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TWO LANGUAGES IN ONE MIND: BILITERACY, SPEECH CONNECTEDNESS AND READING IN 5TH GRADE BILINGUAL CHILDREN

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Abstract

This study examined the effects of bilingual education and simultaneous biliteracy on children's levels of speech connectedness and reading in Portuguese and English. Thirty-two 5th graders completed oral production tasks and took reading fluency and comprehension tests in L1 and L2. Our results show that, in general, children show connectedness and reading scores which are correlated in the two languages, that is, the languages follow different, but related paths in the time point they were assessed. We conclude that simultaneous biliteracy, in the case of the participants of this research, is not detrimental to the outcomes of either language. On the contrary, it promotes the concomitant use of languages, which, in turn, seems to guarantee support for both languages, L1 and L2, in a bidirectional fashion.

Keywords: biliteracy; bilingual education; bilingualism; speech connectedness, reading

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Introduction

In recent years, there has been a significant increase in the number of children who study in schools that offer bilingual curricula or programs in Brazil, starting in early school years, with English and Portuguese being the predominant languages offered. For Marcelino (2009), this increase is related to the need of learning a language other than Portuguese to communicate globally, and to meet parents' expectations regarding the necessary skills for their children to succeed in the world.

With that in mind, it becomes imperative to better understand how reading and writing skills develop when children are enrolled in bilingual schools in order to design effective instructional pedagogies that support their growth as readers and writers. To contribute to this discussion, we designed the present study, which aimed to investigate simultaneous biliteracy, speech connectedness and reading skills in L1 and L2 in a group of 5th grade children enrolled in a bilingual school in the northeast of Brazil.

More specifically, we aimed at investigating the strength of the relationship between speech connectedness measures of these children's oral productions in Portuguese and English using an innovative computational tool called *Speech Graphs* (Mota et al., 2012, 2016, 2019). In addition, we also had the goal of examining the strength of the relationship between reading fluency and comprehension skills of these children in both languages, given that they received literacy instruction simultaneously in Portuguese and English. It is worth mentioning that, despite the growth in the offer of this kind of reading instruction in Brazil, the existing literature in the national context is still scarce.

Developing biliteracy

We use the term 'literacy' here to define the set of linguistic and cognitive skills that accompany the individual reader throughout life (Morais, 2020). In the period of emergent literacy, specifically, that refers to the manipulation of graphic symbols and the sounds associated with them. In this sense, the term 'biliteracy', therefore, refers to these processes occurring in parallel and concomitantly in two languages, in our case, Portuguese and English, regardless of how much the instruction favors one of the child's language or both (Lemke et al., in press). The continuous instruction of reading and writing in two languages in the context of bilingual teaching happens in a bidirectional way, that is, the languages follow different but related paths (Ahmadi, Khoii & Taghadosian, 2015; Lemke et al., in press).

A very recurrent issue in studies on biliteracy revolves around the greater or lesser effectiveness of simultaneous or consecutive models. In the first, students learn to read and write in both languages concomitantly; in the second, students are first taught to read and write in their dominant language and, after reading and writing in it, they go through the literacy process in their additional language.

There are many myths and speculations on the part of teachers, families, and the school community, in general, about the potential harm caused by

simultaneous literacy in two languages. However, several studies conducted in this area have accumulated to demonstrate the benefits of simultaneous biliteracy, as we show in the brief review that follows (Escamilla et al., 2014; Ahmadi, Khoii & Taghadosian, 2015; Williams & Lowrance-Faulhaber, 2018; Mota et al., 2019; Lemke et al., 2021; Lemke, 2022).

A study by Escamilla et al. (2014), which included a total of 13 schools in the United States, pointed out that emerging bilinguals, that is, those who are learning an additional language at the same time as they are developing their mother tongue, when evaluated in bilingual educational programs, demonstrate benefits when they receive teaching instruction in two languages. The authors also claim that children do not demonstrate to be confused or delayed by the inclusion of learning instruction in the two languages simultaneously. The authors point to the "Literacy Squared" model as something innovative in the development of biliteracy for emerging bilingual students of Spanish as L1 and English as L2, using reading and writing instruction with specific time allocations for each language, with a focus on developing connections between the two.

Escamilla et al. argue that their findings support the idea that providing emerging bilingual learners with literacy instruction in two languages and explicitly teaching them to make connections between them does not confuse learners or impede their natural academic development. Instead, it allows students to develop their literacy skills simultaneously in two languages, accelerating their L2 literacy development, supporting their L1 literacy development, and helping them to become proficient readers and speakers of both languages.

Following the same line, Ahmadi, Khoii and Taghadosian (2015) conducted a study with bilingual students in Iran, using Persian as L1 and English as L2, pointing out long-term effects on reading fluency for bilingual students. Prior to the study, Iranian teachers reported believing that simultaneous biliteracy was a challenge, so they thought that postponing literacy in the second language, focusing first on the mother tongue, would make it a less confusing path. Contrary to such predictions, the research results showed advantages in the concomitant teaching model in both languages.

The research by Ahmadi, Khoii and Taghadosian had as participants bilingual (Persian and English) students with an average of seven years old, and they also included a monolingual control group (Persian). Both groups received instruction in Persian for a period, and the bilingual group also received additional instruction in English at the same time. Reading tests were applied and data analysis showed that in a short period of time, no major differences were observed between bilinguals and monolinguals; therefore, they found no negative impacts on simultaneous biliteracy. Interestingly, after a few weeks of instruction, in the second part of the analysis, bilinguals outperformed monolinguals in terms of fluency and reading accuracy, that is, they had advantages in both languages. Therefore, according to the findings of Ahmadi, Khoii and Taghadosian (2015), learning to read and write in two languages, despite being a complex process in

the short term, can promote, in the long term, an opportunity to develop and improve skills that will serve both languages.

