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LETICIA RODRIGUES DE SOUSA

PORTUGUESE-ENGLISH INTERLINGUAL HOMOPHONES IN WORD READING AND TRANSLATION

FORTALEZA
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Dissertação apresentada ao Programa de Pós-Graduação em Linguística, da Universidade Federal do Ceará (PPGLin/UFC), como requisito parcial à obtenção do título de mestre em Linguística. Área de concentração: Linguística. Linha de pesquisa: Aquisição, Desenvolvimento e Processamento da Linguagem.

Orientadora: Profª. Dra. Pâmela Freitas Pereira Toassi.

Coorientador: PhD. Professor Justin Lauro.

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ABSTRACT

This study aimed at contributing to the understanding of bilingual lexical access in the area of Psycholinguistics by investigating the effect of interlingual homophones on word recognition and translation, examining processes involved in silent reading at the word level. Interlingual homophones are words that sound very similar in English and Brazilian Portuguese, but have different meanings, as is the case for 'pie-pai' and 'value-velho'. In order to achieve the goals of this study, the general objective is divided into three specific ones: 1) To examine the processing cost of reading isolated Brazilian Portuguese-English interlingual homophones in relation to control words in a language decision task; 2) To investigate whether there is a repetition priming effect for isolated BP-En interlingual homophonic words in a translation task.; and 3) To examine whether there is a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2. The following hypotheses were proposed: H1 – Interlingual homophones between Brazilian Portuguese and English have a higher processing cost in relation to control words in a language decision task, reflected by longer reaction times; H2 – There are repetition priming effects for interlingual homophones in a subsequent translation task; H3 – Interlingual homophones from the participants' L1 are recognized with greater ease in relation to L2 interlingual homophones. This research was carried out with a quantitative experimental methodology applied in real time through the online and free software PsyToolKit (Stoet, 2010, 2017), which allowed the data collection for two experiments: a language decision task, and subsequent multiple-choice task. The results of reaction times (RTs) and accuracy rates provided information about the cost of processing different types of stimuli. The present study is part of a larger project from the Laboratory of Phonetics and Multilingualism (LabFoM – UFC), which aims at conducting and disseminating experimental research in the fields of phonetics and language processing for bilinguals and multilinguals. The studies of Brysbaert et al. (1999, 2002), De Groot (2011), Diikstra et al. (1999, 2002, 2005, 2018), Haigh and Jared (2007), Toassi and Mota (2015), Van Assche, Brysbaert, and Duyck (2020), among other authors, provided theoretical support for the present research. The results of Experiment 1 showed that participants were significantly less accurate, but not less quick, to respond to interlingual homophones in comparison to matched controls only for the Portuguese language, partially supporting Hypothesis H1. Language decisions to English homophones were significantly faster than those to Portuguese homophones, opposing hypothesis H3. In Experiment 2, there were repetition priming effects only for control words in the accuracy data, which opposes hypothesis H2. Moreover, homophone effects were not consistent across experiments, which suggested that these effects were modulated by task nature and also by prior exposure. The results provided further evidence supporting the language non-selective hypothesis predicted by recent models of bilingual lexical access and highlights that effects can be modulated by task requirements and language dominance.

Keywords: psycholinguistics; lexical access; interlingual homophones; bilingualism.

RESUMO

Este estudo pretendeu contribuir para a compreensão do acesso lexical bilíngue na área da Psicolinguística, investigando o efeito dos homófonos interlinguísticos no reconhecimento e na tradução de palavras, examinando os processos envolvidos na leitura silenciosa no nível da palavra. Homófonos interlinguísticos são palavras que soam muito semelhantes entre o inglês e o português brasileiro, mas têm significados diferentes, como é o caso de "*pie*-pai" e "*value*-velho". Para atingir as metas deste estudo, o objetivo geral é dividido em três objetivos específicos: 1) Examinar o custo de processamento da leitura de homófonos interlinguísticos isolados português brasileiro-inglês em relação a palavras controle em uma tarefa de decisão linguística; 2) Investigar se há um efeito de priming de repetição para palavras homófonas interlinguísticas isoladas PB-En em uma tarefa de tradução; e 3) Examinar se há diferença no custo de processamento da leitura de homófonos interlinguísticos isolados da L1 ou da L2. As seguintes hipóteses foram propostas: H1 - Homófonos interlinguísticos entre o português brasileiro e o inglês têm um custo de processamento maior em relação a palavras controle em uma tarefa de decisão linguística, refletido em tempos de reação mais longos; H2 - Há efeitos de *priming* de repetição para homófonos interlinguísticos em uma tarefa de tradução subsequente; H3 - Homófonos interlinguísticos da L1 dos participantes são reconhecidos com maior facilidade em relação aos da L2. Esta pesquisa foi realizada com uma metodologia experimental quantitativa aplicada em tempo real por meio do software on-line e gratuito PsyToolKit (Stoet, 2010, 2017), que permitiu a coleta de dados para dois experimentos: uma tarefa de decisão linguística e uma tarefa subsequente de múltipla escolha. Os resultados dos tempos de reação (TRs) e das taxas de acurácia forneceram informações sobre o custo do processamento de diferentes tipos de estímulos. O presente estudo faz parte de um projeto maior do Laboratório de Fonética e Multilinguismo (LabFoM - UFC), que tem como objetivo realizar e divulgar pesquisas experimentais nas áreas de fonética e processamento de linguagem para bilíngues e multilíngues. Os estudos de Brysbaert et al. (1999, 2002), De Groot (2011), Diikstra et al. (1999, 2002, 2005, 2018), Haigh e Jared (2007), Toassi e Mota (2015), Van Assche, Brysbaert e Duyck (2020), entre outros autores, forneceram suporte teórico para a presente pesquisa. Os resultados do Experimento 1 mostraram que os participantes foram significativamente menos precisos, mas não menos rápidos, para responder aos homófonos interlinguísticos em comparação com os controles pareados apenas para a língua portuguesa, apoiando parcialmente a Hipótese H1. As decisões linguísticas para homófonos em inglês foram significativamente mais rápidas do que para homófonos em português, contrariando a hipótese H3. No Experimento 2, houve efeitos de *priming* de repetição apenas para palavras de controle nos dados de acurácia, o que contraria a hipótese H2. Além disso, os efeitos dos homófonos não foram consistentes entre os experimentos, o que sugere que esses efeitos foram modulados pela natureza da tarefa e por exposição prévia. Os resultados forneceram mais evidências que sustentam a hipótese não seletiva do idioma prevista por modelos recentes de acesso lexical bilíngue e destacam que os efeitos podem ser modulados pelos requisitos da tarefa e pela dominância do idioma.

Palavras-chave: psicolinguística; acesso lexical; homófonos interlinguísticos; bilinguismo.

SUMMARY

1 INTRODUCTION

The phenomenon of bilingualism has been expanding in different contexts and places at the present time (Costa, 2020; Grosjean, 2013). This scenario has instigated the interest of psycholinguistic scholars to investigate how the human mind processes various language aspects and how the bilingual and multilingual brain handles more than one language at the same time. Experimental evidence has indicated that bilinguals cannot avoid activation of both of their languages even when they intend to use only one of them (Schwartz; Kroll, 2006; Lauro; Schwartz, 2017; Dijkstra *et al*., 2018; Toassi; Mota; Teixeira, 2020). In this perspective, it is relevant to better understand the cognitive processes that underlie linguistic acts such as reading, recognition, and comprehension of words in order to contribute to the understanding of bilingual mental lexicon organization.

Considering the assumption that bilinguals do not behave as two monolinguals in one (Grosjean, 1989; Basseti; Cook, 2011), and thus do not process their languages in the same way as monolinguals do, one of the fields of this research domain focuses on experimental studies that investigate lexical processing of bilinguals and multilinguals by examining how they select and recognize ambiguous words that share similarities across their languages (Van Assche; Brysbaert; Duyck, 2020).

These similarities can be semantic, orthographic, and/or phonological. In the case of cognates, for instance, words share both form and meaning across languages. It has been reported that this type of stimulus is processed more easily than noncognate words by bilinguals and multilinguals (Schwartz; Kroll, 2006; Lauro; Schwartz, 2017; Dijkstra *et al*., 2018; Toassi; Mota; Teixeira, 2020), evidencing a cognitive advantage and facilitation effect for cognates.

Interlingual homographs, on the other hand, share form but have dissimilar meanings across languages. These words have been reported to present a stronger processing cost in relation to control words (Gadelha, 2021) alongside interlingual homophones, which have similar pronunciations but dissimilar spellings and meanings (Cristoffels *et al*., 2016).

Investigating how bilinguals access and process these types of stimuli provides insights on the organization of the mental lexicon and allows researchers to hypothesize about interference effects languages have on each other, as well as whether they are separated or not on the mental lexicon organization of bilinguals and multilinguals. For example, if words that share form overlap across languages are activated independently of language mode and show to compete for selection through higher reaction times, this is taken as evidence that both languages of a bilingual are stored together in an integrated lexicon and that bilingual word activation is language nonselective, i.e., word candidates of different languages are activated for recognition and compete for selection when an input word is presented (Dijkstra, 2005; Dijkstra; Van Heuven, 2002).

On the other hand, if bilingual lexical access is language selective, cross-language overlap should be irrelevant for bilingual word processing and results from experiments with bilinguals should not differ from those of monolinguals (KROLL; TOKOWICZ, 2005). If words from different languages are stored separately and if bilinguals could select the language that is relevant to the context of use by ignoring the other irrelevant language, no benefit or inhibition effect should be evident on the bases of cross language overlap. Conversely, effects of crosslinguistic similarity on lexical processing of words by bilinguals suggest interaction of the languages in a single storage system.

That being the case, the object of interest of the present study is the bilingual lexical access of Brazilian Portuguese-English interlingual homophones. An example of this type of stimulus between English and Portuguese would be the interlingual homophonic word pair of pie – *pai* (/paj/ - /paɪ/). The words have very similar sounds, but dissimilar spellings and meanings (a type of dish and a male parent). For the purposes of this research, interlingual homophones are words which share high phonological overlap between Brazilian Portuguese and English but are not necessarily identical because the phonological repertoire of these languages differs considerably. Nevertheless, the words are evidently similar in phonological representations and most bilinguals may not be able to distinguish some vowel and consonant contrasts across these BP-En word pairs.

The purpose of this research is to examine how Brazilian Portuguese-English bilinguals access, process, and deal with such condition of words which share high phonological overlap in silent reading at the word level. As far as the author of this research knows, this is the first study that investigated bilingual lexical access of interlingual homophones in the language pair of Brazilian Portuguese and English (henceforth BP-En)

One question of particular interest in psycholinguistic research has been how bilinguals access words in their mental lexicon while going through a given linguistic process, such as reading. A traditional experimental task used in such studies is the lexical decision task, which requires participants to make a decision about a presented visual stimulus (EYSENCK; Keane, 2015). Typically, participants must decide whether a sequence of letters forms a real word or not in a target language. Other experimental tasks commonly used in these studies are naming, in which participants must read stimuli aloud, and priming, in which the critical word that participants must recognize is preceded by a related stimulus (the prime) or an unrelated stimulus (the control) to verify their influence and interaction in different representational levels.

