e sem sofrer prejuízo ou ter meus direitos afetados.

3 – Concordo em participar da pesquisa acima.

Email:

____

Nome do responsável pelo participante:

____

Nome do participante:

____

Data de hoje:

____/____/____

Concordo Com o Termo de Consentimento Livre e Esclarecido (responsáveis):

(   ) sim

(   ) não

APPENDIX 5

Table 64 - Standard scores for the average frequency of errors in the Dictation Test (version reduced) as a whole, by age, for elementary school children (DIAS;CAPOVILLA, 2013).

Frequency of Errors Average	Age in Elementary School					
	6	**7**	**8**	**9**	**10**	**11**
5,8	82	75				
5,75	83	75				
5,7	83	76				
5,65	84	76				
5,6	84	76				
5,55	84	77				
5,5	85	77				
5,45	85	77				
5,4	86	78				
5,35	86	78				
5,3	86	79				
5,25	87	79				
5,2	87	79				
5,15	88	80				
5,1	88	80				
5,05	88	80				
5	8	9				
4,95	8	9				
4,9	9	0				
4,85	9	0				
4,8	9	0				
4,75	9	1				
4,7	9	1				
4,65	9	2				
4,6	9	2				
4,55	9	2				
4,5	9	3				
4,45	9	3				
4,4	9	4				
4,35	9	4				
4,3	9	4				
4,25	9	5				
4,2	9	5				

4,15	9	6				
4,1	9	6				
4,05	9	6				
4	9	7				
3,95	9	7				
3,9	9	8				
3,85	9	8				
3,8	98	90				
3,75	99	90				
3,7	99	91				
3,65	100	91				
3,6	100	92				
3,55	100	92				
3,5	101	92	1			

Table 64

Table 65 - Standard scores for the average frequency of errors in the Dictation Test (reduced version) as a whole, by age, for elementary school children (continued) (DIAS;CAPOVILLA, 2013).

Frequency of Errors Average	**Age in Elementary School**					
	6	**7**	**8**	**9**	**10**	**11**
3,45	101	93	3			
3,4	102	93	4			
3,35	102	93	6			
3,3	102	94	8			
3,25	103	94	9			
3,2	103	95	11			
3,15	104	95	13			
3,1	104	95	15			
3,05	104	96	16			
3	3,4	102	93			
2,95	105	96	20			
2,9	106	97	22			
2,85	106	97	23			
2,8	106	98	25			
2,75	107	98	27			
2,7	107	98	28			
2,65	108	99	30			
2,6	108	99	32			
2,55	108	100	34			
2,5	109	100	35			

2,45	109	100	37			
2,4	110	101	39			
2,35	110	101	41			
2,3	110	101	42			
2,25	111	102	44			
2,2	111	102	46			
2,15	112	103	47			
2,1	112	103	49			
2,05	112	103	51			
2	113	104	53			
1,95	113	104	54			
1,9	114	104	56			
1,85	114	105	58			
1,8	114	105	60			
1,75	115	106	61			
1,7	115	106	63			
1,65	116	106	65			
1,6	116	107	66			
1,55	116	107	68			
1,5	117	108	70	1		
1,45	117	108	72	5		
1,4	118	108	73	10		
1,35	118	109	75	14	1	
1,3	118	109	77	18	5	
1,25	119	109	79	23	10	1
1,2	119	110	80	27	14	6
1,15	119	110	82	31	19	11

Table 65

Table 66 - Standard scores for the average frequency of errors in the Dictation Test (reduced version) as a whole, by age, for elementary school children (continued) (DIAS;CAPOVILLA, 2013).

Frequency of Errors Average	**Age in Elementary School**					
	6	**7**	**8**	**9**	**10**	**11**
1,1	120	111	84	35	24	16
1,05	120	111	85	40	28	21
1	121	111	87	44	33	26
0,95	121	112	89	48	37	31
0,9	121	112	91	53	42	36
0,85	122	112	92	57	47	41

0,8	122	113	94	61	51	46
0,75	123	113	96	65	56	51
0,7	123	114	98	70	60	56
0,65	123	114	99	74	65	61
0,6	124	114	101	78	70	66
0,55	124	115	103	83	74	71
0,5	125	115	104	87	79	76
0,45	125	116	106	91	83	81
0,4	125	116	108	96	88	86
0,35	126	116	110	100	93	91
0,3	126	117	111	104	97	96
0,25	127	117	113	108	102	101
0,2	127	117	115	113	106	106
0,15	127	118	117	117	111	111
0,1	128	118	118	121	115	116
0,05	128	119	120	126	120	121
0	129	119	122	130	125	126

Table 66

Table 67 - Dictation standard score classification (CAPOVILLA, 2000 – based on PINHEIRO, 1994).

Standard score < 70	very low
Standard score between 70 and 84	low
Standard score between 85 and 114	medium
Standard score between 115 and 129	high
Standard score ≥ 130	very high

Table 67