A review study carried out by Williams and Lowrance-Faulhaber (2018), in the period from 2000 to 2017, analyzed 35 articles that addressed the development of reading and writing by bilinguals. The results, in general, demonstrated that simultaneous instruction in two languages seems to be beneficial. In the study, the researchers sought to observe some issues, such as what bilinguals know about writing, what strategies they use, the similarities and differences in the writing development of bilingual and monolingual students of English, and the pedagogies used to support the development of bilingual writing.

Important aspects emerged from the analysis of the articles reviewed by Williams and Lowrance-Faulhaber. First, Spanish-English bilingual students in preschool were able to distinguish between drawing and writing when requested. In addition, they also differentiated between the conventions of the spellings and impressions of their languages. Another interesting aspect was that Spanish-English bilinguals in the first year of elementary school, when learning to write, used accents in their texts only in Spanish and apostrophes only in English. Surprisingly, they were able to preserve the linguistic reference of each language at such a very early age.

Another important factor of these studies, in the case of bilinguals specifically, was the way they demonstrated the use of different strategies in the development of writing. One of these strategies was using orality to write, that is, speaking aloud to segment the sounds of words they were planning to write. They also used code-switching as a strategy to understand and contextualize the meaning between the languages used in learning through biliteracy.

When considering the 35 studies reviewed by Williams and Lowrance-Faulhaber (2018) as a whole, we note that in simultaneous biliteracy students demonstrate the ability to make connections between the knowledge they already have in one language to learn the other one, and this process, in turn, develops strategies that seem to favor learning. Therefore, the authors conclude that biliteracy seems to be a favorable opportunity for students both cognitively and linguistically, and that it does not cause confusion. Instead, students seem to use their knowledge of both languages strategically to facilitate learning in both L1 and L2.

Considering the research on biliteracy briefly reported in this section, which was carried out in other countries, we believe it is important to investigate the case of biliteracy in bilingual children in the Brazilian context. A few studies about biliteracy have been developed in Brazil. An important one is Lemke et al. (2021), which investigated the effects of bilingualism and biliteracy on the levels of thought organization and syntactic complexity in the written production in Portuguese and English in a group of 11-year-old children. This study is reviewed in more detail in the next section.

With the purpose of finding more data about the effects of bilingual education and biliteracy, our study complements the previous studies mentioned above. Moreover, it is the first in Brazil to include reading and oral language measures.

We selected a bilingual school where children go through the process of learning to read and write in two languages - Portuguese and English simultaneously. We used computational analysis to measure children's speech connectedness in both L1 and L2, piggybacking on previous research that has been carried out by Mota and collaborators (2012, 2014, 2016, 2018, 2019) with monolingual and bilingual children in different contexts.

What graph analysis can inform us about monolingual and bilingual language development

In recent years, computational language analysis and graph theory have been very informative in the fields of neuroscience (Mota et al., 2012, 2014), psycholinguistics (Luz, 2018) and education (Mota et al., 2016, 2019). Mota et al. (2016, 2019) performed a series of experiments based on graph analysis to explain cognitive development in typical children as they progressed through their educational trajectory through elementary school. The results showed that children whose oral reports generated graphs with a greater number of nodes (which denotes a larger vocabulary), more long-range connectedness and fewer repetitions were also the ones who obtained higher scores in cognitive and academic assessments (reading), thus demonstrating the predictive power of graph analysis in mapping children's L1 development.

In the case of written language, a study of particular interest is that developed by Luz (2018), who used graph analysis to investigate connectedness patterns in texts produced by proficient readers, readers with reading difficulties, and dyslexics. The writing task required the children to produce a story based on a comic strip in their L1 (Portuguese), with no duration constraints. The author compared text graph parameters to confirm that the attributes were effective in classifying the three types of readers, revealing patterns of textual connectedness, measured by the number of nodes and edges, LCC, and text density.

Another important study was that of Lemke and collaborators (2021), which aimed to compare the levels of syntactic complexity and thought connectedness in bilingual children's written production in Portuguese and English. The authors predicted that both variables would correlate in both languages, showing positive effects of early biliteracy. Sixty children (M = 10.7) enrolled in the 5th and 6th grades of a bilingual school in the metropolitan region of Porto Alegre, Rio Grande do Sul, Brazil, screened for proficiency, constituted the study cohort. The children's community language was Portuguese, but they had been exposed to English at school for 10 hours a week for at least 5 years. Participants were asked to create a narrative from a sequence of five images (Cambridge Assessment, 2018) one in English and one in Portuguese, in counterbalanced order.

The analysis of syntactic complexity in Lemke et al. involved the evaluation of T-Units (Hunt, 1965), and thought connectedness in writing was measured through the analysis of graph trajectories performed with the computational tool *SpeechGraphs* (Mota et al., 2016, 2019). As expected, the results indicated

a positive correlation in the levels of syntactic complexity and in the attributes of thought connectedness in both languages, demonstrating that, as children advanced in the development of more complex writing strategies in Portuguese, they progressed in their written production in English to the same extent. According to the authors, their data reinforce the importance of teachers evaluating the written production of students in their two languages from a bilingual perspective, and supported by the conception that the languages that make up the linguistic repertoire of the bilingual individual constitute an entire integrated system and not two independent systems (García, 2009).

To the best of our knowledge, Lemke et al. was the first study to adopt graph analysis in the investigation of writing development in bilingual children. However, the analysis relied exclusively on data from the children's written production. The study reported here advances this discussion by also considering oral production data from children in the same age group.

Together, these two studies intend to argue in favor of computational language analysis as a tool to understand early biliteracy, making use of low-cost, feasible and ecological assessment instruments, which can help to provide important information about the development of language skills in bilingual children. Moreover, the findings generated by such analyses can be used to design intervention strategies to better suit the needs of children in bilingual educational contexts.

Methods

The study reported here, which was naturalistic in nature (i.e., took place in the school setting), aimed to investigate simultaneous biliteracy, speech connectedness and reading skills in L1 and L2 in a group of 5th grade children enrolled in a bilingual school in the northeast of Brazil. More specifically, our first goal was to investigate the strength of the relationship between speech connectedness measures of children's oral reports in Portuguese and English. Our second goal, in turn, was to better examine the strength of the relationship between these children's reading fluency and comprehension skills in both languages, provided that they received reading instruction simultaneously in Portuguese and English.