The concept behind priming experiments is verifying the connections the human mind makes to process language. Semantic, orthographic, phonological, and morphological effects may be observed. For example, if prior exposure to a phonetically related stimulus from the first language (L1) does not influence on the activation and subsequent recognition of a second language (L2) target word when compared to a control condition, this would be considered as evidence of a lack of interaction between the two languages in the mind. In essence, it suggests that an L2 word does not have the capacity to activate related words in the L1 because they are stored separately or because bilinguals are always able to ignore the context-irrelevant language. Conversely, when facilitation priming effects are observed across languages, it lends support to the hypothesis that there is indeed interaction and coactivation of lexical items from both L1 and L2. Interestingly, many priming experiments are carried out without the participants being aware of the prior presentation of stimuli before the target word (masked priming paradigm).

Following an experimental methodology applied in real time, the tasks used in the present study were the language decision task and a multiple-choice translation task. In the first task, participants ha to indicate which language a visual stimulus belonged to as quickly and as accurately as possible (GRAINGER; Dijkstra, 1992; Gadelha, 2021; Borém, 2023). In the later task, translation responses are useful to verify priming effects for interlingual homophones and control words. Depending on the stimulus item, the results related to the response reflected in reaction times (RTs) and accuracy rates provided information about processing cost of different types of stimuli and about the mental lexicon organization of people who speak more than one language. The experimental tasks and the data collection were carried out online through the Psytoolkit software (STOET, 2010, 2017).

1.1 Objectives and hypotheses

Considering the research background discussed above, this study's general objective is to investigate the effect of interlingual homophones on bilingual lexical access through an experimental language decision task and a subsequent translation task, examining the interlingual interaction of phonological features and bilingual cognitive processes involved in silent reading at the word level.

In order to achieve the goals of this study, the general objective is divided into three specific ones: 1) To examine the processing cost of reading isolated Brazilian Portuguese-English interlingual homophones in relation to control words in a language decision task; 2) To investigate whether there is a repetition priming effect for isolated BP-En interlingual homophonic words in a translation task.; and 3) To examine whether there is a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2.

With that in mind, the following research questions were raised for this study: RQ1 – What is the processing cost of reading isolated BP-En interlingual homophones in relation to control words in a language decision task? RQ2 – Is there a repetition priming effect for isolated BP-En interlingual homophones in a translation task? RQ3 – Is there a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2?

Correspondingly, the following hypotheses are proposed: H1 – Interlingual homophones between Brazilian Portuguese and English have a higher processing cost in relation to control words in a language decision task, reflected on longer reaction times; H2 – There are repetition priming effects for interlingual homophones in a subsequent translation task, evidenced by the fact that interlingual homophones that were seen in task 1 will be processed more quickly and more accurately in task 2, as compared to control words and interlingual homophones that were not present in task 1; H3 – Interlingual homophones from the participants' first language (L1) are recognized with greater ease in relation to L2 interlingual homophones, that is, inhibitory phonological effects are stronger for interlingual homophones from the L2 than from the L1.

The following subsections address the justification of the present study and the organization of the remainder of this text.

1.2 Justification

As already discussed, the present study focuses on bilingual recognition processes of interlingual homophones in silent reading at the word level. As remarked by Fonseca, Lukasova and Carthery-Goulart (2022, p. 232), the automaticity of word recognition is a necessary feature to achieve reading proficiency. Experimental studies that examined bilingual processing of cognates, homographs, and homophones have shown that overlap in all levels of representation (semantic, orthographic, and phonological) play an important role in visual word recognition during reading (Dijkstra; Grainger; Van Heuven, 1999; Lemhöfer; Dijkstra, 2004; Van Assche; Duyck; Brysbaert, 2020). Nevertheless, Carrasco-Ortiz, Midgley, and Frenck-

Mestre (2012) point out that few studies have investigated this phonological component in the bilingual context.

In a literature review, Sousa (2021) made a bibliographic survey providing an overview of 17 influential studies that investigated the effect of interlingual homophones on bilingual lexical access. Besides missing one study with Vietnamese-English bilinguals (Nguyen, 2013), the survey demonstrated that experimental research with this type of stimulus has only reached to explore 9 different language pairs, among which none included the bilingual population of Brazilians who have English as a second or an additional language.

Thus, the need to investigate bilingual lexical processing of interlingual homophones by Brazilian Portuguese-English bilinguals becomes evident. It is also relevant to highlight that, to the present date, only cognate words and interlingual homographs have been used to investigate the mental lexicon of Brazilians who have English as their L2, leaving a fertile research gap to be explored with interlingual homophones on psycholinguistic experimental research at the word level.

Furthermore, when discussing the history of bilingual lexical access research in Brazil and perspectives for future studies, Freitas and Toassi (2022) made a survey of the most influential studies in this area in the last 5 years, both in Brazil and internationally. By checking the articles cited, it is possible to observe that none of them dealt with the processing of interlingual homophones.

If phonological overlap plays an important role in reading and lexical processing in bilinguals and multilinguals (Sousa, 2021), it is essential to build more evidence on this interaction of phonological overlap between languages. Interlingual homophones seem to be the appropriate critical stimuli for such investigation, since these words share high phonological overlap, but differ in meaning and vary in orthography. Considering that research on bilingual Portuguese-English lexical processing has focused more particularly on the investigation of cognate words and interlingual homographs, investigation on interlingual homophones and the role of phonological information of the two languages of a bilingual still need to be further examined and empirically tested.

In addition, it is worth mentioning that the present study is part of a larger project from the Laboratory of Phonetics and Multilingualism (LabFoM – UFC), entitled "The Portuguese-English bilingual lexicon" (Toassi *et al.*, 2020), which is coordinated by Professors Pâmela Freitas Pereira Toassi and Ronaldo Lima Júnior. LabFoM's main goal revolves around conducting and disseminating experimental research in the fields of phonetics and language processing for bilinguals and multilinguals. The results and evidence of the current research are also relevant to complement the studies of LabFoM that have already investigated matters of bilingual language processing.

So far, the aforementioned umbrella project has counted on the contribution of 4 experimental studies from the Federal University of Ceará (UFC). Gadelha and Toassi (2022) investigated the recognition and translation processes of interlingual homographs by Brazilian Portuguese-English bilinguals with the participation of 23 Brazilians who were English Teachers. The results pointed to significant effects of BP-En interlingual homographs on reaction times, evidencing a higher processing cost for these words in relation to their controls in a language decision task.

Furthermore, the study of Batista (2022) examined the effect of Portuguese-English false cognates in a language decision task applied to 11 participants. Despite the small number of participants, her results showed greater accuracy and faster reaction times for false cognates in relation to control words in a language decision task. Interestingly, Batista (2022) also showed that participants had greater accuracy rates for false cognates in their L1 than in their L2, even though they took the longest to do it.

Moreover, Nogueira (2022) and Borém (2023) examined the processing cost of cognate words in a language decision task in comparison to noncognate control words. Since the first study of Nogueira had limitations concerning the small number of participants, it was considered a pilot experiment for the later study of Borém. In summary, they reported that cognate words in Portuguese (CGP) had the highest RTs, followed by cognates in English (CGE) and Portuguese controls (CTP) in language decision. In line with the previous study of Gadelha and Toassi (2022), their results showed that control words in English (CTE) had faster and more accurate responses, suggesting that participants may have their L2 more active during the experiments. The results also indicated a greater L2 activation and an inhibitory language conflict for cognates in the language decision experiment. Additionally, Borém (2023) delved deeper in the investigation of the processing of these cognates and found evident repetition priming effects for cognate words in a translation task.

One limitation of these previous studies that the present research aimed at overcoming was increasing the number of participants and including bilinguals who aren’t necessarily English teachers or linguistics academics. It might be possible that the higher L2 activation happened due to the fact that most of the participants were from a specific group of bilinguals who are engaged in a context of language teaching and analysis, which may not be representative of the broader population of bilingual Brazilians who have English as their L2.

More recently, Mota (2024) conducted another LabFoM study which investigated the translation process of interlingual homographs by Brazilian Portuguese – English bilinguals. In his translation task, participants had to type the Portuguese translation equivalent to interlingual homographs and control words written in English. Besides showing that interlingual homographs had an inhibitory effect both in reaction times and accuracy rates, the author argued that an activation of the phonological component was also observed in the translation of certain words. As an example, participants mistakenly translated the words “deft”, “noon” and “ache” as “surdo” [deaf], “freira” [nun] and “cinza” [ash].

1.2.1 Significance of the study

Besides filling these research gaps concerning the effect of interlingual homophones, this study can contribute not only to the understanding of human cognition, but also contribute to the development and improvement of methodologies and strategies for teaching, learning, and translating languages. As remarked by Batista (2022, p. 12), it is rather difficult to proceed in the search for methodological improvements for teaching English as a second language without considering the connections that the mind operates when there is more than one language at work.

For Dijkstra and Van Heuven (2002), the reasons behind the interest and relevance of research into bilingual word processing include problems to be investigated that do not exist with monolinguals, the opportunity to test hypotheses derived from the monolingual domain, and the practical consequences of this research for educational purposes. The authors also point out that

> […] because words are the basic building blocks of sentences, it is important to understand how words are recognized in a bilingual context as a prerequisite for understanding how sentences are parsed by bilinguals. For all these research issues, reaching a detailed understanding of the bilingual word recognition system is an important aim (Dijkstra; Van Heuven, 2002, p. 175).

All in all, this study could also test hypotheses from the literature in the specific community of Brazilian bilinguals who have English as their L2. Furthermore, the BP-En language pair lacks research into bilingual lexical access compared to other languages. Freitas and Toassi (2022) emphasize that, even though it is on the rise in Brazil, there is still a lot of room for research into bilingual lexical access.

Finally, it is believed that the experiments of this research contribute to relevant theoretical discussions about the role of phonology in reading and its interaction with the other levels of representation during bilingual lexical access, which should be taken into account when forming, reformulating and updating cognitive models of the bilingual mind, since it is from empirical evidence that conclusions can be drawn about which theoretical models best explain the architecture of the human mind in certain processes (Leitão, 2008).

1.3 Organization of the research text

The configuration of this text is divided into different chapters. The introduction, chapter 1, contextualizes the theme of the research, specifies the stablished objectives, the questions, their hypothesis, and arguments about the importance of the study.

