

ORIGINAL ARTICLE

An investigation of the possibility of assessing general language proficiency and reading proficiency in English as a foreign language through scrambled-lettered texts

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ABSTRACT

Reading Scrambled-Lettered Texts (SLT) is a complex activity, related to many factors, including language proficiency. This study investigates the possibility of using SLT as an integrative method to assess language and reading proficiency in English as a Foreign Language (EFL). A SLT reading test in English was applied to ten Brazilian EFL learners and the results were compared to their global and reading scores in the TOEFL ITP. Despite the limitation of the sample size, a negative correlation between the TOEFL scores and the number of errors in the SLT test was found. The results were significant in terms of p-value in four out of six cases and the presence of an outlier suggested an even higher correlation and relevance. A Portuguese SLT test was also applied to the sample, and the participants, who had a similar level of education, presented homogeneous results, contrasting with those found in the English test.

KEYWORDS: EFL proficiency; reading proficiency, scrambled-lettered texts, foreign language assessment.

Uma investigação acerca da possibilidade de avaliar proficiência geral e leitora em Inglês como língua estrangeira através de textos com letras embaralhadas

RESUMO

A leitura de Textos com Letras Embaralhadas (TLE) é uma atividade complexa, relacionada, entre outros fatores, à proficiência na língua. Este estudo investiga a possibilidade de usar TLE como um método integrativo de avaliação de proficiência geral e leitora em Inglês como Língua Estrangeira. Um teste de leitura de TLE foi aplicado a dez aprendizes brasileiros de Inglês e os resultados comparados com os escores globais e de leitura deles no TOEFL ITP. Apesar da limitação do tamanho da amostra, uma correlação negativa entre os escores no TOEFL e o número de erros no teste foi encontrada. O valor-p foi relevante em quatro das seis comparações, e a presença de um dado espúrio sugere uma correlação e relevância ainda maior. Um teste de TLE em português também foi aplicado e os mesmos participantes, que tinham escolaridade semelhante, tiveram uma performance homogênea em contraste com o teste em Inglês.

PALAVRAS-CHAVE: proficiência em Inglês como Língua Estrangeira, proficiência leitora, textos com letras embaralhadas, avaliação de língua estrangeira.

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1. INTRODUCTION

This paper aims to investigate if there is a correlation between levels of proficiency in English as a Foreign Language (EFL) and the ability to read designed scrambled-lettered texts¹ in the target language. If the correlation exists, the development of a new test (a Letter Transposition Test – LT Test) to predict EFL proficiency or to diagnose reading ability in second language (L2)² is possible, justifying the relevance of this research.

The idea for this research arose three years ago from the observation that one of the researchers, a Brazilian learner of English and French as foreign languages, had different performances in time of reading and of word-recognition while reading the scrambled-lettered texts that follow³:

Aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mttar in waht oredr the ltteers in a wrod are, the only iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe.

Sleon une édtue de l'Uvinertisé de Cmabrigde, l'odrrre des ltteers dnas un mot n'a pas d'ipmrotncae, la suele coshe ipmrotnate est que la pmeière et la drenère ltteers sinoet à la bnnoe pclae. Le rsete peut êrte dnas un dsérorde ttoal et vuos puoevz tujoruos lrie snas porblmèe. C'est prace que le creaveu hmauin ne lit pas chuaqe ltetre elle-mmêe, mias le mot cmome un tuot.

Although there is no such research at Cambridge University, and the information contained in the texts is most biased, it seems that, with some cost of time and comprehension, it is possible to read some types of scrambled-lettered texts, not only in the first language (L1), but, depending on the level of proficiency, also in the L2. Indeed, in spite of being able to read both texts above, this reader's performance in time of reading and in word recognition was better while reading the English version, which is the language he was more proficient in, even being already familiar with the context when reading the French version. Like wise, his performance reading the L1 version of the same text⁴ was better both in time of reading and in word recognition in comparison to his performances reading the L2 versions.

The different performances observed seem to suggest that reading scrambled-lettered texts is not just a matter of ability in unscrambling, as it happens in some children's unscramble games in which the words are shown isolated, but a complex activity related, among other factors, to language knowledge (including vocabulary size), to word recognition and to the context of the text. In L1, it is possible to associate reading proficiency with the level of formal education or increasing literacy, once research shows

¹ Texts in which the letters of the words were somehow transposed.

² In this paper L2 will be used as a broad term, encompassing both foreign and second languages.

³ These texts, as well as versions in 15 other languages, including Brazilian Portuguese, can be found in <<https://www.mrc-cbu.cam.ac.uk/people/matt.davis/Cmabrigde/>>. The English version is also found in Eysenck (2017, p. 359).

⁴ The version of the text in Brazilian Portuguese is: De aorcdco com uma pesqiusa de uma uinrvesriddae ignlsea, não ipontra em qaul odrem as lrteas de uma plravaa etâso, a úncia csioa iprotmatne é que a piremria e útmliã lrteas etejasm no lgaur crteo. O rseto pdoe ser uma ttaol bçguana que vcoê pdoe anida ler sem pobrlmea. Itso é poqrue nós não lmeos cdaa lrtea isladoa, mas a plravaa cmoo um tdo.

that the longer the time of study, the better the performance in reading activities and in other neuropsychological tasks (Alderson, 2005; Parente et al., 2009), with structural and functional changes being observed in the brain related to educational attainment (Parente et al., 2009; Dehaene, 2012). In L2, reading performance is associated mainly to syntactic and lexical knowledge (Alderson, 2005) as well as to the achievement of a language threshold⁵, allowing for L1 reading ability transference.

As a result, it seems reasonable to hypothesize that there is a positive correlation between the level of proficiency in the L2 and the ability of reading jumbled-lettered texts in it. In this case, if someone can achieve a high performance in reading a battery of English-L2 scrambled-lettered texts, the person will probably have a high proficiency in the language, and vice versa.

To test this hypothesis, which is the first objective of this research, an exploratory study with 10 participants was designed. The participants were Brazilian undergraduates or majors of English who had global and reading scores in the TOEFL ITP. They had to read and transcribe three English scrambled-lettered texts designed to have, according to the factors discussed in the literature review, different levels of difficulty.

Since the participants have a similar level of formal education, a Brazilian Portuguese (L1) scrambled-lettered text test was also applied to them to verify, as a second objective, if they presented homogeneous results in the L1 test, as expected.

Hence, the research questions that guided this study are:

1. Is there a positive correlation between the learners' general level of proficiency or their reading proficiency in EFL and the ability to read designed jumbled-lettered texts in that language?
2. Do the participants, who have a similar educational background, present a homogeneous performance while reading the designed scrambled-lettered texts in their L1?

This introduction presented the research motivation, objectives, hypotheses and questions of the study. Following it, we will present the main theoretical background related to letter transposition effects in reading, to the reading models adopted⁶ and to reading assessment methods, which were the basis to design the specific reading tests used in this research. Then, the methodological procedures of the study, as well as the details concerning to the data analysis, will be presented, followed by sections on results and the discussion. Finally, the conclusion highlights the most relevant aspects of the research findings, referring back to the objectives, questions and hypotheses of the study.

⁵ The idea that readers will not be able to read effectively until they have "attained a certain minimum or threshold level of competence in a second language" was first discussed by Cummins (1979, p.229). Concerning lexical threshold, scholars diverge about the vocabulary size necessary for reading. For instance, while Laufer (1992) considers 4000-5000 families of word necessary for a minimal understanding of a text, Nation (2006) estimates it from 8000-9000 families of words.

⁶ Actually, there are no reading models, but different theoretical models related to different aspects of reading, such as word recognition, syntactic parsing, eyes-movement, brain activation, etc. In this research only models related to word recognition and reading processing in the level of the text are discussed (Rayner & Reichle, 2010).

2. THEORETICAL BACKGROUND

This section presents the theoretical background related to letter transposition effects in reading, to word recognition and reading processing models adopted, as well as to reading assessment methods, which are the basis to construct the theory on which this research was based.