The instruments used for data collection were: (a) a picture-cued narrative to measure speech connectedness attributes in Portuguese and English, using the computational tool *SpeechGraphs* (Mota et al., 2014, 2016, 2019), (b) reading tests to assess reading fluency and comprehension in both Portuguese (Saraiva et al., 2007) and English (www.raz-kids.com). These instruments are described in more detail below.

In regard to our first specific goal, our derived hypothesis predicted that children's speech connectedness scores (measured by long-range recurrence scores) would positively correlate in L1 and L2, despite an anticipated advantage towards their Portuguese scores, since this is their L1 and the language spoken in the community. Studies conducted with similar aims have shown that, in such

contexts (where the L1 is the dominant language in the community and the L2 is only spoken at school), growth in the two languages does not necessarily display a linear trajectory, revealing deceleration of L1 in the first grade, overall rapid growth of the L2, but loss of L2 skill during summer vacations or the pandemic, for instance, when children receive major input in their L1 at home (Rojas & Iglesias, 2013).

Moreover, concerning our second specific goal, we hypothesized that there would be a positive relationship between reading in L1 and L2, in terms of reading fluency and comprehension, despite an expected advantage for Portuguese, as well. Taken together, if our hypotheses are confirmed, our data may contribute to the view of bilingualism and simultaneous biliteracy do not present harmful consequences. Instead, we hope to reinforce the perspective that children who are simultaneously exposed to two languages make use of their whole linguistic repertoire so that both languages follow a similar and parallel path.

Participants and research context

This research was approved by the Ethics Committee of UFRN, under protocol number 5.007.372. The 5th graders participating in this study were authorized by their parents, who signed an informed consent form. The children also signed an informed consent form themselves.

The data collection took place in 2021, when in-person classes resumed after the school closing due to the COVID-19 pandemic. Therefore, data collection took place in person, during regular school hours. The cohort consisted of 32 children (15 girls), who were all 5th graders at the time of data collection (M=10.6 years old) enrolled in a private bilingual school in the city of Natal/RN. The tests were applied by one of the authors, who was also working as a pedagogical coordinator at the school at that time.

The bilingual school where the study took place has an integrated, cross-curricular English-Portuguese program and follows a Canadian bilingual methodology. The school promotes simultaneous biliteracy through a program with thematic units, in which the contents are developed through reading. In this educational setting, in early childhood education, for children up to 4 years old, instruction takes place 100% in the L2 (English); at 5 years old, 25% of instruction happens in the L1 (Portuguese), and, from 1st grade (emerging literacy) up to Middle School, instruction takes place 50% in English and 50% in Portuguese.

Data collection instruments and procedures

In this section, we first describe the oral tasks used to generate narrative texts which were then analyzed with the help of the *SpeechGraphs* software to measure connectedness attributes. Then, we present details of how the tasks used to measure reading skills (fluency and comprehension) in L1 and L2 (Portuguese and English, respectively) were selected, adapted, and applied.

Oral tasks to measure connectedness through *SpeechGraphs*

Language sample analysis (Ebert, 2020; Gagarina et al., 2019) has been called the gold standard of language analysis for bilingual children in both clinical and non-clinical settings. It offers a flexible and ecologically valid tool for the analysis of developing bilingual individuals. Within this paradigm, there are several narrative elicitation tools that can be used with bilingual children. According to Ebert (2020), it is important that these tools provide a consistent structure in the picture narrative and that protocols include different but parallel stories for different languages, so that comparisons between languages and different children can be facilitated.

To elicit children's oral production in Portuguese and English in this study, we used two picture-cued narratives, adapted from the Cambridge Proficiency Test (Cambridge Test, 2018). The children were asked to tell a spontaneous story based on a sequence of pictures. There were two versions of the task, one in English and one in Portuguese, which were applied in a counterbalanced order.

The children performed these tasks individually in a separate room near their classroom. They received the instructions from the researcher and then told their story while looking at the images, sometimes in English, sometimes in Portuguese, depending on the instruction given (Figure 1).

Figure 1: *Oral production tasks*

Source: Cambridge Test 2018

Each child's speech sample was recorded, transcribed, and then analyzed using the *SpeechGraphs* software. This analysis is described in more detail in the Data Analysis Procedures section.

Reading Tests in L1 and L2

Although there seems to be a clear consensus that language assessment of bilingual children should be done in the two languages, it is also often documented in the literature the fact that it is difficult to find equivalent language assessment tools in the two languages (Ebert, 2020). This was the

case for the reading assessment of Portuguese-English bilingual children in our study. Facing the challenge of not having standardized reading tests for bilingual children in our country, to measure children's reading skills (fluency and comprehension) in their two languages, we selected distinct tests in Portuguese and English that seemed to be comparable. Both tests were paper-based. Children were asked to read the texts silently and answer the reading comprehension questions orally afterwards.

To assess reading fluency and comprehension in Portuguese, we used a narrative text that contained 157-182 words from a validated national testing battery (Saraiva et al., 2007), which has been validated with children from 2nd grade up to adulthood. Children first silently read the text, and then the researcher asked eight comprehension follow-up questions. One example of a follow-up question in this comprehension test would be *"describe the characteristics of an otter"*.

To assess reading fluency and comprehension in English, we used Running Records of the Reading A to Z program, level U, suitable for 5th graders (https://www.raz-kids.com/), which is routinely used at the school where this research was conducted. Children first silently read the narrative text, which also ranged between 157-182 words in length, and then the researcher asked five comprehension questions afterwards. One example of a follow-up question in this test would be "*what can you conclude about nesting sea turtles?"*.

It is worth noticing that, although the tasks that aim to assess reading skills (namely, fluency and comprehension) are of the same length and text type, we acknowledge that they have important differences. For example, while the Portuguese task mainly focused on recalling information from the text (*describe the characteristics of an otter*), the English task, on the other hand, assessed the children's abilities of making inferences and drawing conclusions from the text (*what can you conclude about nesting sea turtles?)*. As mentioned before, to our knowledge, there are no validated test protocols for reading fluency and comprehension that directly compares performances in both languages in the Brazilian context.