Chapter 2, Theoretical Framework, encompasses the theoretical foundation and empirical evidence that supports this research. This section is divided into four parts. Subsection 2.1 "The role of phonology in word reading" addresses monolingual studies that provided evidence of the role of phonology in visual word recognition. Subsection 2.2 "Bilingual lexical access" brings discussion about the matter of how bilinguals access words and store their languages in the mind. Subsection 2.3 "The effect of interlingual homophones on bilingual lexical access" delves deeper into the topic of phonological processing in the bilingual domain by discussing empirical evidence regarding the effect of interlingual homophones, and subsection 2.4 "Similarity measures "addresses the matter of similarity measures required to control variables in stimuli preparation of psycholinguistic experimental research that investigates bilingual lexical access.

Chapter 3, Methodology, specifies the objectives, hypotheses, and research questions of this study, as well as the experimental design, the characteristics of participants, the specification of the elaborated corpus, and the instruments and procedures for data collection and analysis.

In Chapter 4, Results, the obtained findings of both experiments conducted in this study are presented and analyzed through descriptive and inferential statistics. In the same chapter, subsection 4.3 offers a discussion of these results, comparing them in a contextualized manner to previous empirical studies and models of bilingual lexical access.

Furthermore, Chapter 5, Final Remarks, final thoughts on the contributions of the study are presented to address the research questions and objectives, as well as to discuss the previously raised hypotheses. In addition, methodological limitations are highlighted, and suggestions for future research are offered.

2 THEORETICAL FRAMEWORK

2.1 The role of phonology in word reading

It is undeniable that knowing how to read is an indispensable skill for human beings and this process is far from simple. Many issues are involved in decoding and interpreting written texts, not to mention reading aloud. Reading extends beyond the mere levels of letters and words, involving intricate complex operations that relate to context and discourse. Nonetheless, the critical step in achieving reading fluency lies in automatizing word recognition (Fonseca; Lukasova; Carthery-Goulart, 2022).

> Automatic word recognition allows the reader to quickly recognize a word, like a snapshot, and thus saves cognitive resources for other concomitant cognitive processes, such as integrating the word into the sentence, and the sentence into the rest of the text, aiding comprehension and inference. (Fonseca; Lukasova; Carthery-Goulart, 2022, p. 241, our translation[1])

This "snapshot" or representation of the word can be at the semantic, orthographic, and phonological level. In silent reading, phonology can play its role without people necessarily having to articulate the sounds, thus benefiting from an "acoustic image," which can even be advantageous to readers in short-term memory. With this acoustic image, experienced readers may not always need to access a word through the orthographic lexicon (Pollatsek, 2015).

Evidence regarding this issue comes mainly from monolingual studies that investigated the influence of phonologically similar words and pseudowords (homophones and pseudo-homophones) in the same language with priming, lexical decision, and semantic categorization experiments (Rastle; Brysbaert, 2006).

In a monolingual study by Van Orden (1987), skilled readers performed a semantic categorization task with intralingual homophones and control words. In this paradigm, participants must decide whether a presented stimulus is a category exemplar or not, e.g., judging whether *meet* is a member of the category of food or whether *rows* is a flower. Matched control words (e.g., *melt*, *robs*) shared the same spelling overlap to the correct category exemplars (e.g., *meat, rose*) as the homophones. Contrary to the assumption that skilled readers make little or no use of phonology in visual word recognition, the results showed that

[1] "O reconhecimento automático das palavras permite ao leitor reconhecer rapidamente uma palavra, como uma foto instantânea, e assim poupar recursos cognitivos para outros processos cognitivos concomitantes, como a integração da palavra à sentença, e essa ao restante do texto, auxiliando na compreensão e na inferência." (Fonseca; Lukasova; Carthery-Goulart, 2022, p. 241)

participants were significantly influenced by phonological coding, as they largely gave more false positive answers to homophones than to control words. In addition, a later experiment also evidenced that phonological processing occurred in the early stages of word identification, suggesting that phonological activation is an early source of constrain in word recognition.

In line with this view, Lukatela and Turvey (1994a; 1994b) tested the influence of phonological codes on monolingual lexical access of English words in a priming paradigm. Participants were required to name a target word (e.g. *frog*) that could be preceded by four types of primes: an associate word (e.g., *toad*), a homophonic word of the associate (e.g., *towed*), a homophonic pseudoword, that is, a pseudo-homophone of the associate (e.g., *tode*), or orthographic control primes (e.g., *told*, *tods*). While orthographic controls had limited effects, results showed that naming the target word was facilitated not only by associate words, but also by words and pseudowords that were homophonic to the associate.

Along with Van Orden's (1987) study, these findings suggest that phonological coding plays a rather initial, prelexical, automatic leading role in monolingual visual word recognition that may be strong enough to activate associated semantic representations. As remarked by Pollatsek (2015, p. 189), "these experiments make clear that people don't go directly from print to the orthographic lexicon; otherwise, subjects wouldn't misclassify fairly common words in the semantic judgment task and even misclassify pseudowords." Having this in perspective, it becomes intriguing to investigate how such processes come about in the bilingual mental lexicon.

As highlighted in the literature review of Sousa (2021), monolingual studies examining phonological overlap in lexical access provide clear evidence of the significant role of phonological processing. This role extends to mediating and enhancing word recognition, thereby providing support for strong phonological reading models (Eysenck; Keane, 2015). Moreover, research employing eye movement tracking to investigate reading has also indicated that phonological processing happens early and quickly in word recognition, even before readers fix their eyes on any of the words (SLATTERY *et al.*, 2011).

A matter of interest on bilingual studies is verifying whether such monolingual phenomena may occur similarly or not when the processing of more than one language is concerned. Various considerations arise concerning the cognitive processes implicated in reading, particularly when individuals must manage more than one language on their minds. This aspect will be further explored in the subsequent subsections of this theoretical framework.

2.2 Bilingual lexical access

Lexical access is related to the process of recognizing and selecting words in one's mental lexicon, involving both the identification of incoming input and the production of output (Dijkstra, 2005; De Groot, 2011). In other words, it can be defined as a match between the word form and its correspondent meaning and function, "covering all mental activity from the perception of the word until all the knowledge stored with its lexical representation is available." (De Groot, 2011, p. 155).

Since bilinguals need to manage more than one language, the way they access lexical representations in their respective language systems has remained a highly debated topic. Researchers have explored whether bilinguals store languages independently or if there is an interconnectedness between them. Investigations have been conducted to determine whether bilinguals activate words solely in the contextually relevant language or if both languages are activated when written or spoken stimuli are presented and recognized.

According to the first view, the language selective access hypothesis proposes that lexical access and activation of word candidates are restricted to the language bilinguals intend to use. On the other hand, the language nonselective access hypothesis assumes that, when bilinguals try to search and select a word in their mental lexicon, this process happens with coactivation from both of their languages independent of which one is the target. (De Groot, 2011). Importantly, ample evidence suggests that bilinguals and multilinguals cannot select only one of their languages while going through a given linguistic process, such as recognizing words. (Schwartz; Kroll, 2006; Dijkstra *et al*., 2018; Toassi; Mota; Teixeira, 2020).

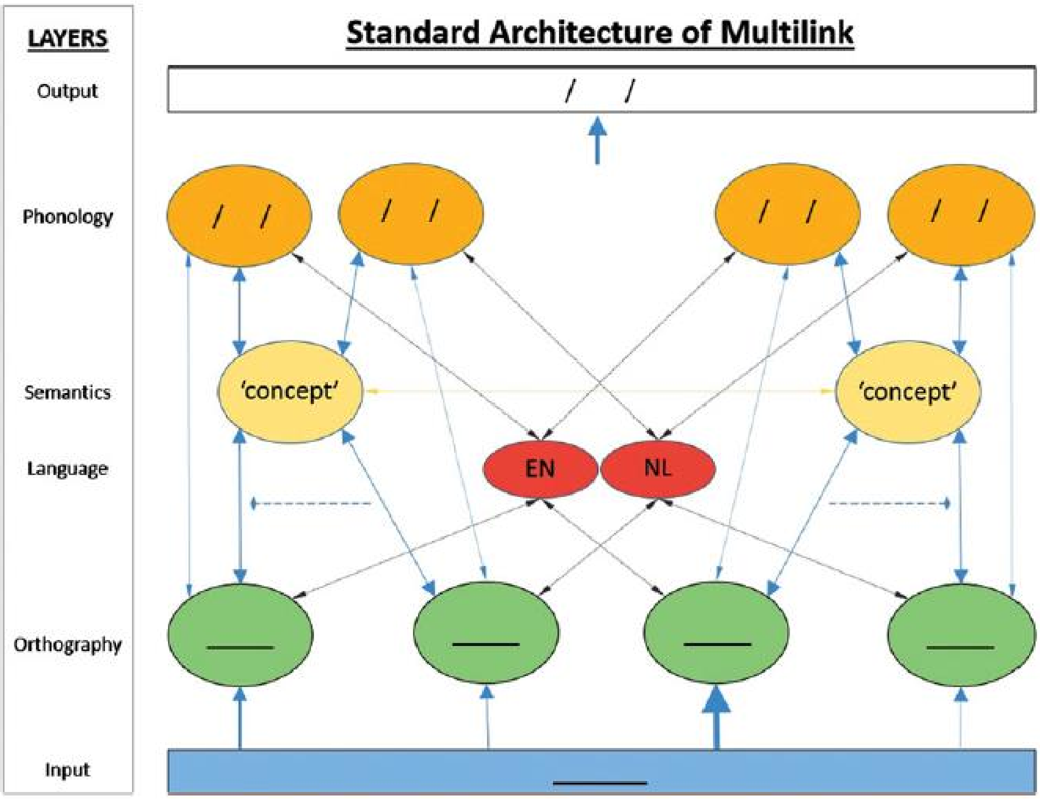
To account for the evidence on the mental lexicon organization in individuals who are proficient in more than one language, different theoretical models have been proposed. The influent Revised Hierarchical Model (RHM) was proposed to account for asymmetries in word translation, for example, and the Bilingual Interactive Activation model (BIA) and its successor BIA+ have been the most referred to when bilingual visual word recognition is concerned. Despite the significant contributions and insights that these models have provided, they have been subject to considerable criticism more recently (Toassi; Mota, 2015; Dijkstra *et al*., 2018).

To cite a few examples, the RHM assumption of separate lexicons for different languages in the mind has not received much empirical support in the literature. In addition, this model lacks specification of different representations for word forms, and L2 words may be more strongly connected to their meanings than what is predicted by the model (Toassi; Mota, 2015). Limitations to the BIA/BIA+ models have also been pointed out: they do not implement semantic representations and their simulations only account for 4-to-5 letter words (Dijkstra *et al*., 2018)

One of the most recent models of bilingual lexical access called Multilink has been proposed by Dijkstra and colleagues (2018) to combine assumptions of both previous models and make up for their limitations. Multilink is a bilingual word recognition and translation model which assumes the lexicon of multilinguals is integrated. That is, the storage of word information is not separated according to different language systems.