2.1 Reading Scrambled-lettered Texts

To answer the research questions, it is necessary to first explain text readability in scrambled-lettered texts, or, in other words, why some jumbled-lettered texts are easy or difficult to read and which variables have to be taken into account to design a valuable test, considering the theories behind them.

Text readability is not an exclusive phenomenon of scrambled-lettered texts. Research developed especially in educational contexts, in which the adjustment of text difficulty is often necessary, shows that in normal texts, both in first and second languages, readability is mainly related to vocabulary/word frequency and to syntax (Alderson 2005, Greenfield, 2014). However, Alderson (2005, p. 73), based on the observation of Strother and Ulijn (1987) that simplifying syntax does not necessarily make texts more readable, highlights that “it has long been known that vocabulary load is the most significant predictor of text difficulty, since a thorough syntactic analysis of text may be unnecessary”. Likewise, Chall (1958, p. 157) states that “once a vocabulary measure is included in a prediction formula (of readability), sentence structure does not add very much to the prediction”.

According to the core of the scrambled-lettered text mentioned above, the only important thing to be able to read scrambled-lettered text is that the first and last letter of each word be in the right place. In fact, as highlighted by Davis in a 2012 website publication⁷ there are many factors beyond first and last letter maintenance which can make scrambled-lettered texts, both in L1 and L2, easy or hard to be read. We can divide these factors, according to a traditional framework adopted for reading in general⁸, and based on interactive models of reading processing⁹, in three groups: 1) factors related to the way the letters of the word are transposed, 2) factors related to the text, and 3) factors related to the reader.

2.1.1 Factors related to the way the letters are transposed

There are different ways of changing the order of the letters in a word and, depending on the way used, the text may be more or less readable. Those factors are: first and last letter maintenance, adjacent letter transpositions, transpositions done in the same half of the word or into morpheme boundaries (multimorphemic words), vowel transpositions and transpositions which maintain the sounds of the original word (Davis, 2012).

⁷ <<http://www.mrc-cbu.cam.ac.uk/people/matt.davis/cmabridge/>>.

⁸ According to Alderson (2005, p. 32), “it has become common practice to divide research into factors that affect reading into the two main constellations of variables that are typically investigated.”, which are reader and text variables.

⁹ Interactive models that consider top-down and bottom-up processes acting together (Grabe, 2004).

One of the most important elements in order to automatize the reading of a jumbled-lettered text is indeed to keep the first and the last letters in their original positions (Christianson et al, 2005; Rayner et al, 2006; Dehaene, 2012, Norris & Kinoshita, 2012). This happens because of a variety of reasons.

First of all, when you keep the positions of the first and the last letters in a word and change the order of the others, those words which have two or three letters, such as most functional words, do not present any change at all, as it happens, for instance, with the article “the” and with the possessive adjective/pronoun “his”. Moreover, in words with four letters, if you keep the first and last letters in their positions, it will be easier to unscramble the two letters of the middle of the word, as it happens, for example, with the scrambled words “ckae” and ‘siut”. It seems self-evident that, for words with more letters, keeping the first and the last in the right positions helps in the reading process, but does not guarantee easiness (as we can see in the scrambled word “tnoaitrascn¹⁰”), since the reading process involves the different elements yet to be mentioned, all of them acting together (Davis, 2012).

The second reason why keeping the first and last letters of a scrambled word makes the reading easier is that our brain uses this kind of information for word recognition. Christianson, Johnson & Rayner (2005, p. 1327), based on other studies, highlighted that “the beginning and ending letters cannot be transposed without significantly hindering recognition”(Chambers, 1979; Holmes & NG, 1993; Perea & Lupker, 2003a, 2003b). As a consequence, first and last letter maintenance facilitates the identification among the thousands of words we know in L1 or L2, of those that can fit in that position in the text, functioning as a positive priming effect for reading, just as context does.

Demonstrating this effect, Rayner et al. (2006) show, through eye-tracking experiments, that, compared to the base reading rate of normal sentences (in English), measured in words per minute (wpm), there is a decrement in number of words read if the transpositions are done just in the internal letters compared with transpositions which include the last and the first letters:

Whereas the base reading rate for normal sentences was 255 wpm, all of the variations involving letter transpositions resulted in some cost to reading. When the transpositions occurred to the internal letters, reading rate was 227 wpm (a 12% decrement in reading speed). However, when the transpositions involved the final or ending letters of words, reading rate was 189 wpm (a 26% decrement) and when the transpositions were at the beginning of the words, reading rate was 163 wpm (a 36% decrement). Readers made more and longer eye fixations (see **Table 1**) with the more difficult transpositions (Rayner et al., 2006, p. 3).

However, keeping the first and the last letters alone does not guarantee the success of reading scrambled words or a scrambled-lettered text in an automatized way, as we can see in the following example:

¹⁰Transaction.

Icannruse aaisgnt priles is an itaomnrpt ascept of iitaeontnanrl crcoeamml tintrosnaas. In the eevnt of lsos or dagmae to cgaro due to hzardas drunig vagoye, an inerud praty wlil be albe to rveecor lesoss form the irnsuer. The tpye of iuncnarse reeurqid dneedps on the mdoe of tasornrpt aeegrđ bweeten pitreas to tpsrnoat the cagro.¹¹

The difficulty in reading the passage is explained because of the other factors that influence reading, such as the way internal transpositions are done, the kind of vocabulary used, the length of the words and the lack of information about context, among others. For the same reasons, sometimes even when all the letters are randomized, that is when the first and last letters are not maintained, it is still possible, of course with a high cost of time, to read the text. For instance, look at the scrambled passage below, which talks about life expectancy in Japan (context) and was adapted from a piece of news published on the CNN website: “naJpa hsa het tlongse-invilg tioauppnlo in eht owdrł, twhi eth agareev 60-yrea-dol ngogi on to lvei tilnu eag 86. pEtesxr say htis si eud to odog itesd, ceaitv elesslftiy nda ivesrpptou mfilya urrcestut”.¹²

Another factor that interferes with the easiness of reading jumbled-lettered texts besides first and last letter maintenance is how letters are transposed in the middle of words. There is evidence that adjacent letter transpositions are easier to be unscrambled than distant ones (Christianson et al., 2005), as we can see in the following example: Cimdrabge and Cmabrigde¹³.

Likewise, in multimorphemic words, trasnposition done into morpheme boundaries are easier than those done across them (Christianson et al, 2005). In the example of the scrambled-word “toansprsiton”, the first and last letters were kept in their original position and just a pair of letters had their position changed, and you probably had much more problem to unscramble it than to unscramble (read) the same word “trasnposition” in the beginning of this paragraph, if you even noticed that the order of the letters ‘n’ and ‘s’ was inverted. Another reason for the difficulty in reading the form “toansprsiton” is because vowel transpositions were partially done. Concerning this subject, Christianson et al (2005, p. 1327) explained that “focusing on word-internal transpositions, Perea and Lupker (2004) found that whereas consonants could be transposed (e.g., *casino*, *caniso*) with little disruption to word recognition, vowels (e.g., *animal*, *anamil*) could not.”

It also seems that vowel transpositions facilitate the formation of pseudo-words, i.e. words that do not exist, but that follow the morphological pattern of the language, which make lexical recovering more difficult. An example of this is when we transpose the vowels of the word “pencil” making the word “pincel”, which still follows the word formation rules of English and is especially problematic to Brazilians since the pseudo-word formed is a word in Portuguese, meaning “brush”.

¹¹ Adapted from <https://en.wikipedia.org/wiki/International_commercial_law>. The original text is “Insurance against perils is an important aspect of international commercial transactions. In the event of loss or damage to cargo due to hazards during voyage, an insured party will be able to recover losses from the insurer. The type of insurance required depends on the mode of transport agreed between parties to transport the cargo.”

¹² Adapted from <<http://edition.cnn.com/2015/12/11/health/oldest-countries-secret-longer-life/>>. The original text is “Japan has the longest-living population in the world, with the average 60-year-old going on to living until age 86. Experts say this is due to good diets, active lifestyles and supportive family structure.”

¹³ Cambridge.