The reading tests in English and Portuguese were applied to the children individually, in counterbalanced order, to reduce possible task order effects. In both tests (L1 and L2), children's silent reading was timed to analyze their reading fluency in each language. In addition to it, we audio recorded their answers to the comprehension questions.

Data analysis procedures

Children's speech samples were transcribed and analyzed using the 1.1.0 version of the *SpeechGraphs* software (Mota et al., 2014). The program transforms each text into a speech graph with several attributes, including speech connectedness measures, used in this analysis.

Graph attributes, particularly the largest connected component (LCC) and the largest strongly connected component (LSC), have been used to demonstrate patterns in oral and written texts that successfully distinguish between groups,

and have evidenced connectedness as a strong marker of cognitive development (Mota et al., 2016, 2019). According to Mota (2017), the LCC is the "largest set of nodes directly or indirectly connected by some path" (p. 2) and the LSC is the "largest set of nodes directly or indirectly connected by reciprocal paths, so that all component nodes are mutually reachable" (p. 2). In this sense, the LSC tends to be a more rigorous predictor of connectedness, as it closes a loop of long-range word repetition. In this study, to measure connectedness in the children's speech, we used LSC scores in L1 and L2.

Although the term "connectedness" is more commonly used in the field of mathematics, where it has emerged, we believe that the closest equivalent in psycholinguistics would be "textual cohesion". That is so because it is assumed that the adjacency between lexical items of a discursive fragment, represented and measured here based on Graph Theory, represents an alternative to obtain a quantitative measure of the unity of a text; that is, of the relationship between the elements that make up its unity and determine its comprehension. As far as we know, in psycholinguistics, there have been few attempts to find linguistic markers of speech connectedness, one being the measure of syntactic complexity in terms of T-Units (Lemke et al., 2021). In addition, the software measures other attributes in each text file, such as number of words. Number of words is the total amount of tokens produced by the child, taken to represent lexical diversity.

Children's scores in the reading tests in L1 and L2 were compiled in a spreadsheet and further analyzed. Silent reading time was operationalized in seconds to represent participants' reading fluency scores, and reading comprehension was measured by the number of correct answers to comprehension questions that followed each text, in both languages.

In order to account for our first hypothesis, according to which children's speech connectedness scores (long-range recurrence scores, here measured by LSC), would correlate in L1 and L2, we adopted a correlational approach to verify the strength of the relationship between these scores. More precisely, we expected a positive correlation between LSC scores in Portuguese and English, indicating that these values increased together. However, we also anticipated a natural advantage for Portuguese oral productions, given that it is the participants' L1, which we verified via paired *t*-tests or their non-parametric alternative, when necessary. Regarding our second hypothesis, which anticipated a positive relationship between reading comprehension and fluency scores in L1 and L2, we have also adopted a similar framework for the analysis, as shown below. All generated data were statistically analyzed using the *R Studio* (Posit Team, 2023) version 2023.3.1.446.

In relation to hypothesis testing, we first examined if the data followed a rather normal or non-normal distribution via a Shapiro-Wilk test, which, provided our within-subjects design, consisted of checking students' difference of scores. After that, we accounted for possible outliers in our sample both visually via boxplot inspection and through *Rstatix* package (Kassambara, 2021). We only excluded extreme[1] outliers and normality was re-checked after this process. Finally, we conducted either a paired *t*-test, when the data were normally distributed, or

its non-parametric alternative, the Wilcoxon Signed Rank Test, using RStudio's base functions *wilcox.test()* and *t.test()*, respectively. For the paired *t*-tests, we calculated effect sizes via using *cohens_d()*[2] function, while for the non-parametric alternative, we calculated it using *wilcox_effsize()*[3], both functions are also from the already mentioned *Rstatix* package (Kassambara, 2021).

Regarding the correlations, we followed a similar path. After checking data distribution, we also accounted for possible outliers via *Rstatix* and visual inspection of scatterplots, rechecking normality in case of deletion of any extreme outliers. Following this, when data were normally distributed, we performed a Pearson correlation test or a Spearman's Rank correlation otherwise, adding the Bonferroni correction, using RStudio's base *cor.test()* function. All reported *p*-values are the adjusted ones and we have used Gries (2013, p. 147) as a reference guide to interpret the correlations coefficients (Pearson's *r* or Spearman's ρ). Finally, we adopted an alpha value of 5% for all tests.

Results and Discussion

The results of the present study are reported and discussed in relation to the two objectives pursued, namely, to investigate the strength of the relationship between speech connectedness measures of children's oral reports, and to examine the strength of the relationship between the children's reading fluency and comprehension scores, in Portuguese and English.

Biliteracy and speech connectedness in L1 and L2

The first goal of this study was to investigate the strength of the relationship between speech connectedness measures of children's oral reports in Portuguese and English. The descriptive results of our participants are displayed in Table 1. These data will be addressed in the verification of our first hypothesis.

Table 1: *Descriptive Statistics of Connectedness Measures*

	L1 (Portuguese)	L2 (English)
N	31	31
WC - Mean (SD)	73.3 (26)	68.4 (32)
WC - Median (IQR)	68 (29)	54 (45.5)
LSC - Mean (SD)	45.7 (14.3)	37.4 (14.2)
LSC - Median (IQR)	45 (13.5)	35 (19)