According to Multilink, when bilinguals and multilinguals want to access information about a word from one of their languages, they do not choose a language system first to then search for the information they need. Instead, the mental lexicon is assumed to be a single storage system with all the languages coactivated at the same time, and lexical access is assumed to be language nonselective. In addition, multilink simulations account for 3-to-8 letter words and the model assumes that "connections between L2 words and their meanings are stronger than proposed in RHM" (Dijkstra *et al*., 2018, p. 661).

Figure 1 - Standard network architecture of Multilink



Source: Dijkstra *et al*. (2018).

The present study is based on the assumptions of the Multilink model. According to its conceptual framework, "when an input word is presented, lexical candidates from different languages compete for recognition” (Dijkstra *et al*., 2018, p. 660). The layered network architecture of the Multilink is presented in figure 1. The model postulates that

> A written input word activates various lexical-orthographic representations, which in turn activate their semantic and phonological counterparts, as well as associated language membership representations (English or Dutch). Multilink is an interactive model, so all activation flows are bidirectional. (Dijkstra *et al*., 2018, p. 662).

Likewise, it can be concluded that the process of language nonselective access happens with the influence and interaction of all representational levels: orthography, semantics, and phonology. When an input word is presented, orthographic representations activate both the meaning and phonological representations of associate and similar word candidates, so empirical studies should account for coactivation of all these levels. Moving forward, the following section provides a more in-depth discussion on the lexical processing of interlingual homophones.

2.3 The effect of interlingual homophones on bilingual lexical access

Christoffels *et al*. (2016, p. 629) define interlingual homophones as "words in the first and second language that have different meanings but a very similar pronunciation." In the words of Carrasco-Ortiz, Midgley, and Frenck-Mestre (2012, p. 532), they are "words that enjoy substantial phonological overlap across languages but have different spellings and meanings."

Studies that examined the effect of words with phonological similarities on the visual recognition of individual words reported that even when they were performing a task in only one of their languages, bilinguals could not avoid activating phonological information from the other language that they did not intend to use (the non-target language).

Brysbaert, Van Dyck, and Van Poel (1999) and Van Wijnendaele and Brysbaert (2002) examined the lexical access of French words with pseudo-homophone primes, which were briefly presented before the French target words. These nonword primes sounded like the target words according to the pronunciation of the nontarget language (Dutch), which the participants did not need to activate. In the first study, participants were Dutch-French bilinguals who had to recognize L2 target words in French. In the second, French-Dutch bilinguals had to read target words in their L1.

The findings revealed, for example, that both Dutch-French bilinguals and French-Dutch bilinguals identified the French word "sourd /suʁ/" [deaf] more easily when it was quickly preceded by the pseudoword "soer". Remarkably, this pseudoword was phonetically similar to the target word based on the pronunciation rules of Dutch, the language the bilinguals did not intend to use in the recognition task. In both studies, bilinguals could not turn off their knowledge of the contextually irrelevant language even though they believed they were being tested only in their L1 or L2. Phonological priming happened both from L2 to L1 and from L1 to L2.

Furthermore, Duyck (2005) investigated the activation of the nontarget language pronunciation rules with pseudo-homophones that sounded like the translation equivalents of the target words. The author was interested in verifying whether hypotheses from the monolingual domain about the activation of associate words by homophones and pseudo-homophones (Lukatela; Turvey, 1994a; 1994b) would generalize across languages. He reported, for example, that recognition of the English target word "back" was facilitated by the pseudo-homophone "ruch" which sounded like its Dutch equivalent translation (rug /rʏx/) if read according to the pronunciation rules of the non-target language: Dutch.

In the study of Dijkstra, Grainger, and Van Heuven (1999), responses to cognates and false cognates that varied in similarity were examined in progressive demasking and lexical decision experiments. Six conditions of words were stablished: cognates that overlapped in the representational levels of semantics, orthography, and phonology (SOP); cognates that overlapped on semantics and orthography (SO); cognates that shared semantics and phonology (SP); interlingual homographs that shared orthography and phonology (OP); interlingual homographs that overlapped only at the orthographic level (O); and interlingual homophones (P). An example of this last condition of the homophonic false cognate with no semantic or orthographic similarity was the English word "cow /kau/" which sounds like the Dutch word "kou /kɑu/" [cold]. The results showed inhibitory effects on lexical processing of this stimulus condition, increasing error rates and response time. In contrast, semantic and orthographic overlap led to facilitation effects on lexical decisions.

While cognate words are generally presented as facilitating bilingual lexical processing, there is still no consensus on the effect of interlingual homophones. Lemhöfer and Dijkstra (2004) used the same stimuli as Dijkstra, Grainger, and Van Heuven (1999) in lexical decision tasks with a different group of Dutch-English bilinguals and failed to replicate the inhibitory effect of homophones that was found in the former study. The effects may depend on task requirements (Dijkstra; Van Heuven, 2002)

In Haigh and Jared's (2007) study involving French-English bilinguals, homophone words had a facilitating effect on the L2 lexical decision task. Participants had to answer whether the stimuli were real English words or not. The authors argued that the effect of interlingual homophones may be influenced by other factors such as the composition of the stimulus list and the target language of the experiment: whether it is the dominant or non-dominant language of the participant. They observed that bilinguals activated phonological representations from both of their languages when reading in L2, but obtained little evidence that the same was true when reading in L1.

Even with highly proficient bilinguals, Haigh and Jared (2007) could not find a significant effect of phonological overlap in the L2-L1 direction. Van Assche, Duyck, and Brysbaert (2020) remark that the dominant language of a bilingual is typically the L1 and the weaker, nondominant language is typically the L2. Taking this into consideration, it is easier to find influence from the L1 to the L2 than vice-versa, but it doesn't mean that the reverse order is impossible. In fact, finding L2 influence on the performance of L1 may be even more theoretically important, since it proves that "the first learned, dominant language is not impervious to a later acquired language." (Van Assche; Duyck; Brysbaert, 2020, p. 52).

> Importantly, one must keep in mind that it is easier to obtain influences from the stronger L1 on the generally weaker L2 and that one must run careful and powerful experiments before deciding that influences from L2 on L1 are nonexistent or limited to certain contexts (Van Assche; Duyck; Brysbaert, 2020, p. 53).

Dimitropoulou, Duñabeitia, and Carreiras (2011) further add that orthographic similarity can also influence the effect of interlingual homophones and that a purely phonological effect is more reliably found when orthographic similarity is limited. These authors investigated the effect of phonological priming in a lexical decision task with Greek-Spanish bilinguals. It is worth mentioning that the languages of these bilinguals do not share the same alphabet. The authors observed that, unlike words which were phonologically similar and orthographically different, words which were similar in both spelling and phonology did not facilitate participants' lexical decisions. Thus, facilitative priming effects were found with fiber - φύτρο (/fiβra - fitro/), but not with ocio - όριο (/oθio - orio/). In addition, effects for these interlingual homophones were found both with L1 and L2 target words.

On top of the bilingual empirical evidence presented above, research examining lexical access of trilingual individuals has provided additional evidence of simultaneous parallel activation of phonological information from all languages within the multilingual lexicon, even though they have not specifically investigated homophone words (Toassi; Mota, 2018; Carvalho; Mota; Rigatti, 2022).

It is important to note that, for the purposes of this research, interlingual homophonic words or interlingual homophones refer to words that sound very similar between English and Brazilian Portuguese, as is the case for "pie-*pai*" and “value-*velho*”. However, the terms used to name this research object do not mean that the words are phonologically identical. As with the definition given by Christoffels *et al*. (2015) before, it is pertinent to emphasize that this categorization of words includes those with a high (not identical) overlap or phonological similarity between the languages, since the phonological repertoire of the languages differ considerably.

As to the considerations of Dimitropoulou, Duñabeitia, and Carreiras (2011), since English and Portuguese are both languages with alphabetic writing systems, it is not feasible to examine phonology in isolation from orthography in the present study. What can be done is try to control for this orthographic overlap and check for its effects.

As Sousa (2021) argues, finding interlingual homophonic words between two languages to conduct a psycholinguistic experiment can be a rather challenging task. Besides orthographic overlap, researchers also take care to avoid semantic overlap and control other variables, such as word frequency, grammatical class, number of orthographic neighbors, and the distance or edit difference between pairs of words, as calculated by Levenshtein's Distance algorithm (Fernandes; Estivalet; Leitão, 2021; Post da Silveira; Van Leussen, 2015; Post da Silveira, 2020).

Such specifications are being considered in the elaboration of the corpus of this research and will be further detailed in the methodology section. The following section delves into the topic of calculating similarity across word pairs of different languages.

2.4 Similarity measures

When selecting words to compose the stimulus list of a psycholinguistic experiment that involves visual word recognition and reading, it is important to control and measure variables such as orthographic and phonological similarity. Orthographic similarity has been much more explored in the literature than phonological similarity. Yet, there are alternatives to properly measure both types of overlap across words from different languages.

Researchers usually do not give much detail on this stage of experimental psycholinguistics stimuli preparation in their papers, although it plays a crucial part on obtaining successful results. This lack of clarification on the proceedings of stimuli preparation poses considerable obstacles to future research and replication studies, for the process of selecting the critical words and controlling for variables such as frequency and cross language similarity can be time consuming and require expertise in other areas such as computational programming. Most of the time, codes used for controlling variables are inaccessible. Indeed, preparing the critical stimulus list may be the most challenging stage of psycholinguistic research, and it was the main time constrain the present study has gone through.

One of the most widely used and accessible measures to calculate orthographic similarity has been the spelling similarity algorithm described by Van Orden (1987). This estimate of **Graphic Similarity (GS)** ranges from 0 to 1, where 0 indicates maximally dissimilar and 1 indicates identical. Van Orden's graphic similarity value is based on:

- A: Sum of letters in each word/2
- B: If first two letters are the same B = 1 else B = 0
- C: Number of letters which are present in both words. Note: for meet / meet this is 4
- E: If last two letters are the same E = 1 else E = 0
- F: number of pairs of adjacent letters in the same order, shared by pairs
- T: ratio of shorter word to longer word
- V: number of pairs of adjacent letters in reverse order, shared by pairs

The measure can be automatically retrieved by entering two different letter strings on a website page (https://www.subjectpool.com/quest/reading/spelling_similarity.php). As described on the link, "Graphic Similarity = 10([(50F + 30V + 10C)/A] + 5T + 27B + 18E). Orthographic Similarity is the ratio between GS of word one with itself and GS of word 1 and word 2 (Van Orden, 1987)."