Finally, letters can be scrambled to keep the original sounds of the words, preserving, therefore, the phonological access to meaning. For instance, as highlighted by Davis (2012), in the text of the Cambridge email, the scrambled words “waht”, “taht” and “toatl” keep their original sounds. The same author mentions the work of Van-Orden, G. C. (1987) to explain that “this will assist in reading, since we often attend to the sound of the words even when reading for meaning”.

It is necessary to remember, though, that English is a less transparent language in the phoneme-grapheme correspondence than most other languages¹⁴, which reduces the effect mentioned above, especially if the learner did not use phonics in his/her learning process.

While the factors described until now concern elements of word formation and word recognition, when the scrambled words form sentences or texts, there are other factors besides the way the letters are transposed that have influence on the ability to read them. These factors can be related to the text formed by the scrambled words or to the reader of those texts, and, sometimes, to both at the same time.

2.1.2 Factors related to the text

There are at least four different factors related to the text that are important in order to read and comprehend scrambled-lettered texts: the number of functional words present in the text, the number of short (up to four letters) content words present in the text, the frequency of the vocabulary in the text and the context (Davis, 2012).

The first important factor to read a scrambled-lettered text is the number of functional words present in it. This happens not only because these words are usually short words, and, therefore, easier to unscramble, but also because in jumbled-lettered texts they have the important role of helping the reader to read the subsequent words in a sentence. For instance, the indefinite article “an” will be followed by a vowel-starting noun in the singular, the number “two” leads the reader to the inevitable prediction that there will be a noun in the plural in the sequence (ended by one of the plural morphemes); and the conjunction “than” many times appears in comparisons.

The next important factor that influences the automaticity of reading a scrambled-lettered text is the number of short content words, meaningful words of up to four letters, which also help the reader in the comprehension of the text as a whole, especially when the first and last letters are maintained.

Another important factor that matters to reading scrambled-lettered texts is the frequency of the vocabulary used. Common words and high-frequency words are well known and more easily recognized when they are scrambled than unusual or less frequent words. In fact, if you do not know a specific word, it will be more difficult to get its meaning from a scrambled form because you may lose both lexical and phonological access. As it was expressed by Lewis (1993, p. 89), “lexis is the core or heart of language”.

¹⁴According to Seymour et al. (2003), compared to Finish, Greek, Italian, Spanish, German, Norwegian, Icelandic, Portuguese, Dutch, Swedish, French and Danish, English is the language with deepest orthographic depth. A compared board of orthographic depth in the languages can be seen in the book *Alfabetização, a questão dos métodos*, by Magda Soares (2016).

The last factor related to the text, which has an important role in the ability of reading jumbled-lettered texts, is the context. According to Therrien & Kubina Jr (2007, p. 1), “reading words in context increases reading speed and word recognition more than reading words out of context”. As it was said before, just mentioning the subject of the text to be read helps with the prediction of the vocabulary and ideas that can be found in the text, as well as with the process of unscrambling words in a text (how much it helps depends on the experience of the reader, as it will be explained later). Therefore, the general context works as a priming effect for the recognition of scrambled words.

In addition, when we are reading a scrambled-lettered text, those words, which were already read (unscrambled), help the reading process of the following ones. For instance, without any hint of context, the reader will probably have a hard time to unscramble the isolated word “neexevisp”, while when this word is in a text and we have already read (unscrambled) the other words before it, as in the sentence “\$500 for a Justin Bieber’s ticket is too ‘neexevisp’”¹⁵, the access to the meaning is automatic. This effect is probably the reason why many times we have the perception that the speed of reading scrambled-lettered texts usually tends to increase from the beginning to the end, and it is similar to those observed in the experiments of Meyer and Schvaneveldt in the 1970s, which showed that a word is easily recognized if it has a semantic relation with a previous one. For instance, the word “doctor” is recognized more quickly following the word “nurse” than following the word “library” (Eysenck, 2017).

2.1.3 Factors related to the reader

Besides the factors mentioned above, there are other elements that influence the success of reading scrambled-lettered texts which are not related to the way the letters are scrambled in the words or to the way these words are organized in a text; instead, they are related to some characteristics and some knowledge the reader might have. We can mention, among these factors, based on the variables that affect reading in general (Alderson, 2005), the following four: individual characteristics (aptitude, ability to unscramble and working memory), knowledge of the language, vocabulary size, and world knowledge.

About the individual characteristics or abilities of the reader, such as aptitude, ability to unscramble and working memory, although it is expected that they help in the task of reading a scrambled-lettered text, both in first and second language, all those elements, but the last one, seem not to be essential to the task. On the other hand, working memory capacity seems to have a more important role in reading scrambled-lettered texts, once it is related to another important element for this task, which is vocabulary size. As a matter of fact, it is known that working memory has a positive influence on lexical access in second language (Silveira, 2011) and “that bigger it is the working memory capacity bigger will be the vocabulary and faster will be the access to this information” (Tokowicz & Kroll, 2004, p. 8).

¹⁵“expensive”

Another, and one of the most important, factor in order to be able to read normal texts (and therefore to read scrambled-lettered texts), is the proficiency the reader has in the language in which the text is written (Alderson, 2005). In L1, proficiency in reading is usually related to the level of formal education the reader has. Supporting this idea, research shows that the longer the time of study, the better the performance in reading activities and in other neuropsychological tasks (Parente et al., 2009) with structural and functional changes observed in the brain related to educational level (Parente et al., 2009, Dehaene, 2012). Therefore, it is likely that expert readers perform better in reading scrambled-lettered texts.

The same reasoning can be applied to L2, in which the learner's level of proficiency influences the domain of the structures of the language, such as word formation, phonological structure, grammar, collocations, formulaic expressions etc., all of which are very important while reading scrambled-lettered texts.

The next important factor strictly related to the knowledge of the language is the reader's size of vocabulary. In second language acquisition, vocabulary is recognized as a central element to English language teaching. As it was highlighted by Schmitt (2010, p. 89), when talking about the importance of vocabulary in language learning, "learners carry around dictionaries and not grammar books".

Finally, both in L1 and in L2 the reader's knowledge of the world or the cultural background helps in reading normal and scrambled-lettered texts. This kind of knowledge is important to better understand the context of the text, references, metaphors and other figures of speech.

The table below summarizes the factors that influence reading scrambled-lettered, as mentioned in this section.

Table 1. Factors that influence reading scrambled-lettered texts.

Factors related to the way the letters are transposed	Factors related to the text	Factors related to the reader
<ul style="list-style-type: none"> • First and last letter maintenance • Adjacent letter transpositions • Transpositions into morphemes boundaries • Vowel transpositions • Transpositions which maintain the sounds of the words 	<ul style="list-style-type: none"> • Number of functional words • Number of short content words (up to four letters) • Proportion between words with and without letter transpositions • Frequency of the vocabulary • Context 	<ul style="list-style-type: none"> • Working memory • Proficiency in the language • Size of vocabulary • Knowledge of the world • Cultural background

Source: Produced by the authors.

All the factors mentioned above are consistent with interactive models of processing in reading, as well as with the most acceptable theories about word recognition, which we will discuss next.

2.2 Word Recognition and Text Processing Models

To understand how it is possible to read scrambled-lettered texts, it is necessary to first understand the act of reading, or, in other words, how some ink on paper or some points on a computer screen can be understood as letters, words and texts, which, in turn, have sounds and meanings associated to them. Reading is a very complex process, not totally understood yet, which

involves biological, cognitive, educational and cultural aspects, each one with many other factors involved.

As a consequence, in spite of the fact that the terms “reading theories” or “reading models” are largely used, what truly exist are models and theories related to different aspects of reading (Rayner & Reichle, 2010), such as word recognition, reading processing, syntactic parsing, eyes movement and brain activation. In this section of this work, we are going to briefly discuss some aspects of those theories related to the ability to read scrambled-lettered texts.