Note. n = sample size, *SD* = Standard Deviation, *IQR* = Interquartile Range

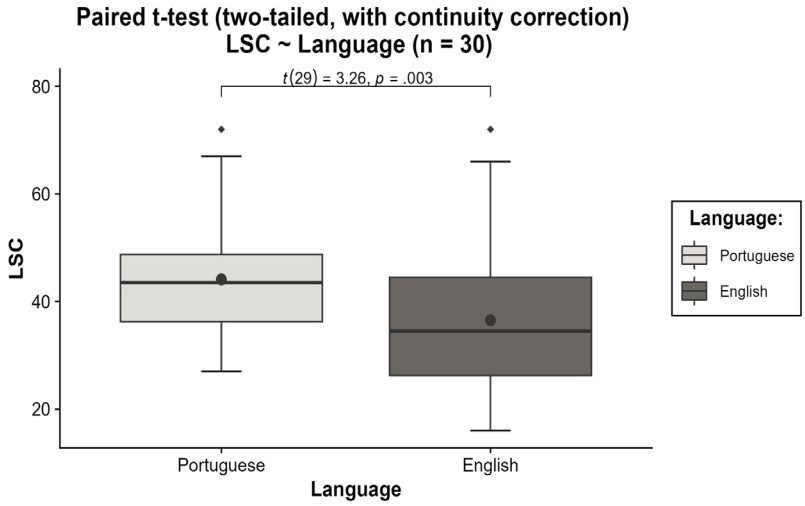
Source: Authors

Our first hypothesis predicted that our participants' LSC scores of Portuguese and English productions would be positively correlated, with an expected

advantage for the former (their L1). The paired *t*-test between Portuguese (n = 30, M = 44.1, SD = 11.14) and English (n = 30, M = 36.5, SD = 13.46) LSC scores indicated that there was a statistically significant difference in LSC between the languages, favoring Portuguese (t (29) = 3.26, p = .003, d = .6). This L1 advantage was expected, since the L1 is more used by participants on their daily routines beyond school. These data replicate those of Lemke et al. (2021), who similarly showed an advantage of L1 writing connectedness (M = 111.52 in L1 and M = 84.42 in L2), with children at the same age group.

These results are also depicted in Figure 2, which visually illustrates the test. The light gray box on the left represents Portuguese data, while the dark gray box on the right represents English productions. The black dot inside each box represents the mean of the variables and the flat line represents their median. As it is possible to notice, the boxes do not overlap, which indicates that the difference between the two variables are significant. In addition, the box that refers to the oral production in Portuguese is higher than the one that refers to English oral texts, which indicates that L1 scores are greater than L2's. We adopted this color convention for all remaining pictures as well.

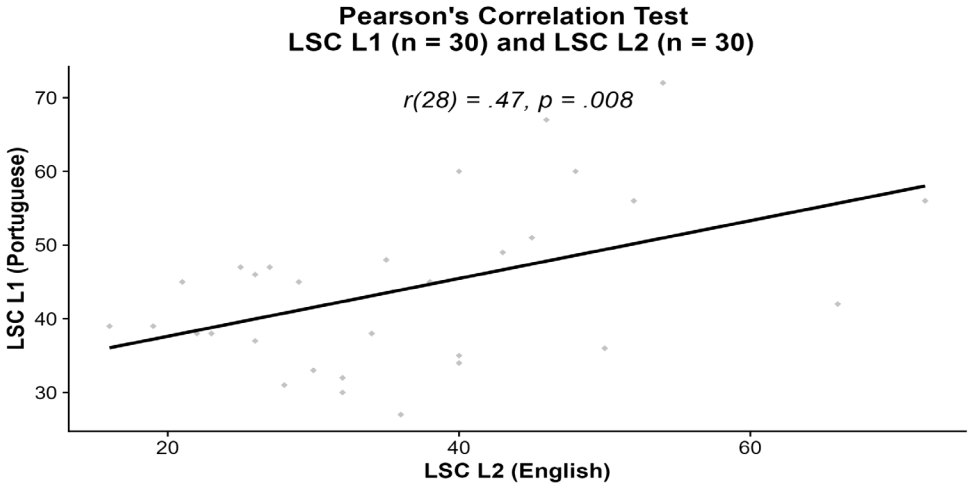
Figure 2: *Comparison between connectedness scores (LSC) in L1 and L2*



Source: Authors

To further address our first hypothesis, we examined the strength of the relationship between Portuguese and English productions' LSC scores. The results of a Pearson correlation test indicate a positive, medium, and significant correlation between the variables (r(28) = .47, p = .008) showing that, with regard to speech connectedness analyzed through oral productions in both languages, L1 and L2 seem to develop simultaneously, that is, the children who present a more connected speech in their L1 also do so in the L2, a result which is in consonance with our hypothesis. This result is visually represented in Figure 3, in which it is possible to observe that the trending line is non-parallel, but ascending in regard to the x-axis, indicating a positive increasing relationship between the variables.

Figure 3: *Correlation between Portuguese and English LSC's scores*



Source: Authors

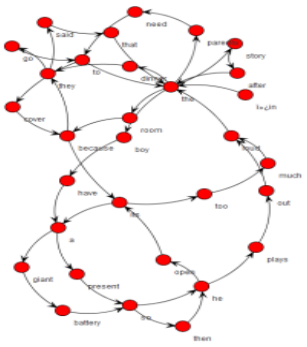
Therefore, our findings are in line with the previous studies reported in this article, which point to positive outcomes of simultaneous biliteracy practices (Escamilla et al., 2014; Ahmadi, Khoii & Taghadosian, 2015; Williams & Lowrance- Faulhaber, 2018; Lemke et al., 2021). Based on our findings, we side with previous researchers who argue that simultaneous biliteracy promotes the concomitant use of languages, which, in turn, seems to guarantee support for both L1 and L2 languages. However, bearing in mind that this study is descriptive and correlational in nature, with a single measurement time point, we advise caution when interpreting its results. Here, a correlation between Portuguese and English scores suggests an association or underlying common skill, but there is no evidence of simultaneous, parallel bilingual development *per se*.

To illustrate the analysis, Figure 4 shows graphs of two children participating in this research, one with low speech connectedness in both languages (LSC = 33 and 30, L1 and L2, respectively) and another with high speech connectedness in L1 (LSC = 95) and L2 (LSC = 65). As it can be clearly depicted from the morphology of the graphs, the same student (Fig. 4 on the top) who had a lower speech connectedness score in Portuguese also demonstrated this path in the English production. Likewise, the second student (Fig. 4 on the bottom) demonstrated greater speech connectedness scores in both languages. Taken together, these figures illustrate the claim of a consistent pattern in the development of speech connectedness in the two languages.