When submitting the orthographic and phonological representations of the interlingual homophone pair of **pie-*pai*** in the given form, the following output is provided, with a graphic similarity value of 386.66666666667 for orthographic overlap, and 475 for phonological overlap.

Table 1 - Van Orden's similarity for orthographic and phonological overlap

Strings	**pie - *pai***	**/paɪ/ - /paj/**
Output	A = 3 (average length of words) B = 1 (shared first letter) C = 2 (shared letters) E = 0 (shared last letter) F = 0 (shared pairs of adjacent letters)	A = 4 (average length of words) B = 1 (shared first letter) C = 2 (shared letters) E = 0 (shared last letter) F = 1 (shared pairs of adjacent letters)

	T = 1 (ratio of the length of the short word to the long word) V = 0 (shared pairs of adjacent letters in word1 with reversed pairs in word2) Similarity = 386.66666666667 Diagnostics: length of word 1 = 3 length of word 2 = 3 first letter of word 1 = P first letter of word 2 = P last letter of word 1 = E last letter of word 2 = I Unique letters of word 1 = "P","I","E" Unique letters of word 2 = "P","A","I" Adjacent pairs of word 1 = "PI","IE" Adjacent pairs of word 2 = "PA","AI" Reversed adjacent pairs of word 2 = "IA","AP"	T = 0.6 (ratio of the length of the short word to the long word) V = 0 (shared pairs of adjacent letters in word1 with reversed pairs in word2) Similarity = 475 Diagnostics: length of word 1 = 5 length of word 2 = 3 first letter of word 1 = P first letter of word 2 = P last letter of word 1 = � last letter of word 2 = J Unique letters of word 1 = "P","A","�","�","�" Unique letters of word 2 = "P","A","J" Adjacent pairs of word 1 = "PA","A�","�","��" Adjacent pairs of word 2 = "PA","AJ" Reversed adjacent pairs of word 2 = "JA","AP"

Source: Van Orden (1987)

As can be seen, a problem occurred in the recognition of the phonetic transcriptions. Since this measure wasn’t built to account for phonological similarity and phonetic symbols, the results should not be appropriate for the purposes of this research.

Another influential measure used in the construction of corpora for psycholinguistic research has been the so called Levenshtein Distance (Levenshtein, 1966). This distance metric calculates the similarity between two strings based on the number of modifications (insertions, deletions, or substitutions) required to transform one string of characters into another.

As an example, the orthographic distance of the interlingual homophone pair of **pie-*pai*** is 2. A limitation of the **Levenshtein Distance (LD)** is that its value is biased by word length. An LD of 2, for instance, represents a change of 66% for pie-*pai*, and 40% for past-*peste*. Thus, shorter words end up having lower values and a single modification can represent a great change for small words and little change for large words (Fernandes; Estivalet; Leitão, 2021).

Fernandes, Estivalet, and Leitão (2021) demonstrate, for example, that a single modification in long words can be virtually disregarded. They demonstrate this with the cognate word pair of independent-*independente*, where the LD indicates too little change (8,3%). To account for comparable similarities between word pairs of different lengths, Schepens, Dijkstra and Grootjen (2012) proposed the **Normalized Levenshtein Distance (NLD)**, also aimed at measuring orthographic similarity. They adjusted the Levenshtein Distance as given in the following equation, where the traditional distance is divided by the length of the longer word.

$$1 - \frac{distance}{length}$$

Under these parameters, the final score ranges from 0 (completely different strings) to 1 (identical matches). Thus, the orthographic NLD for pie-*pai* is

$$1-\frac{2}{3}=0{,}34$$

while the orthographic NLD for past-*peste* is

$$1-\frac{2}{5}=0{,}6$$

And the score for independent-*independente* (Fernandes; Estivalet; Leitão, 2021) turns out to be the following, indicating a significant improvement that favors longer words.

$$1-\frac{1}{2}=0{,}92$$

Importantly, both Van Orden's graphic similarity and Levenshtein Distance were developed aiming at measuring orthographic similarity. Although one may use them to measure phonological overlap, they were not developed for this purpose. Another drawback of these measures is that they do not consider diacritics and alphabetical signs such as Á, Â, Ã, É, Ê, Í, Ó, Ô, Õ, and Ú, which are present in the Portuguese language.

Moreover, phonological overlap may be underestimated by the Normalized Levenshtein Distance because the metric may not efficiently consider bilingual's interlanguage perception and categorization of L2 sounds (Post da Silveira; Van Leussen, 2015). To illustrate, the homophonic pair of hood – *rude* /hʊd - ˈxuʤɪ / has an orthographic NLD of

$$1-\frac{4}{4}=0$$

and a phonological NLD as well of

$$1-\frac{4}{4}=0$$

which does not seem to represent the real similarity for /hʊd - ˈxudʒɪ/. These words evidently sound alike between English and Portuguese, at least considering their first sounds, so a zero score indicating complete dissimilarity might be inadequate. In order to avoid that the distance score might underestimate the phonological cross-language similarity in such words, the measure should account for the fact that bilinguals may perceive and categorize some of the L2 phonemes according to L1 frames (Nobre-Oliveira, 2007; Flege; Mackey, 2004).

To account for these constraints, Post da Silveira and Van Leussen (2015) proposed a new method to calculate **Interlanguage Normalized Levenshtein Distance (InLD)** "using pre-categorized segments according to L1-specific L2 perception" (p. 2). In this case, phonological strings must be represented with a specific computer-readable code such as SAMPA (Speech Assessment Methods Phonetic Alphabet).

They used this InLD in the construction of a corpus with phonological information of cognate words between English and Portuguese. Their novel method consisted of pre-processing the transcriptions of the English words in SAMPA so that it would more closely represent the perception of L2 sounds that bilinguals have based on existing L1 categories. In addition, an edit cost of 0,5 was stablished for diacritics.

Table 2 compares scores of the Normalized Levenshtein Distance (NLD) and the Interlanguage Normalized Levenshtein Distance (InLD) for examples of cognate word pairs, as implemented by Post da Silveira and Van Leussen (2015). Their new measure considers diacritics cost for orthographic similarity and pre-categorized segments according to non-native L2 phonological perception.

Table 2 - Interlanguage Normalized Levenshtein Distance comparison

Word pairs	**NLD**	**InLD**
minister - *ministro*	$1 - \frac{2}{8} = 0.75$	$1 - \frac{2}{8} = 0.75$
/ˈmɪnɪstər/ - /miˈnistrʊ/	$1 - \frac{5}{8} = 0.375$	$1 - \frac{2}{8} = 0.75$
replica – *réplica*		

	$1-\frac{0}{7}=1$	$1-\frac{0.5}{7}=0.9286$

Source: Post da Silveira and Van Leussen (2015)

As can be observed, the orthographic InLD only differs from the NLD when diacritics are concerned and a cost of 0.5 is implemented. As to the phonemic InLD, the higher similarity InLD score of 0.75 seems to better represent the phonological overlap of minister - *ministro* than the NLD score of 0.37, considering sounds that are not distinguished my many BP-En bilinguals.

With the given considerations, the present study used the InLD to control and account for the orthographic and phonological overlap of the selected word pairs in the stimulus list. These similarity scores are addressed in the Corpus description of this study. The next chapter discusses the entire method of the research.

3 METHODOLOGY

This section specifies the methodological trajectory adopted for the present study, encompassing the corpus preparation and the procedures for data collection during the conducted experiments. First, a characterization of the research is provided. Next, the general and specific objectives are presented, as well as the research questions and their respective hypotheses. The subsequent subsections delve into the research procedures, covering the participants, the steps for their recruitment, the corpus of the study, the research instruments, and the data collection steps for each experiment.

3.1 Objectives

3.1.1 General objective

This study's general objective is to investigate the effect of interlingual homophones on bilingual lexical access through an experimental language decision task and a subsequent multiple choice translation task, examining the interlingual interaction of phonological features and bilingual cognitive processes involved in silent reading at the word level.

3.1.2 Specific objectives

1) To examine the processing cost of reading isolated Brazilian Portuguese-English interlingual homophones in relation to control words in a language decision task;

2) To investigate whether there is a repetition priming effect for isolated BP-En interlingual homophonic words in a translation task;

3) To examine whether there is a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2.

3.2 Research questions

RQ1 – What is the difference in the processing cost of reading isolated BP-En interlingual homophones in relation to control words in a language decision task?

RQ2 – Is there a repetition priming effect of isolated BP-En interlingual homophones in a translation task?

RQ3 – Is there a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2?

3.3 Research hypotheses

H1 – Interlingual homophones between Brazilian Portuguese and English have a higher processing cost in relation to control words in a language decision task, reflected on longer reaction times.

H2 – There are repetition priming effects for interlingual homophones in a subsequent translation task, evidenced by faster and more accurate responses for interlingual homophones previously seen in Task 1, as compared to control words and interlingual homophones that were not present in task 1.

H3 – Interlingual homophones from the participants' first language (L1) are recognized with greater ease in relation to L2 interlingual homophones, that is, inhibitory phonological effects are stronger for interlingual homophones from the L2 than from the L1.

3.4 Research characterization and experimental design

Based on the objectives and method of the study, this research can be classified as exploratory, descriptive, and experimental. It is worth mentioning that the present study makes part of a larger project from the Laboratory of Phonetics and Multilingualism (LabFoM) from the Federal University of Ceará (UFC) entitled "The Portuguese-English bilingual lexicon" (Toassi *et al*., 2020). As a result, the methodological procedures employed in this research closely align with those used in prior studies from the laboratory. The project was approved by the Ethics Review Board of the Federal University of Ceará – UFC (Certificate of Application for Ethical Appraisal (CAAE) number: 33969320.8.0000.5054 and opinion number: 5.801.726).

In order to answer the research questions and investigate bilingual lexical processing of BP-En interlingual homophones, two experiments were planned: a language decision task and a subsequent translation task. Target words were both from the participants L1 and L2. The experimental conditions were composed of interlingual homophones from the L1 and L2 (conditions HFP and HFE), while the control condition were composed of L1 and L2 non-homophonic words (conditions CTP and CTE). Care was taken so that no homograph or cognate would be present in the stimulus list, nor intralingual homophones. It is believed that this design allowed to assess the bilingual lexical access processes during silent reading at the word level, specially concerning the cross-language phonological interaction.

The main independent variables of interest of this experimental design is the word status for the stimuli. Four conditions of words were stablished: interlingual homophones in Brazilian Portuguese (HFP), interlingual homophones in English (HFE), control words in Brazilian Portuguese (CTP), and control words in English (CTE). Considering discussions in the literature (Haigh; Jared, 2007; Dimitropoulou; Duñabeitia; Carreiras, 2011; Sousa, 2021), the effect of orthographic similarity on interlingual homophonic words has also been taken into account. It is not possible to investigate the effect of phonological overlap between these two languages in isolation, i.e., without any orthographic overlap. Thus, we can only limit the orthographic similarity of the critical words and use matched control words that share the same frequency and number of letters to isolate any graphemic effect (Brysbaert; Van Dyck; Van Poel, 1999).