Except for braille, reading starts in the eye, and it is in the central and narrow part of the retina, called the fovea, which contains a large number of photoreceptor cells, where the recognition of small print occurs (Dehaene, 2012). Due to that narrowness, the number of letters and words that can be seen clearly at a time is limited¹⁶, which results in the fact that, for reading, the eyes have to move constantly from one point to another in non-linear jumps, named saccades. In each of these saccades, the visual system extracts graphemes, syllables, morphemes, and word roots and then the brain accesses their meanings (Dehaene, 2012).

To explain how the reader recognizes words and their meanings from the elements extracted by the visual system different models have been proposed along the time. These models are based on two word-recognition hypotheses: a single-route hypothesis, advocating “a single procedure for computing phonology from orthography” (Coltheart, 1994), and a dual-route hypotheses, meaning the existence of a phonological route, responsible for the conversion grapheme-phoneme, and a lexical route, responsible for the recovering of meanings and pronunciations in a mental lexicon. Connectionist Models based on the single-route hypothesis, such as the Interactive Activation Model (McClelland & Rumelhart, 1981), have problems to deal with letter transpositions (Eysenck, 2017).

In this work a dual-route hypothesis is adopted because it can explain reading in general, reading impairment, for example dyslexia, and, together with other elements, it can also explain why it is possible to read scrambled-lettered texts. As highlighted by Coltheart (2005, p. 06) “the dual-route conception of reading seems first to have been enunciated by Saussure (1922; translated 1983, p. 34): (...) We read in two ways; the new or unknown word is scanned letter after letter, but a common or familiar word is taken in at a glance, without bothering about the individual letters (...)”

In fact, according to the dual-route hypothesis, two parallel processing routes in the brain can be used for reading: the phonological route, which converts letters into speech sounds for meaning access; and the lexical route, which gives direct access to a mental dictionary of meanings and pronunciations (Dehaene, 2012). For instance, even in languages like Portuguese, in which the grapheme-phoneme correspondence is more regular than in English, the lexical route is used to access the meaning of neologisms and of words with irregular pronunciation, such as “êxito” (the grapheme “x” usually corresponds to the phoneme /ʃ/ and in this word is

¹⁶You can test it keeping your eyes focused in the last word of any line of this paragraph and trying to read at the same time the other words on its left.

pronounced /z/). Furthermore, skilled readers use the semantic route a lot for words they already know, while beginners use the phonological one more often.

Most influential word-recognition models nowadays, including computational ones, such as the Triangle model (Seidenberg and McClelland, 1989) and the Dual-Route Cascaded model – DRC (Coltheart et al., 2001) accept a dual-route hypothesis (Coltheart, 2012). Nevertheless, they were designed aiming to predict models for reading isolated words aloud. When we move from the level of words to the level of texts, reading is also related to text processing, a cognitive process. In order to read the text, the reader has to simultaneously deal with different information which comes from the small units of the language, such as letters, syllables, morphemes and words (in a bottom-up process), from the text and from the linguistic and cultural background knowledge of the reader (in a top-down process) (Van Dijk & Kintsch, 1983).

In terms of text processing, the ability of reading scrambled-lettered texts can only be explained by interactive models, i.e. those models where bottom-up and top-down processes compete (Grabe, 1988). For these models, reading is a complex activity which involves word recognition, syntactic processing, context, semantic priming and the background knowledge of the reader. Eye-tracking experiments show that there is a cost in terms of time and comprehension when we read scrambled-lettered texts, because the time of fixation has to be longer in order to identify word elements, such as morphemes (Rayner et al., 2006). In L2, text comprehension is even more difficult, therefore, in order to integrate information, the reader has to simultaneously use bottom-up and top-down processes at different levels to try to access meaning, which demands a high level of proficiency in the language.

All these elements show how complex the process of reading normal texts is and, as a consequence, the process of reading scrambled-lettered texts. To be a skilled reader in L1 or in L2, it is crucial to have, among other factors, a large vocabulary bank; a domain of the structure of the language, including the phonemes; and knowledge of the world, allowing for the understanding of different contexts. To read scrambled-lettered texts, the same factors are required. Therefore, the literature herein presented supports the hypothesis that being able to read those kinds of texts in L2, with different levels of difficulties, means a high domain of the language, or, in other words, that there is a positive correlation between the proficiency in the language and the ability of reading scrambled-lettered texts in it. If the correlation exists, it is possible to assess the level of proficiency in L2 through designed tests of reading scrambled-lettered texts. Actually, it is already possible to find some theoretical support for this kind of test among some of the reading assessment tests most frequently used, as will be shown next.

2.3 Reading Assessment

The Letter Transposition Test (LT Test) herein proposed intends to be a more integrative and holistic (in opposition to a discrete-point) L2 reading or

proficiency test, which means it demands from the reader many aspects of language simultaneously, such as word recognition, morphology, vocabulary, syntax, semantics, grammar, schema, pronunciation, sensitivity to topic, cultural awareness and reading skills. The LT Test is based, just as other tests, such as the Cloze test (Abreu et al., 2017) and the C-test (Alderson, 2009), upon the law of closure from Gestalt psychology, according to which even when some piece of information is missing, we tend to see complete figures. In the field of Linguistics, Lipka (2012, p. 67) explains that “if given information is insufficient or if there is lack of information, human beings tend to use the law of closure, strive for meaning”. Thus, in this section, a review of other reading assessment methods largely used to assess reading or language proficiency will be presented, and their relation to the TL Test will be argued.

There are several different methods to assess reading ability or reading proficiency in L1 or L2, such as open questions, multiple-choice questions, ordering tasks, matching tasks, information transposition tasks, gap-filling questions, cloze tests, c-tests, portfolios etc. (Alderson, 2005), each one assessing one or more aspects of this complex activity that is reading. It is important to say that once reading is so complex, none of these methods alone is able to fulfill all the aspects or abilities involved in reading, which is why usually the methods are used together, including discrete-point and integrative ones. Next, we will discuss if some characteristics of these methods can justify the use of scrambled-lettered texts as another tool to evaluate aspects of reading and of general language proficiency.

2.3.1 The Ordering Test

Among the types of reading tests described by Alderson (2000), there is the Ordering Test, whose objective is to put a group of words, sentences, paragraphs or texts (why not letters?), which are scrambled, in order. This kind of test demands from the reader the domain of elements of cohesion, coherence and general comprehension.

2.3.2 The Cloze Test

Another test with similarities with the LT Test is the Cloze Test. Cloze tests are constructed by deleting every *n*-th word from selected texts (Alderson, 2009), usually the 5th or 7th word, and requiring the reader to restore the deleted word. It is worthy to mention that in cloze tests one or two sentences have to be fully kept at the beginning and end of the text to maintain unity, a procedure quite similar to first and last letter maintenance in scrambled-lettered texts already mentioned, as well as to the importance of giving some context.

The logic behind the cloze-test is that the reader (test-taker) has to integrate his own world knowledge and linguistic experience with the semantics and syntactic clues present in the text to complete the meaning of the words deleted. Cloze techniques were first used in the fifties, with native speakers of English, in order to evaluate text readability and later to

assess text comprehension. In the seventies cloze procedures started to be used in English-L2 to evaluate general proficiency in English and in reading. In spite of some criticism with the use of Cloze Tests as an instrument to measure EFL proficiency, Alderson (1979, p. 220) recognizes that the research done so far (1979) “suggests that Clozes correlate well with measures of EFL proficiency”.

2.3.3 The C-Test

The other traditional test which relates with the LT Test is the C-Test. Alderson (2005, p. 225) explains that in the C-Test “the second half of every second word is deleted and has to be restored by the reader.” The procedure of keeping the first half of the word in the C-Test intends to avoid the possibility found in Cloze Tests of more than one word possible in the gaps. Furthermore, Eckes & Grotjahn (2006) conclude, after researching a total of 843 participants, that the C-test was a reliable, unidimensional instrument, which measured the same general dimension as the four Test DaF (Test of German as a Foreign Language) sections: reading, listening, writing and speaking. The C-Test procedures resemble the procedures adopted in the TL Test. In the introduction of this paper it was said that the LT Test could measure reading ability and/or predict foreign language proficiency.