Figure 4: *Examples of graphs obtained through Speech Graphs*

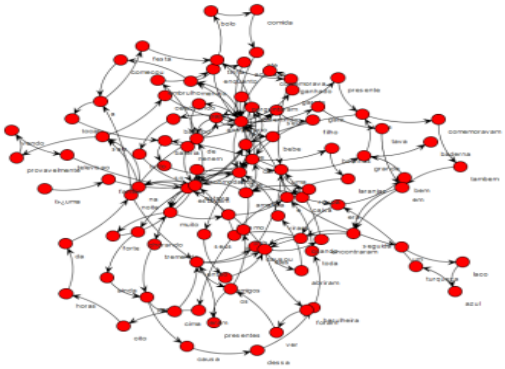
PO4 - L1 (LSC= 33)

PO4 - L2 (LSC= 30)

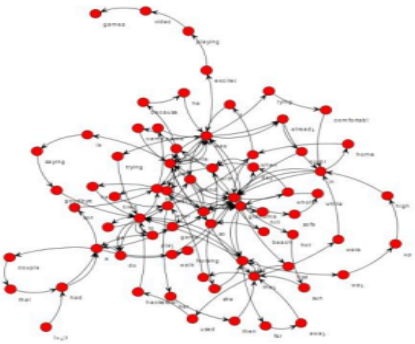


primeiro o paul se despede dos pais porque vai ficar com a avo ai depois eles vao jogar tenis e ela ganha e vai para a praia correndo para	in the story after the dinner they go to the room because they said that the boy have a present so then he open its a giant battery so he plays
chegar em casa e o paul tenta seguir ela ai quando ela chega vai jogar video game e ele ja dormiu de tanto cansaco	out loud the parents need to cover because its too much loud

PO12 - L1 (LSC= 95)



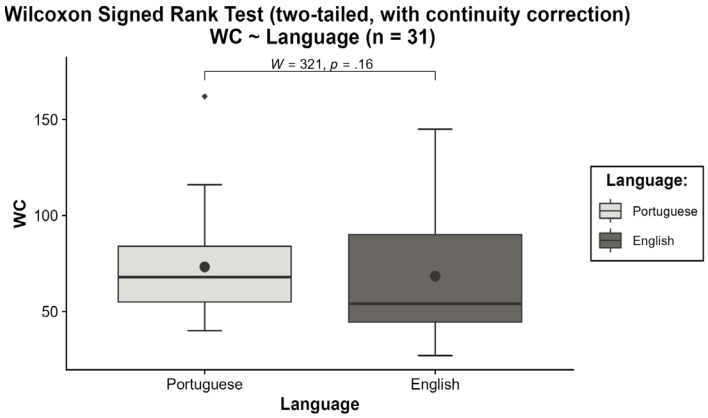
PO12 - L2 (LSC= 65)



Source: Authors

Another result that leads us to conclude that simultaneous biliteracy, in the case of the participants of this research, is not harmful to the development of both languages was the similar number of words (hereafter, WC) produced by the participants in their oral narratives in L1 and L2, despite the greater (and expected) WC in Portuguese. Having been given the same time frame to narrate their stories in the two languages, children's WC in Portuguese (n = 31, *Median* = 68, *IQR* = 29) and English (n = 31, *Median* = 54, *IQR* = 45.5) productions did not significantly differ from one another, as it was indicated by a Wilcoxon Signed Rank Test (W = 321, p = .16, r = 0.26). This result is visually depicted in Figure 5, in which it is possible to observe that the boxes do overlap with one another, indicating no significant difference between these variables.

Figure 5: *Comparison between word count (WC) in L1 and L2*



Source: Authors

The relationship between reading fluency and comprehension in L1 and L2

The second aim of this study was to examine the strength of the relationship between the children's reading fluency and comprehension scores in both languages, provided that they received reading instruction simultaneously in Portuguese and English. We display the descriptive statistics of reading data (fluency and comprehension) in L1 and L2 in Table 2.

We note that, at a first glance, these results may seem rather conflicting, as they indicate that children read more fluently in their L2 but comprehend better while reading in their L1. The mean reading fluency score in L2 (M = 91.4) was greater than that of L1 (M = 70.6), while in comprehension, the mean reading score of L1 (M = 84.9) was greater than that of L2 (M = 58.7). These data will be addressed in the verification of our second hypothesis.

Table 2: *Descriptive Statistics of Reading Measures in L1 and L2*

	L1 (Portuguese)	L2 (English)
N	31	31
Reading Fluency - Mean (SD)	70.6 (20)	91.4 (29.3)
Reading Fluency - Median (IQR)	70 (26)	91 (46)
Reading Comprehension - Mean (SD)	84.9 (14.7)	58.7 (23.1)
Reading Comprehension - Median (IQR)	87 (25)	60 (40)

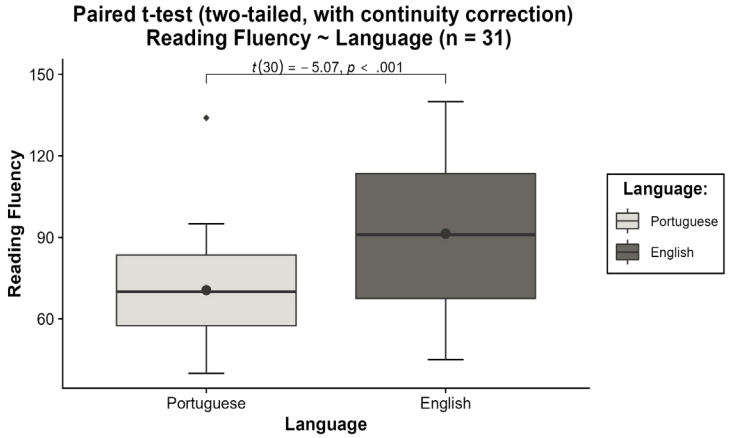
Note. n = sample size, SD = Standard Deviation, IQR = Interquartile Range

Source: Authors

Our second hypothesis anticipated a positive relationship between reading comprehension and reading fluency scores in Portuguese and English, with an

advantage for the children's performance in Portuguese, since it is the participants' L1. First, we addressed the issue of reading fluency. To do so, we conducted a paired *t*-test between Portuguese (M = 70.6, SD = 20) and English (M = 91.4, SD = 29.3) reading fluency's scores, which, unexpectedly, indicated an advantage for the performance in English ($t(30)$ = -5.07, $p < .001$, d = - .91). The test is visually illustrated in Figure 6, in which it is possible to notice that the boxes do not overlap, indicating a significant difference between these variables; the box that refers to the scores in English, on the right, is higher than the one that refers to the Portuguese scores, which, in turn, indicates that the scores in L2 are greater than in L1.