As to the dependent variables of this study, the response time (RT) and the number of hits (accuracy) of the participants for each type of word were registered. These measures provide us with information about bilingual lexical processing. It is argued that the longer the response time, the higher the processing cost. Thus, RTs can indicate which experimental condition is more demanding for lexical access. On the other hand, the number of correct answers (accuracy) can ascertain the effect of the languages (L1/L2) of the bilinguals.

The following subsections describe the participants, the corpus, the instruments of this research and the data collection procedures.

3.5 Participants

In total, 48 participants submitted their responses to the research. From these, 44 were considered in the results analysis. The data from 2 participants were deleted because they did not conclude the last stage of the research: responding and sending their answers from a vocabulary proficiency test. One participant (P20) submitted their answers twice, so the second repeated data was excluded. Another participant had their data deleted because the PsyToolKit software registered they took more than 20 hours to conclude all the steps of the study. This probably happened because long pauses were taken between each step. In the end, the data from 44 participants remained for the results analysis.

Participants were invited to take part in the experiments through social networks, private communication, and via email. They were all native speakers of Brazilian Portuguese, volunteers who wished to contribute to the research, over the age of 18, who speak English as a foreign language. There was no requirement for them to be academics or university students, since one of the shortcomings of psycholinguistic studies on bilingualism is not reaching a sample of participants who are not linguistics or psychology academics or foreign language teachers. Since the invitations were shared online, one participant from Chile submitted their answers, but these were deleted because all subjects had to be Brazilian.

The participants were informed that the experiments were going to be conducted online, and that they had to use a laptop or a desktop computer to participate in the study, because it was not possible to complete the tasks using a mobile phone. After agreeing to participate, they received a link to the PsyToolKit software (Stoet, 2010, 2017), where the tasks were carried out and their responses recorded. Before starting the tasks, each participant was instructed to create an anonymous identification code with two letters and two numbers.

To control and analyze possible intervening variables, their language experience and educational background were reported and evaluated in a questionnaire. Participants were asked to answer biographical questions about their age, sex, and nationality. They were also asked to answer some linguistic questions concerning their use of language and to self-indicate their L2 proficiency in the four skills (listening, speaking, writing, and reading) in a scale from 1 to 7 as very bad, bad, fair, functional, good, very good, or excellent. These participant characteristics are showed on Tables 3 and 4.

Table 3 – Participants' general characteristics

Sample size	44	
Mean age	32.7 (19-67)	
Gender	21 men	23 women
City of birth	Fortaleza, CE (70.5%) Caucaia, CE (6.8%) Guaiúba, CE (2.3%) Maracanaú, CE (2.3%) Maranguape, CE (2.3%) Rio de Janeiro, RJ (4.5%) Alagoinhas, BA (2.3%) Caravelas, BA (2.3%) Jacobina, BA (2.3%)	

	Regente Feijó, SP (2.3%) São Paulo, SP (2.3%)	
Dominant hand	Right (95.5%)	left (4.5%)
Education level	Under graduation (45.5%) Master's degree (25%) Specialization (18.2%) Doctor degree (4.5%) High school (6.8%)	

Source: own authorship.

As observed in Table 3, the group of participants had more women than men and had a mean age of 32.7 with a range from 19 to 67, evidencing they were all adults. All participants were Brazilian and most of them (more than 70%) were from the city of Fortaleza in the state of Ceará. Only two of them (4.5%) reported to be left-handed. Concerning their education level, the majority reported to have concluded an under graduation course or a post-graduation course, and only 6.8% reported they stopped their education after high school. Participants also answered questions concerning their linguistic characteristics, which are showed on Table 4.

Table 4 – Participants' linguistic characteristics

Mean L2 Age of acquisition	13.25 (3-30)
Subjective L2 rating (1 – 7)	
Speaking	5.11 (1.73)
Listening	4.43 (1.56)
Writing	4.16 (1.52)
Reading	4.80 (1.30)
Way(s) in which L2 was acquired*	
L2 Immersion	6.82%
With friends	20.45%
At home	38.64%
At school	81.82%
At work	11.36%
Self-taught	72.73%

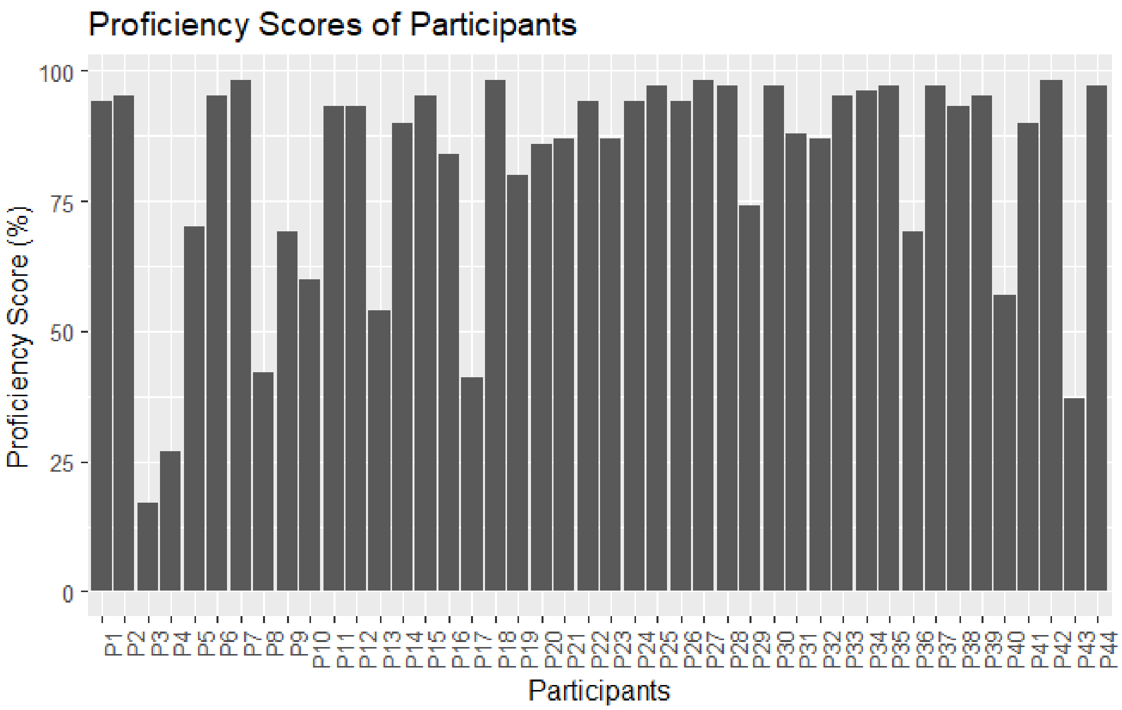
Source: own authorship.

*Percentages do not add up to 100 because participants could select multiple options.

The mean L2 age of acquisition of the group is 13.25, with a minimum of 3 and a maximum of 30. As to their subjective L2 rating for the four skills, the mean values on Table 4 show that participants generally classified their L2 speaking skills as good, listening and writing skills as functional, and reading skills as good. The great majority of participants reported that they acquired their L2 in the school environment (81.82%) or by self-learning (72.73%). Only 6.82% reported to have some kind of immersion experience with the L2, which well represents the profile of bilinguals in Brazil, who generally learn English as a second language through formal instruction classes or courses.

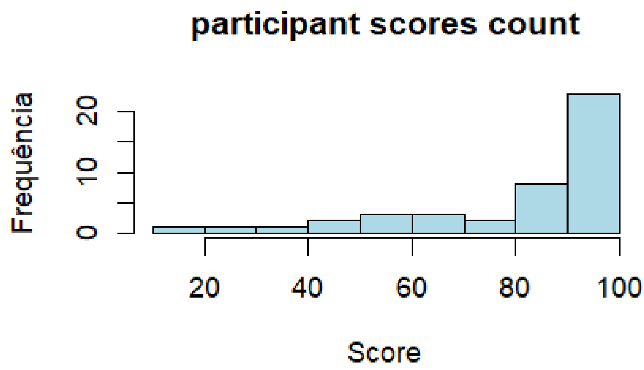
Moreover, the participants' L2 proficiency was assessed through a receptive vocabulary English test from the Research and Development Institute at the University of Leipzig in Germany (Institute for Test Results and Test Development - https://itt-leipzig.de/about-the-vocabulary-tests-2/?lang=en). Their individual scores are showed on Graph 1, which ranged from 17% to 98% of accuracy to the vocabulary proficiency test, with a mean value of 81.73%. Graph 2 shows most of the participants got a high score in the vocabulary proficiency test.

Graph 1 – Proficiency score of participants.



Source: own authorship.

Graph 2 - Histogram of proficiency scores



Source: own authorship.

The next subsection details the elaboration of the corpus of this research.

3.6 The corpus

Parting from an initial word list proposed by Sousa (2021), a set of interlingual homophones between Brazilian Portuguese and English was selected and updated to compose the critical stimuli list of the experimental tasks. It is worth restating that, for the purposes of this research, interlingual homophones are words that share high phonological overlap but no meaning across languages. Orthographic overlap may be present or limited across these words, but there is no semantic similarity.

Since the phonological repertoire of languages differ considerably, interlingual homophones do not necessarily have to be identical, but must share a high phonological similarity. In fact, in most cases, word pairs of interlingual homophone experiments differ in vowel and consonant sounds whose contrast may not be distinguished by bilinguals. As an example, Sousa (2021) cited the word pairs of bun /bʌn/ - *bonne* /bɔn/ and fibra /fiβra/ - *φύτρο* /fitro/ that were used in the studies of Haigh and Jared (2007) and Dimitropoulou, Duñabeitia, and Carreiras (2011), respectively. Although sharing a high phonological overlap across the languages under investigation, these examples do not have identical phonological representations. Even so, their high phonological similarity was the criterion used to consider them as interlingual homophones.

Likewise, even not being identical, the main criteria used to select the interlingual homophones of this study was their subjective high phonological similarity across Brazilian Portuguese and English. For example, the BP-En word pairs of pie – *pai* (/paj/ - /paɪ/) and past – *peste* (/pæst/ - /pɛstʃɪ/) sound very alike between the languages. The words aren't phonologically identical but are considered interlingual homophones because of their high similarity. They also present some orthographic overlap, but completely differ in meaning. The main question this study aims to answer is whether such words are processed differently than their controls by BP-En bilinguals in silent reading at the word level.