3. METHODOLOGY

This study is a quantitative exploratory study conducted to analyze the possible existence of a correlation between levels of proficiency in English as Foreign Language (or proficiency in L2 reading) and the ability to read designed scrambled-lettered texts in the L2. It also aimed to verify if people with similar educational level have similar performances while reading a Portuguese L1 designed scrambled-lettered text.

3.1 Participants

The experiment was carried out with 10 Brazilian participants, 5 women and 5 men, ranging from 20 and 45 years old (mean age 25,5). Nine participants were undergraduate students of English at the time of data collection and the other one has a doctorate degree in Language (English). All participants had a global and reading score in the Test of English as Foreign Language – TOEFL ITP

Participants had global scores on the TOEFL ITP varying from 450 to 677 and reading scores varying from 48 to 67 points. According to the TOEFL ITP Test Score Descriptors¹⁷, the equivalence between the TOEFL ITP Scores and the Common European Framework of Reference for Languages (CEFR) levels is the following:

¹⁷<http://www.etsglobal.org/Global/Eng/Tests-Preparation/The-TOEFL-Family-of-Assessments/TOEFL-ITP-Assessment-Series/Scores-Overview>.

Table 2. Equivalence between TOEFL ITP and Common European Framework of Reference

CEFR Levels	Total Cut Score	Listening Comprehension	Structure and Written Expression	Reading Comprehension
C1	627 points	64	64	63
B2	543 points	54	53	56
B1	460 points	47	43	48
A2	337 points	38	32	31

Source: TOEFL ITP Test Score Descriptors.

Therefore, participants' proficiency levels vary from A2 to C1, while their reading levels vary from B1 to C1 in the CEFR.

3.2 Procedures

Participants were submitted to a test of reading, consisting of one Portuguese scrambled-lettered and then three English scrambled-lettered texts designed to have, according to the factors discussed in the literature review, with different and increasing levels of difficulty.

The Portuguese test was the first to be answered by the participants to set the stage. The authors decided to use just one text in Portuguese in contrast with three texts in English in order to prevent fatigue from test takers and also considering the different objectives of the research stated in the introduction. While the English texts are used to investigate if participants' performances correlate with their different levels of proficiency in EFL, the Portuguese text was used to investigate if people with similar level of education present homogeneous performances while reading SLT.

To compensate for the difference in the number of texts in each language, the Portuguese text was slightly longer than the English ones and was designed to present sentences with different levels of difficulties according to the variables described in the literature review sections (word frequency, ways of transpositions etc.).

Test-takers were adverted to write down the texts as fast as possible, observing a time limit for the conclusion of each text. The words not read/unscrambled should be replaced for an interrogation mark. The participants did not receive any information about the texts and about how the words were scrambled. For instance, they were not informed about first and last letter maintenance in the words in all texts. The results achieved in the test (number of errors) by each participant were compared to their general and reading scores in the TOEFL separately.

3.3 Tests design

For the scrambled-lettered texts tests, authentic texts from open sources of public domain were adapted by the third version of the software Shuffle Letters (2015)¹⁸. This software allows for the elaboration of scrambled-lettered

¹⁸Software specifically developed for this research by the former under-graduate student of Tecnologia em Mecatrônica Industrial of Instituto Federal do Ceará, Raul Victor Medeiros da Nóbrega.

texts of different levels of difficulty according to the variables discussed in topic “2.1.1 Factors related to the way the letters are transposed” of the literature review, e.g. first and last letter maintenance, adjacent or distant transpositions. The selection of texts for the three scrambled-lettered texts took into account the factors discussed in the topic “2.1.2 Factors related to the text” of the literature review, e.g. predictable context, number of short and long words, proportion between words with and without letter transposition and frequency of the words in English according to the Corpus of Contemporary American English – COCA.

The first English scrambled-lettered text was designed to be the easiest one for reading. The text used was retrieved on April 23, 2015 on the website <<http://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/exercise/art-20048389>> and had the letters scrambled by the software Shuffle Letters. The features of the text are the following:

- a) Number of words: 70 (including 11 repeated words)
- b) Number of words up 3 letters: 22
- c) Number of words with 4 letters: 14
- d) Number of words with 5 or more letters: 32
- e) Proportion between words with and without letter transposition: 64,3% / 35,7%
- f) Frequency of vocabulary: high
- g) Context: predictable
- h) Time for reading: 5 minutes.

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Wnat to feel bteetr, hvae mroe eerngy and papehrs eevn lvie lngoer?
 Look no fuhrter tahn eiecsxre. The htelah beitefns of rlgeuar eeirsxce and
 pyhsacil avcttiy are hrad to igrnoe. And the btienfes of esiercxre are yuors
 for the tnikag, rrgseaedls of yuor age, sex or piayhscl aitbliy. Need mroe
 coinninvcg to eicexrse? Chcek out teshe seevn wyas erxecise can iopmvre
 yuor lfie.

Image 1. Text 1 from the English test.
 Source: Produced by the authors.

Below is the table with the frequency of the 35 words longer than 3 letters in the Corpus of Contemporary American English (COCA)¹⁹. The words are organized from most frequent to least frequent:

¹⁹<<https://corpus.byu.edu/coca/>>.

Table 2. Inventory of the frequency of the words longer than 3 letters in text 1.

Word	Frequency in the text	Frequency in the corpus	Word	Frequency in the text	Frequency in the corpus
Have	1	2576350	Ways	1	96878
More	1	1336613	Longer	1	92134
More	1	1336613	Energy	1	88014
Your	1	943151	Further	1	81873
Than	1	890568	Seven	2	74046
These	1	722146	Physical	3	73615
Even	1	624428	Ability	1	65301
Want	1	467900	Activity	2	53287
Life	1	390751	Benefits	3	48452
Look	1	360912	Regular	2	38144
Need	1	315308	Exercise	5	37728
Better	1	235309	Improve	1	36343
Health	1	198218	Regardless	1	16644
Feel	1	193225	Yours	1	14073
Hard	1	168160	Ignore	1	13183
Live	1	142924	Check out	1	7715
Taking	1	122079	Convincing	1	5860
Perhaps	1	116525			

Source: Produced by the authors.

The second English scrambled-lettered text was designed to have an intermediate level of difficulty for reading. In comparison with the first text, this one demands specific knowledge about the context, which is Shakespeare's masterpieces. The proportion between words with and without letter inversion is higher and some parts of the vocabulary is less frequent than in the previous text. The text used was retrieved on April 23, 2015 on the website <https://en.wikipedia.org/wiki/Shakespeare%27s_plays> and had the letters scrambled by the software Shuffle Letters. The features of the text are the following:

- a) Number of words: 61
- b) Number of words up 3 letters: 19
- c) Number of words with 4 letters: 7
- d) Number of words with 5 or more letters: 35
- e) Proportion between words with and without letter transposition: 67,3% – 32,7%.
- f) Frequency of vocabulary: high
- g) Context: predictable.
- h) Time for reading: 6 min

Ssrekaaphee's msrtaeipeces

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Image 2. Text 2 from the English test.
Source: Produced by the authors.

Below is the table with the frequency of the 38 words longer than 3 letters in the Corpus of Contemporary American English (COCA):

Table 3. Inventory of the frequency of the words longer than 3 letters in text 2.

Word	Frequency in the text	Frequency in the corpus	Word	Frequency in the text	Frequency in the corpus
They	1	2623996	William	1	43740
Have	1	2576350	Literature	1	38048
Been	1	1112445	Plays	2	34238
Into	2	940656	Greatest	1	31321
World	1	407900	Performed	1	23474
Being	1	385125	Actor	1	21983
Being	1	385125	Divided	1	18489
Around	1	379873	Reputation	1	17413
Every	1	304607	Comedy	1	14673
Among	1	195616	Tragedy	1	13423
History	1	158457	Poet	1	10532
Major	1	129110	Traditionally	1	10113
Living	1	116494	Shakespeare	2	7435
Language	1	78158	Genres	1	7086
English	1	58629	Translated	1	7006
Written	1	57305	Continually	1	5540
Western	1	56341	Playwright	1	2504
in addition	1	52590	Masterpieces	1	983

Source: Produced by the authors.