Figure 6: *Comparison between reading fluency scores in L1 and L2*



Source: Authors

A possible explanation for the greater reading fluency found in the L2 may be related to the reading test used, the Running Records of the Reading A to Z program, level U, suitable for 5th graders. It is important to observe that this test format is part of the reading daily routine at school, and students may have felt more comfortable with the test, therefore reading the English text faster than the one written in Portuguese. This may be one of the reasons for the children to have generated better results in L2 reading fluency. On the other hand, even though the text used to assess reading in Portuguese is part of a testing battery validated for research, this task format is not part of the children's daily L1 reading routines at school. Therefore, we speculate that such an unfamiliar task may have been responsible for less fluent reading scores in the children's more dominant language, since children were not used to this type of text nor such an oral reading practice in their L1 classes.

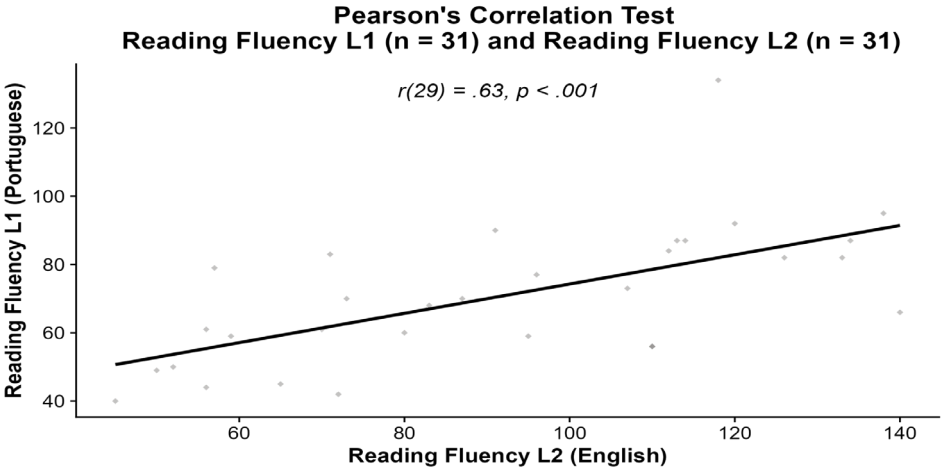
Another reason that could explain the children's advantage in their reading fluency scores in English is the fact that the participants in our study were students in an immersion program in the L2 from a very early age, so reading in English was a very recurrent practice in their daily lives. In fact, as previously mentioned, the children who participated in this study had received instruction

solely in the L2 (English) until they were 4 years old, 25% of instruction in the L1 (Portuguese) at 5 years old, and, from 1st grade up to 5th grade, instruction had been taking place in a balanced way, 50% in English and 50% in Portuguese. Therefore, it seems plausible to suggest that this extensive exposure to the L2 may have accounted for the L2 reading fluency advantage in our study.

The next step in our data analysis was to examine the strength of the relationship between reading fluency scores in L1 and L2 to verify, despite the L2 advantage just reported, whether reading fluency was developing in parallel in the two languages, as expected. The results of a Pearson's correlation test indicates a positive, high, and significant correlation between Portuguese (M = 70.6, SD = 20) and English (M = 91.4, SD = 29.3) reading fluency scores ($r(29)$ = .63, p < .001). The test is visually represented in Figure 7, in which it is possible to notice that the trend line is ascending, and not parallel, in relation to the x-axis, which indicates a positive relationship between the variables.

These results corroborate the second hypothesis of this study — that the relationship between reading fluency in L1 and L2 for children undergoing a simultaneous biliteracy program follows a similar path in terms of fluency. In other words, the positive correlation between reading fluency in both languages suggests that children have similar fluency levels in both languages, that is, children who read more fluently in L1 also do so in L2, and vice versa.

Figure 7: *Correlation between reading fluency scores in L1 and L2*

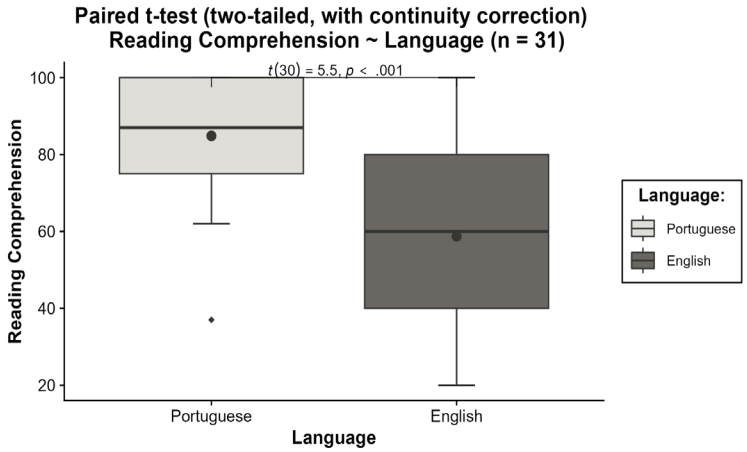


Source: Authors

Concerning the examination of the strength of the relationship between the children's comprehension in L1 and L2, the same steps previously reported in the case of reading fluency analysis were taken. As it can be recalled from the data presented in Table 2, reading comprehension scores in Portuguese (M = 84.9, SD = 14.7) were greater than those in English (M = 58.7, SD = 23.1), pointing to a superior performance in reading comprehension in the children's L1. A paired t-test suggested that there was a statistically significant difference for reading comprehension in both languages, with an advantage for the performance

in Portuguese ($t(30)$ = 5.5, p < .001, d = .99), as anticipated. These results are visually displayed in Figure 8, in which it is possible to notice that the boxes do not overlap, reflecting the significant difference between the variables, and that the box that refers to Portuguese texts is higher than the box that refers to English, demonstrating that the scores in L1 were greater than in L2. Regarding the relationship between Portuguese and English reading comprehension scores, a Spearman Rank's correlation did not indicate a significant relation between the variables (r = .03, p = .88).