Considering that Brazilian Portuguese and English share the same alphabetical writing script, orthographical overlap may also interfere and should be controlled in the elaboration of the word lists. Care was taken to limit graphemic similarity and avoid semantic overlap as much as possible. Thus, no cognate and no interlingual homograph make part of the present corpus. Such conditions of words are evaluated in other studies of LabFoM (Borém, 2023; Gadelha; Toassi, 2022; Batista, 2022; Nogueira, 2022).

Furthermore, when selecting the control words, care was taken so that they would have the same initial letter as the interlingual homophone and that they would match as closely as possible on linguistic information for Zipf scale value, number of letters, part of speech, and orthographic similarity. Neighborhood density and family size of the words could not be controlled because such data information is not standardized across the English and Portuguese corpora databases that were used to select the words. Control words were selected via R (R CORE TEAM, 2023), using the Readxl and Tidyverse packages (WICKHAM; BRYAN, 2019; WICKHAM *et al*., 2019) by creating subsets and filtering words with matched characteristics from corpora databases.

Two corpora were used in the selection of stimuli: SubtlexUS and LexPorBR. The Open Lexicon – SubtlexUS was used to retrieve information for the English words of the corpus. SubtlexUS (Brysbaert; NEW, 2009) is a database of American English words based on English-US movies and TV series subtitles. It is based on 51 million words and brings information on the frequency of words with a new standardized frequency measure called the Zipf Scale. This measure ranges from 1 to 7, with low-frequency words being indicated by the values 1-3 and high-frequency words being indicated by the values 4-7.

To retrieve information for the Portuguese words, the Léxico do Português Brasileiro – LexPorBR was used. LexPorBR (Estivalet; Meunier, 2017) is a corpus which brings metalinguistic and psycholinguistic information on over 200,000 lexical entries from Brazilian Portuguese. It also brings Zipf Scale values for the words in Portuguese, which makes it possible to compare and match lexical frequencies of words from different corpora. Table 3 depicts the experimental stimuli of this research with their respective IPA phonological representations and Zipf Scale values.

Table 5 - Experimental stimuli list with IPA transcriptions and Zipf Scale values

Nº	HFE	ZIPF	CTE	ZIPF	HFP	ZIPF	CTP	ZIPF
1.	alley /ˈæli/	4,21	anger /ˈæŋgər/	4,29	ali /aˈli/	4,95	ato /ˈatu /	4,95
2.	can /kæn/	6,72	are /ɑr/	6,72	quem /kẽ/	5,85	qual /kwau/	5,56
3.	center /ˈsentər/	4,66	career /kəˈrɪr/	4,65	senta /ˈsẽĩta/	3,41	sedia /seˈʤia/	3,38
4.	color /ˈkʌlər/	4,6	coast /koʊst/	4,43	cola /ˈkɔla/	3,7	coca /ˈkɔka /	3,72
5.	cow /kaʊ/	4,41	cap /kæp/	4,27	cal /kaʊ/	3,39	cru /kɾu /	3,57
6.	day /deɪ/	5,9	dad /dæd/	5,7	dei /dei/	4,04	dou /dou/	4,04
7.	face /feɪs/	5,46	fire /ˈfaɪər/	5,33	fez /fes/	5,58	faz /fas/	5,66
8.	fail /feɪl/	4,39	flip /flɪp/	4,15	feio /ˈfeju/	4,01	fiel /fiˈɛu /	4,14
9.	few /fju/	5,48	far /fɑr/	5,34	fio /fio/	4,37	fia /fia /	4,28
10.	flew /flju/	4,19	flag /flæg/	4,24	flúor /ˈfluox/	2,66	floco /ˈflɔku /	2,21
11.	hood /hʊd/	4,19	bend /bɛnd/	4,18	rude /ˈxuʤɪ/	3,38	reto /ˈxɛtu /	3,24
12.	hoper/ˈhoʊpər/	1,77	sizer /ˈsaɪzər/	1,77	roupa/ˈxoʊpa/	4,53	rosto /ˈxostu /	4,64
13.	lack /læk/	4,25	flag /flæg/	4,24	leque /ˈleki/	3,74	lápis /ˈlapis /	3,76
14.	late /leɪt/	5,43	lost /lɔst/	5,44	leite /ˈleɪʧi/	4,72	lança /ˈlɐ̃sa /	4,78
15.	last /læst/	5,86	left /lɛft/	5,68	leste /ˈlesʧi/	4,81	lucro /ˈlukɾu /	4,81
16.	lay /leɪ/	4,76	low /loʊ/	4,77	lei /leɪ/	5,59	luz /lus /	5,01
17.	leader /ˈliːdər/	4,49	lesson /ˈlɛsn/	4,51	lida /ˈlida/	3,76	leio /ˈleɪu /	3,61
18.	loner /ˈloʊnər/	3,49	loans /loʊnz/	3,44	lona /ˈlõna/	3,51	lobo /ˈlobu /	3,52
19.	mail /meɪl/	4,57	meal /miːl/	4,46	meio /ˈmeɪu/	5,22	medo /ˈmedu /	4,93
20.	match /mætʃ/	4,69	madam/ˈmædəm/	4,64	mete /ˈmeʧɪ/	3,4	moro /ˈmɔɾu /	3,54
21.	mean /min/	6,09	make /meɪk/	6,14	mim /mĩ/	5,03	mal /mau /	5,01
22.	mice /maɪs/	3,82	mode /moʊd/	3,71	mais /maɪs/	6,53	como /ˈkõmu /	6,56
23.	never /ˈnɛvər/	6,13	after /ˈæftər/	5,83	neva /ˈneva/	2,36	neve /ˈnɛvi /	4,12
24.	paint /peɪnt/	4,57	plant /plænt/	4,44	pente /ˈpẽʧi/	3,13	parto /ˈpaxtu /	3,97
25.	pass /pæs/	5,03	pain /peɪn/	4,99	pés /pɛs/	4,63	paz /pas /	4,96
26.	past /pæst/	5,09	plan /plæn/	5,16	peste /ˈpesʧi/	3,8	pesos /ˈpezʊs /	3,9
27.	pie /paɪ/	4,46	pen /pɛn/	4,39	pai /paɪ/	5,22	pra / pɾa /	4,78
28.	sail /seɪl/	4,14	slap /slæp/	4,1	seio /ˈseɪu/	4,12	saia /ˈsaia /	3,97
29.	say /seɪ/	6,21	had /hæd/	6,22	sei /seɪ/	5,05	ser / sex /	6,36
30.	sat /sæt/	4,46	spy /spaɪ/	4,3	sete /ˈseʧi/	5,23	seis / seis /	5,41
31.	sell /sɛl/	4,96	step /stɛp/	5,07	céu /sɛʊ/	4,63	sol /sɔu/	4,81
32.	seller /sɛlər/	3,34	elbows /ˈɛlbəʊz/	3,39	cela /ˈsɛla/	3,99	copo /ˈkɔpu/	3,98
33.	shack /ʃæk/	3,75	shade /ʃeɪd/	3,78	cheque /ˈʃɛki/	4,42	chuvas/ˈʃuvas/	4,57

34.	shoot /ʃuːt/	5,22	throw /θroʊ/	5,11	chute /ˈʃuʧi/	4,18	chave /ˈʃavi/	4,4
35.	sue /suː/	4,47	sum /sʌm/	4,01	sul /sul/	5,27	sob /ˈsobi/	5,42
36.	under /ˈʌndər/	5,42	hands /hænd/	5,37	anda /ˈɐ̃da/	4,42	arma /ˈaxma/	4,58
37.	vain /veɪn/	3,81	vast /væst/	3,79	vem /vẽĩ/	5,44	ver /ˈvex/	5,46
38.	value /ˈvæljuː/	4,33	solve /sɑːlv/	4,29	velho /ˈvɛʎu/	4,89	vagas /ˈvagas/	4,72
39.	view /vjuː/	4,59	suck /sʌk/	4,5	viu /viʊ/	4,86	vir /vix/	4,65
40.	sigh /saɪ/	3,53	sung /sʌŋ/	3,54	sai /saɪ/	4,98	som /sõ/	4,93

Source: own authorship.

The corpus of critical stimuli consisted of 160 words: 40 interlingual homophones in English (HFE), 40 control words in English (CTE), 40 interlingual homophones in Portuguese (HFP), and 40 control words in Portuguese (CTP), as shown in Table 5. Sixty of these stimuli were used as target words in Experiment 1, equally distributed across conditions. Experiment 2 had 120 critical words: 60 stimuli that were used in Experiment 1, and 60 non-studied words that participants had not seen before. Besides, each task block of Experiment 2 had 10 practice trials.

The word length of critical words ranged from 3 to 6 letters long. Although a few words were not a perfect match of linguistic features due to the difficulty of controlling for many variables across different languages and different corpora, meticulous care and efforts were taken so that control words would have the same initial letter, word length, frequency, and part of speech as their interlingual homophone counterparts. Table 6 presents the descriptive statistics of word frequency on Zipf scale across conditions in the present corpus.

Table 6 - Descriptive statistics for frequency on Zipf scale across conditions

Condition	Mean	Median	SD	Minimum	Maximum	Range
CTE	4.58	4.43	0.91	1.77	6.72	4.95
CTP	4.34	4.48	1.00	1.51	6.56	5.05
HFE	4.64	4.53	0.92	1.77	6.72	4.95
HFP	4.31	4.40	0.94	2.36	6.53	4.18

Source: own authorship.

The critical stimuli were initially chosen based on their subjective phonological similarity. However, in order to compare words in a more objective way and validate their similarities, their phonological and orthographic overlap were calculated using the Interlanguage Normalized Levenshtein Distance (InLD), as proposed by Post da Silveira and Van Leussen (2015). It is important to note that this metric was used to confirm the similarities after the words had already been selected. The values from InLD were not used as a threshold to determine homophone status or exclude words from the list. This was primarily due to the challenge of finding and selecting appropriate words.

The InLD is discussed in detail in the Theoretical Framework section of this text. To enable the calculation of this metric to the words of this study, an adaptation of the traditional Levenshtein Algorithm was implemented in Python, parting from a web tutorial (André, 2024) and following the methodology of Post da Silveira and Van Leussen (2015). The script of the developed code can be found in Appendix A.

Beyond the critical stimuli presented in Table 5, the multiple choice translation task (Experiment 2) also counted on the use of distracting and confounding words to compose the translation options that participants had to select. Every target word had its translation equivalent as the correct option and two other words as incorrect options, that could be a confounder, a distractor, or a homophonic counterpart. Target words that were interlingual homophones had their homophonic counterpart from the other language as a confounder and another control word as a distractor, while control target words had a confounder and a distractor as incorrect options.

To illustrate, the English target word "can" had the words "poder", "quem", and "quais" as translation options to be chosen. In this example, the target word "can" is an interlingual homophone in English, the first word option "poder" is the correct translation answer in Portuguese, the second word "quem" is the Portuguese homophonic counterpart, and the third option "quais" is a distractor word. Likewise, for the target control word "are", the word "são" is the correct translation equivalent in Portuguese, and the words "foi" and "diz" are a confounder and a distractor, respectively. The order of the correct answer key in Experiment two was randomized across trials.