The third text was designed to have the most difficult level for reading in comparison to the other two. The text demands specific knowledge about the context (which is America's system of private health insurance) and has more low frequency words in English. So as not to make the text excessively difficult, the proportion between words with and without letter inversion was inferior to the other tests. The text used was retrieved on April 23, 2015 on the website <<http://www.economist.com/news/united-states/21696999-welcome-proposal-cut-payments-drugs-has-doctors-defensive-fat-loss-needed>> and had the letters scrambled by the software Shuffle Letters. The features of the text are the following:

- a) Number of words: 98 (including numbers)
- b) Number of words up 3 letters: 36
- c) Number of words with 4 letters: 8
- d) Number of words with 5 or more letters: 56
- e) Proportion between words with and without letter transposition: 59,2% – 40,8%
- f) Frequency of vocabulary: low
- g) Context: not predictable
- h) Time for reading: 9 min

A wmcloe psoopral to cut pteymnas for durgs has dtoocrs on the dfveinese Wehn a dtocor ttaers a panetit enloerld in Mdecraie—gonmnervt-fduned htaelh iucsnrane for the old—for braest ceacnr, he may prsicebre Pxlietcaal, a tmeerantt cisntog the gonernevtm \$201 and netntig the dotcor \$12 in pirfot. Or he may pcsibrree a clpbaamroe tanteermt, Arnxbaae, ctniosg the geenrmovnt a wkcihnag \$16,700 but ntietg the dtoocr \$1,000. Wtih icntinvees lkie thsee, it is lltlie wndoer taht, deptsie Aeimcra’s seytsm of patvrie htealh icnnaruse, the gvrnmoenet sedpns mroe on htaleh tahn Biitarn deos on its nlniaseotad ht Leah sercvie.

Image 3. Text 3 from the English test.
Source: Produced by the authors.

Below is the table with the frequency of the 43 words longer than 3 letters in the Corpus of Contemporary American English (COCA):

Table 4. Inventory of the frequency of the words longer than 3 letters in text 3.

Word	Frequency in the text	Frequency in the corpus	Word	Frequency in the text	Frequency in the corpus
That	1	3709830	Doctors	1	39371
With	1	2911620	Breast	1	21996
When	1	1349336	Proposal	1	20794
More	1	1336613	Defensive	1	17154
Than	1	890568	Nationalized	1	16428
These	1	722146	Medicare	1	15395
Like	1	619270	Payments	1	12893
Government	2	240841	Incentives	1	9057
System	1	215748	Funded	1	9019
Health	4	198218	Enrolled	1	7937
Spends	1	125139	Comparable	1	7728
Service	1	118156	Treats	1	5292
Treatment	2	69378	Costing	2	2855
Private	1	66100	Prescribe	2	1859
Cancer	1	56521	Netting	2	1207
Despite	1	55875	Doctor	1	1189
Little	1	48996	Whacking	1	357
Insurance	2	48778	Paclitaxel	1	59
Drugs	1	46572	Abraxane	1	1
Patient	1	45040	America	1	Not found
Welcome	1	44147	Britain	1	Not found
Wonder	1	40220			

Source: Produced by the authors.

Lastly, the L1 test had only one scrambled-lettered text, which was designed to have easy, intermediate and difficult passages. This also explains why the text is longer than the others. The text used was retrieved on April 23, 2015 on the website <<http://www.blogdoneylima.com.br/educacao/informe-escola-dinamica-3>> and had the letters scrambled by the software Shuffle Letters. The features of the text are the following:

- a) Number of words: 140
- b) Number of words up 3 letters: 61
- c) Number of words with 4 letters: 13
- d) Number of words with 5 or more letters: 66
- e) Proportion between words with and without letter transposition: 50% – 50%.
- f) Frequency of vocabulary: mixed
- g) Context: predictable
- h) Time for reading: 5 min

O psesorofr é o gdnare pgtosaoitrna do esnino. Sem a itneãçaro dele com os aulons, o prssceoo de aednagiezprm não é omiazdtio. Para pseoiserduds de drvesias áraes, não há ddiúavs de que o pepal do psforsoer é ditereatnmne para o bom dpmeeshneo elocsar dos anolus. Qatnuo moehlr for o dhpseenmo do pfsorsor, moehlr será o deesnemhpo do aluno. Orotus froates - cmoo ealocrsddaie dos pias, iutnrsfauretra eocasl, ascseo a mriaateis ddtcoiias tabémm iueilnafcnm a apzagedienrm, calro, mas a qlauiafaciço do psooresr é o que mias itampca no êitxo do anulo. O psoofrser pdoe, por epemxlo, pniroacoopr ciõeçndos para algraar os hteorionzs da vdia de um aunlo, eunaldsitmo, por exmeplo, o gotso pelo crhinceetmoo. Ele dá para os aulnos o eexmplo de que edtsaur é bom e vlave a pnea. Ele aidna eisutlma o ptneamesno ciictro e a lruieta do mnduo

Image 4. Portuguese text.
Source: Produced by the authors.

4. RESULTS, ANALYSES AND DISCUSSION

Before presenting the results, it is important to highlight that 100% of the participants presented more errors in the text meant to be the most difficult one, and 100% of the participants presented more or the same number of errors in the text with intermediate level of difficulty in comparison with the easiest one. Individual participants' results are reproduced in the table below:

Table 5. Individual results on alltests.

Participant	General TOEFL ITP Score	Reading TOEFL ITP Score	Errors Portuguese Text	Errors English Text 1	Errors English Text 2	Errors English Text 3
1	677	67	2	0	0	4
2	647	64	6	0	2	11
3	627	64	5	0	0	8
4	623	60	4	0	3	9
5	587	59	5	4	7	22
6	580	59	7	0	4	16
7	580	58	3	1	1	14
8	537	57	3	0	3	7
9	510	51	8	3	6	12
10	450	48	6	7	8	22
Average				1,5	3,4	12,5

Source: Produced by the authors.

The data analysis of the English Test was done using Pearson Correlation and Linear Regression with the scores in TOEFL ITP (general and reading ones, separately) and errors in the three texts.

The correlations found between each of the three English LT Tests and the TOEFL Global Score can be seen below (Pearson's *r*). They show, in spite of the possibility of an outlier (participant number 5), a moderate negative correlation between the independent variable (TOEFL ITP score) and the dependent ones (number of errors) in Tests 1 and 2, and a weak correlation in test 3:

Table 6. Correlations between English tests and TOEFL ITP Scores.

	Errors Text 1	Errors Text 2	Errors Text 3
TOEFL ITP Score	-0,75699	-0,77089	-0,58708

Source: Produced by the authors.

Below are the summaries of the outputs for the linear regression for texts 1, 2 and 3.