Figure 8: *Comparison between reading comprehension scores in L1 and L2*



Source: Authors

It is possible to attribute these results to the different demands of the Portuguese and English comprehension tasks. That is to say that a possible explanation for this difference in reading comprehension results in L1 and L2 is the nature of the comprehension questions presented, which varied significantly across tests in the two languages. As mentioned in the Methods section, in Portuguese, comprehension questions recruited declarative memory, facts and information contained in the text, which could be recalled (apparently) more easily from children's silent reading of the text. In the reading comprehension test in English, on the other hand, in order to answer the questions, in addition to remembering what was read in L2, the children needed to employ other comprehension strategies to be able to answer the questions, such as explaining the main idea of the text, making inferences, describing vocabulary, relating cause and effect, and drawing conclusions. Therefore, the absence of a significant relationship between these scores does not imply that the development of this reading skill does not occur in parallel, but it may rather capture the fact that the nature of the available tasks was different in the first place. This finding has led us to acknowledge a methodological limitation in our study design, which ignites a discussion about the need to think about reading measures that are suitable to bilingual children enrolled in bilingual programs or curricula in Brazilian schools, such as the ones in our study.

Final Considerations

The study reported here aimed to investigate simultaneous biliteracy, speech connectedness, and reading skills in L1 and L2 in a group of 5th grade children enrolled in a bilingual school in the northeast of Brazil. Our first goal was to investigate the strength of the relationship between speech connectedness measures of children's oral reports in Portuguese and English. Our second goal was to examine the strength of the relationship between these children's reading fluency and comprehension skills in both languages, provided that they received reading instruction simultaneously in Portuguese and English.

For this purpose, we used tests in Portuguese and English as data collection instruments to assess fluency and reading comprehension, and we analyzed the measures of thought connectedness attributes in children's L1 and L2 speech, through graph analysis, with the computational tool *SpeechGraphs*. Concerning speech connectedness, we hypothesized that students' production in both languages would develop in parallel, despite an expected advantage for Portuguese (their L1). Our results sustain this hypothesis, given that, although children's oral productions significantly had greater speech connectedness scores in Portuguese, we found a positive correlation between the measures in Portuguese and English. In addition, we did not find a significant difference between students' word count in both oral productions. Taken together, these results suggest that their development of speech connectedness is indeed increasing together, in parallel.

Regarding children's reading skills, we also anticipated an advantage for their performance in their L1, while we hypothesized that their performance in L1 and L2 would also develop in parallel. Interestingly, concerning reading fluency, our results indicate that children's reading fluency scores were greater in English, which we attribute to their early exposure to English during the school's immersion program before Elementary school and to their familiarity to the task used, Learning Records (https://www.raz-kids.com/), since students have performed this task daily since 1st grade. Not surprisingly, though, we found a positive correlation between the reading fluency scores in both languages, suggesting that the development of this skill is occurring in parallel. When it comes to reading comprehension, we found, as expected, that students' performance was better in Portuguese, and we did not find a correlation between the scores in both languages. These results should be interpreted with caution, though.

As previously mentioned, our research has some limitations. First, we are not aware of a current validated test battery in Brazil that enables a direct comparison between children's reading comprehension in Portuguese and English. With this in mind, we acknowledge that the tasks may potentially have different levels of difficulty, being that the English task involved other processes apart from reading comprehension, such as the ability to make inferences and draw conclusions from a text, which recruited more complex cognitive engagement from participants than the Portuguese task, which could only be answered with items retrieved from memory. Secondly, our study only explores cross-linguistic skills in oral

language and reading separately. A logical next question would be whether oral language in one language is related to reading skills in another, which could also be explored in future studies. Finally, we also acknowledge that our sample size was small; hence, replicating these tests with a broader range of children would be ideal in the future.

Despite its limitations, our study brings important contributions to bilingual education, particularly considering the Brazilian context, where evidence-based studies are scarce and rare. We hope to contribute to the field by providing more evidence that simultaneously reading instruction brings no detrimental effects to linguistic and cognitive development. Instead, we also demonstrate that children who are exposed to two languages make use of their whole linguistic repertoire to develop their language abilities in parallel, which is in consonance with previous findings in a similar context (Lemke et al., 2021; Lemke, 2022; Lemke et al., in press). All things considered, our findings may provide one more piece of evidence in favor of acknowledging that the effects of early biliteracy, at least in terms of speech connectedness and reading skills assessed in this study, occur in an incremental and parallel way, for the two languages in the bilingual's mind.

Notes

1. According to Rstatix's documentation, values above Q3 + 3xIQR or below Q1 - 3xIQR are considered as extreme outliers. In these formulas, Q1 and Q3 stand for the first and third quartiles, respectively, and IQR is the interquartile range (IQR = Q3 - Q1).
2. According to Rstatix's documentation, this function calculates Cohen's d by dividing the mean difference by the standard deviation of the difference (d = Meand / SDd, where d is the difference of the paired sample values).
3. According to Rstatix's documentation, the effect size r is calculated as a Z statistic divided by the square root of the sample size (n) ($r = Z / \sqrt{n}$). The Z value is a standardized W statistic extracted from coin::wilcoxsign_test() and n corresponds to the total number of pairs for paired samples test.

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