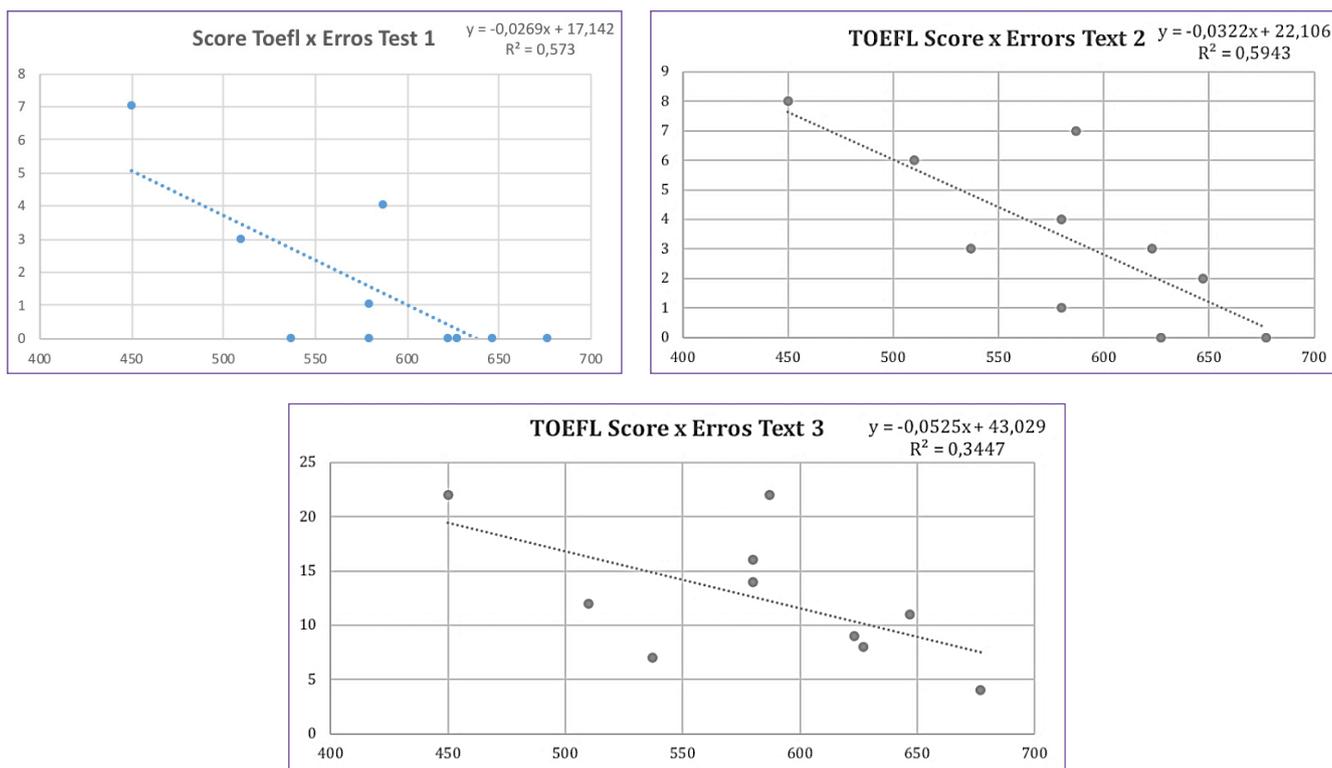


Image 5. Linear regressions for each English test and TOEFL ITP Scores.
Source: Produced by the authors.

As can be seen in the models above, 57% of the TOEFL ITP score can be explained by the results in test Test 1 ($r^2=0,573$; $p=0,011$); 59% of the TOEFL ITP score can be explained by the results in test Test 2 ($r^2=0,594$; $p=0,009$); and, considering all participants, only 35% of the TOEFL ITP score would be explained by the results in test Test 3, but the results was not statistically significant ($r^2=0,345$; $p=0,074$). Nevertheless, it is important to highlight that due to the small number of participants in the sample, individual results have a big influence in the statistical results. For instance, through the analysis of the results of participant number 5 in the three texts, it is possible to consider him an outlier. Without participant number 5, the r -squared in the third test increases to 0,45 with a significant p -value of 0,007, as can be seen in the linear regression output below.

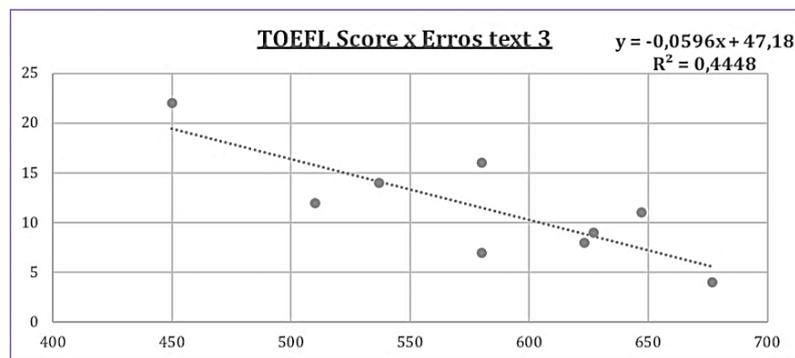


Image 6. Linear regression between Test 3 and TOEFL ITP scores without outlier. Source: produced by the authors.

The correlation between the TOEFL reading score and the test results was also investigated. The correlation indices (Pearson’s r) of each English text compared to the TOEFL Reading Score can be seen below. Just as with the general scores analyzed before, they show, in spite of the possibility of an outlier (participant number 5), a moderate correlation between the independent variable (TOEFL ITP Reading score) and the dependent ones (number of errors) in Texts 1 and 2, and a weak negative correlation in texts 3:

Table 7. Correlations between English tests and TOEFL ITP Reading Scores.

	Errors Text 1	Errors Text 2	Errors Text 3
ITP TOEFL Reading Score	-0,77956	-0,71303	0,61481

Source: Produced by the authors.

Below are the summaries of the outputs for the linear regression for texts 1, 2 and 3.

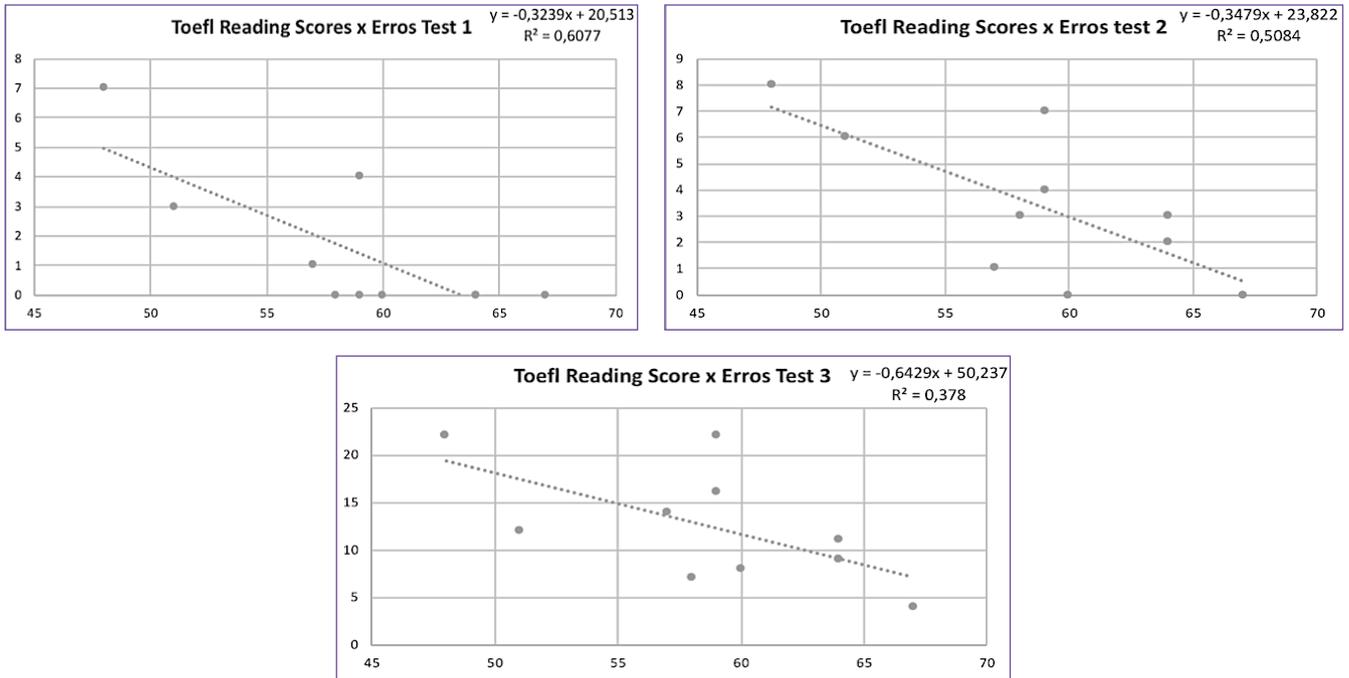


Image 6. Linear regressions for each English test and TOEFL ITP Reading Scores.
 Source: Produced by the authors.

As can be seen in the models above, 61% of the TOEFL ITP Reading score can be explained by the results in test Test 1 ($r^2=0,608$; $p=0,007$); 51% of the TOEFL ITP score can be explained by the results in test Test 2 ($r^2=0,508$; $p=0,02$); and, considering all participants, only 38% of the TOEFL ITP score would be explained by the results in test Test 3, but the results was not statistically significant ($r^2=0,378$; $p=0,058$). Nevertheless, once again, it is important to highlight the presence of an outlier, with big influence in the statistical results in a sample of just 10 participants. Without participant number 5, the r -squared increases to 0,559, with a p -value of 0,020, as can be seen below.

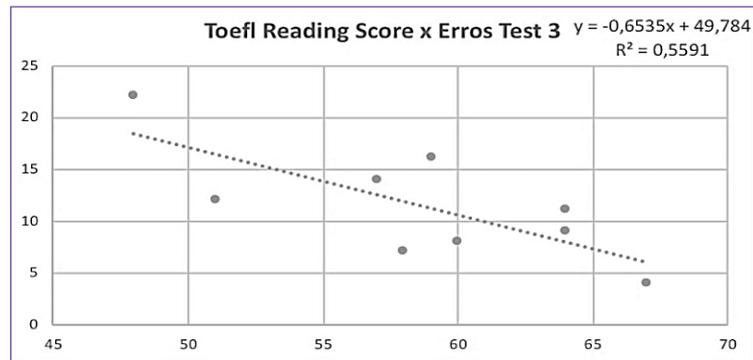


Image 7. linear regression between Test 3 and TOEFL ITP Reading scores without outlier.
 Source: Produced by the authors.

Regardless the small sample used in the experiment, the results obtained suggest that there might be indeed a correlation between levels of proficiency in EFL or reading ability in EFL and the results obtained in reading designed scrambled-lettered texts. Besides, while the errors made by the test-takers, regardless of their proficiency level, were more frequent in long and low-frequency words, as well as in those words with distant transpositions, less proficient participants made mistakes also in short and more frequent words.

Indeed, while the most frequent errors made in text 2 were in the words “cnlolnutaiv” (“continually” - 4 out of 10) and “pahigrylwt” (playwright - 3 out of 10), which are among the three less frequent words in the COCA, in text 3, the most frequent errors were, as expected, in the name of the drugs mentioned in the text, and in the words “nlñiaseotad” (“nationalized” - 9 out of 10), “netntig” and “ntnietyg” (“netting” - 8 out of 10) and “wkcihnag” (“whacking” - 8 out of 10), which can be explained both by the low frequency of these words, but also because of the distant transpositions in the scrambled forms, with disruption of the morphemes.

Interestingly, two of the participants transcribed the word “getting” instead of “netting” in the following sentence of text 3 “(...) cisntog the gonernevmt \$201 and netntig the dotcor \$12 in pifrot”²⁰. Although the two words differ only by the first letter and only a pair of letters were transposed, participants’ answer suggests they did not know the correct word and recovered the most frequent form “getting” in that position. This fact may also indicate that test-takers do not realize first and last letter maintenance in the text.

Another interesting finding was the relatively high number of errors in the word “payments” (4 out of 10). This finding is probably due to the disruption in the first syllable and in the suffix “ment”, as well as to presence of distant transpositions found in the scrambled form of the word in the text (pteymnas). Furthermore, the word appears in the very beginning of the text, when the reader still does not have many clues about the context.

In the Portuguese L1 test the results were homogeneous, as expected. The results in terms of errors in the Portuguese test vary from 2 errors (one test-taker) to 8 errors (one test-taker) in a universe of 139 words, which means a variation from 1,11% to 5,75% of the total number of words. It is also important to highlight that the best performance in the test was achieved by the participant with the highest level of formal education, which is coherent with the observations that the longer the time of study, the better the performance in reading activities in L1 and in other neuropsychological tasks (Alderson, 2005; Parente et al., 2009).

One interesting finding in the Portuguese test was the fact that 50% of the participants read and recalled the word “determinante” as “diretamente” in the sentence “(...) o papel do professor é determinante para o bom desempenho escolar dos alunos”²¹. The high percentage of mistake in this word seems to be due to some of the already explained variables that affect a scrambled-lettered text readability acting together. First of all, the way the

²⁰(...) costing the government \$201 and netting the doctor \$12 in profit”.

²¹The sentence to be recalled is “o papel do professor é determinante para o bom desempenho escolar dos alunos”.

letters were scrambled, especially in the first syllable (“di”), had a strong influence over the readers to recover the word “diretamente” (87069), which, by the way, is more frequent in Portuguese than the word “determinante” (12176), according to the Brazilian corpus Linguateca²².

Besides that, when we compare the two words, it is possible to see that they are quite similar. While “determinante” has 5 syllables and 12 letters, “diretamente” has 5 syllables and 11 letters and all the letters but one are the same, meaning that the bigrams or trigrams are quite similar too. It is also worthy to note that the last three letters in both words are the same. Moreover, the word “diretamente” is syntactically coherent in that position in the sentence, although not semantically. Interestingly, two of the participants informally reported to the examiner after the test that there was an error in the text in that position, meaning that they were able to realize that the word “diretamente” was not semantically coherent in that position, yet being certain of the word recognition. This seems to be evidence for bottom-up and top-down processing occurring simultaneously and competing to one another.

Considering that the participants were instructed to try to read the text as fast as possible, and that they did not review their responses, it is quite acceptable that an expressive number of them have made such mistake despite the lack of coherence in the context. On the other hand, those who recalled the right word may have self-monitored the activity better, as Alderson (2009, p. 57) explains that “it has been suggested that after initial word identification, but still during the fixation, good readers move onto higher-level prediction and monitoring, as well as planning of subsequent fixations”. Since the data collected in this research are small, further investigation about this fact and its implications is necessary.

5. FINAL REMARKS

The questions proposed at the beginning of this paper were:

1. Is there a linear correlation between the general level of proficiency in EFL or the reading level and the ability of reading designed jumbled-lettered texts in that language?
2. Do the participants, who have a similar educational attainment, present a homogeneous performance while reading the designed scrambled-lettered texts in Portuguese L1?

The answer for question number 1 is that the data collected suggest that there might be indeed a positive correlation between levels of proficiency in EFL or reading ability in EFL and the results obtained in reading designed scrambled-lettered texts, or, in terms of error in the test, a negative correlation. Nevertheless, due to the small sample size used in this research, the repetition of the experiment with a larger sample is necessary. In terms of validity, once the Letter Transposition Test proposed has the same rationale and similar procedures of the Cloze and C-tests, whose validity has already been tested, it is possible that the validity already recognized for the Cloze test and C-test also be found for the LT Test when further and more complete research is made.

²²<<https://www.linguateca.pt/cgi-bin/aceso.pl>>.

The answer to question 2 is that the results obtained from the participants in their L1 scrambled-lettered text were homogeneous. This finding, in comparison with the heterogeneous results found in the English Tests, reinforce the existence of correlation between levels of proficiency in the language and the ability of reading jumbled-lettered texts.

The existence of correlation between the variables allows for the idea of developing a Letter Transposition Test to predict or to diagnose EFL proficiency or reading proficiency in EFL. The new test would be cheaper and easier to prepare and to correct than traditional proficiency tests, because different authentic texts could be selected on the internet and scrambled by the software Shuffle Letters and the scores, in terms of number of errors in word recognition, would be compared with the intervals of errors expected for the different levels of proficiency. Despite the advantages pointed so far, the new test would demand readability control in the selection of the texts used, which involves word frequency and length of words, features that the software does not make yet. In the meantime, these results show that scrambled-lettered texts could be used as one of the means to assess language proficiency, and also as a teaching/assessing tool in language classrooms.

As was already acknowledged, this research has the limitation of a very small sample size. Therefore, the next step is clearly the replication of this study with a much larger sample size.

In order to investigate the subjacent processes involved in reading scrambled-lettered texts, another possibility of future studies is the use of eye-tracking as a tool to investigate if readers with different levels of proficiency in L2 present different patterns of saccades and fixations.

To finish, there is a proverb according to which “a word to the wise is sufficient”, meaning that, under certain circumstances, wisdom and experience can solve the lack of information. Based on the results of this research, in an educational context of EFL learning, we might rewrite the proverb as “a scrambled-lettered text to the wise is sufficient”.

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