The word lists of Experiment 2 were carefully selected to ensure that translation trials were neither too difficult nor too simple to answer. For interlingual homophone targets, distractor words were selected to combine with the other homophonic counterpart in word length, Zipf scale frequency and part of speech. For control targets, distractors combined with the correct translation equivalent in word length and Zipf frequency, while confounders combined with the target word in orthographic similarity. The lists with target words and translation options with their respective characteristics for the two blocks of Experiment 2 can be found in Appendix B and C.

Having detailed the research corpus, the next subsection addresses the research instruments that were used in the present study.

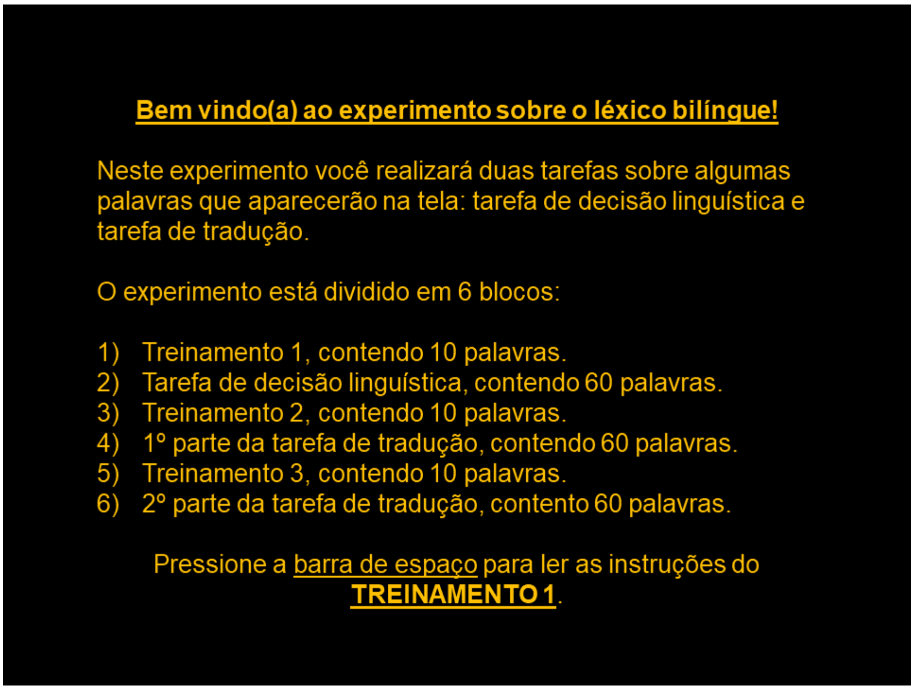
3.7 Research Instruments

To better illustrate how the experiments were carried out, this subsection details and explains the instruments of the present research: Language Decision Task, Multiple Choice Translation Task, English Receptive Vocabulary Test, and the Biographical and Linguistic Questionnaire.

3.7.1 Experiment 1 – Language Decision Task

After accepting the Consent form and creating the personal identification code, participants were greeted with the welcoming instructions of the first experimental task, as shown in Figure 2. The first screen explained the following steps to be concluded. Instructions were given in Portuguese, participants' L1.

Figure 2 – Welcoming screen



Source: own authorship.

Language decision is an experimental technique which requires participants to indicate which language a visual stimulus belongs to as quickly and as accurately as possible (Grainger; Dijkstra, 1992; Gadelha, 2021; Borém, 2023). In this type of experiment, the dependent main variables of interest are reaction time (RT) and accuracy. The purpose of this first task is to measure how quickly or easily bilinguals can process certain types of words in comparison to their controls in order to shed light into how cross-language overlap influences lexical access.

Before the actual language decision task, participants had a training session to familiarize themselves with the procedures. This step had 10 trials to practice the task, with 5 words from each language, as shown on Table 6.

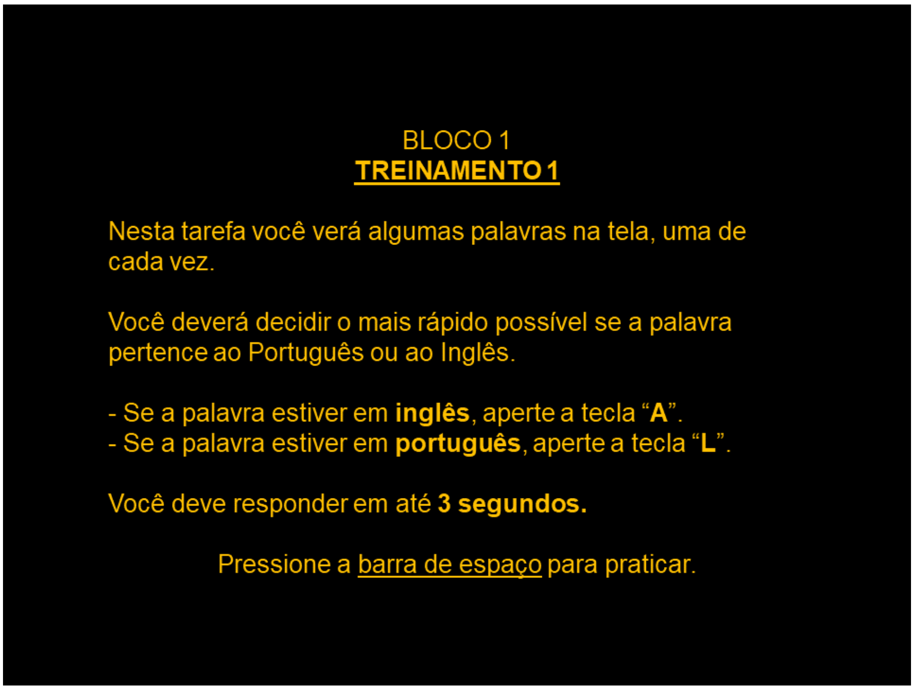
Table 7 - Experiment 1 - practice words

sell
sol
step
céu
flew
pés
flag
flúor
pain
floco

Source: own authorship.

As shown in Figure 3, participants had to indicate the language a word belonged to by pressing the keys "A" and "L" in the computer keyboard. After the training session, the instructions reappeared to start the actual experimental task. Besides the practice words, Participants responded to 60 stimuli in experiment 1, these were divided into 15 words for each condition (HFE, CTE, HFP and CTP). This first task took about less than 4 minutes to be concluded.

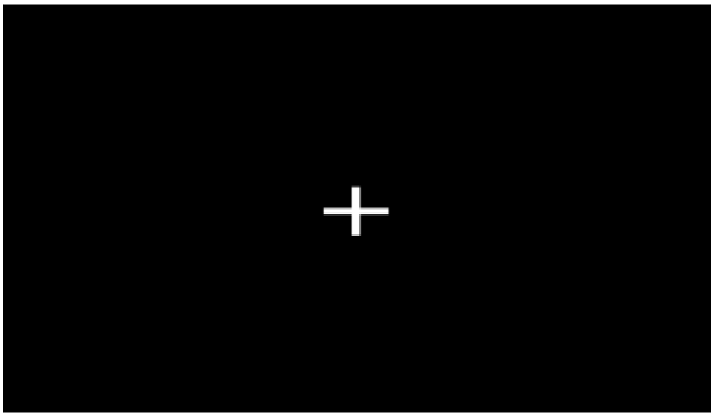
Figure 3 - Experiment 1 – language decision training



Sourse: own authorship.

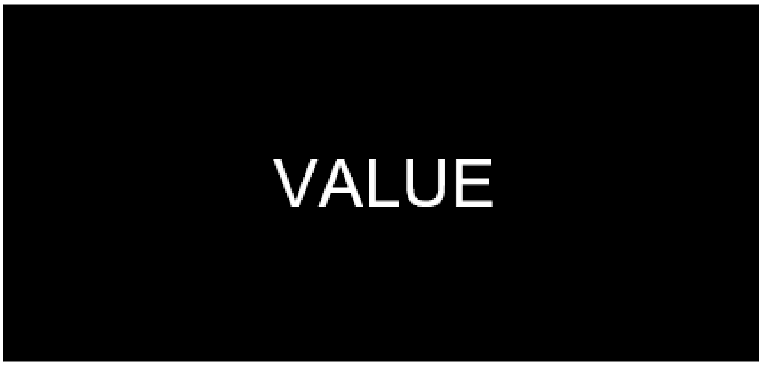
To avoid any effect of dominant hand, Experiment 1 was divided into two models: for Experiment 1A, the Portuguese language had to be indicated by pressing "A" and the English language by pressing "L". The reverse order was used for Experiment 1B, that is, Portuguese had to be indicated by pressing "L" and English by pressing "A". These two models of Experiment 1 were randomly assigned to the participants by the PsyToolKit software. Participants either responded to 1A or 1B. A fixation cross (+) that flashed in the screen for 500 milliseconds preceded the presentation of each stimulus word, which remained on the screen for 3000 milliseconds, which was the time limit participants had to respond to each word. Figures 4 and 5 illustrate the fixation cross and an example of stimulus word used in Experiment 1.

Figure 4 - Fixation cross



Source: own authorship.

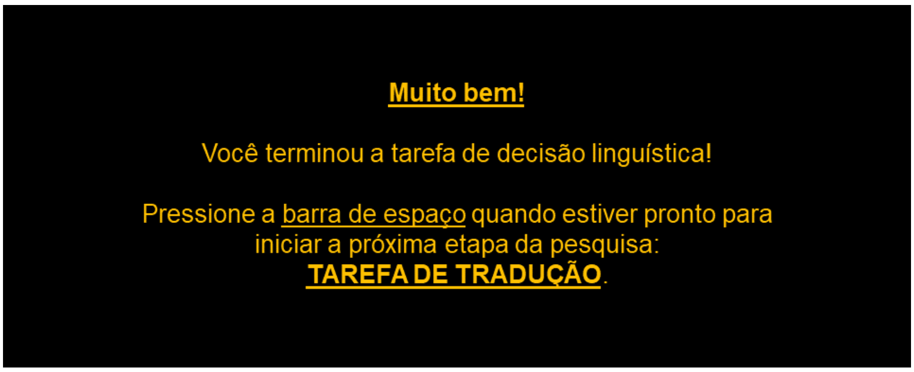
Figure 5 – Experiment 1 – Stimulus example



Source: own elaboration.

Participants had up to three seconds to make their language decisions for each word. When they finished responding to experiment 1, a thank you message appeared (Figure 6), and they were redirected to the second task when pressing the space bar key. Participants could make small pauses in between sessions if they wished to.

Figure 6 - Experiment 1 - Thank you message

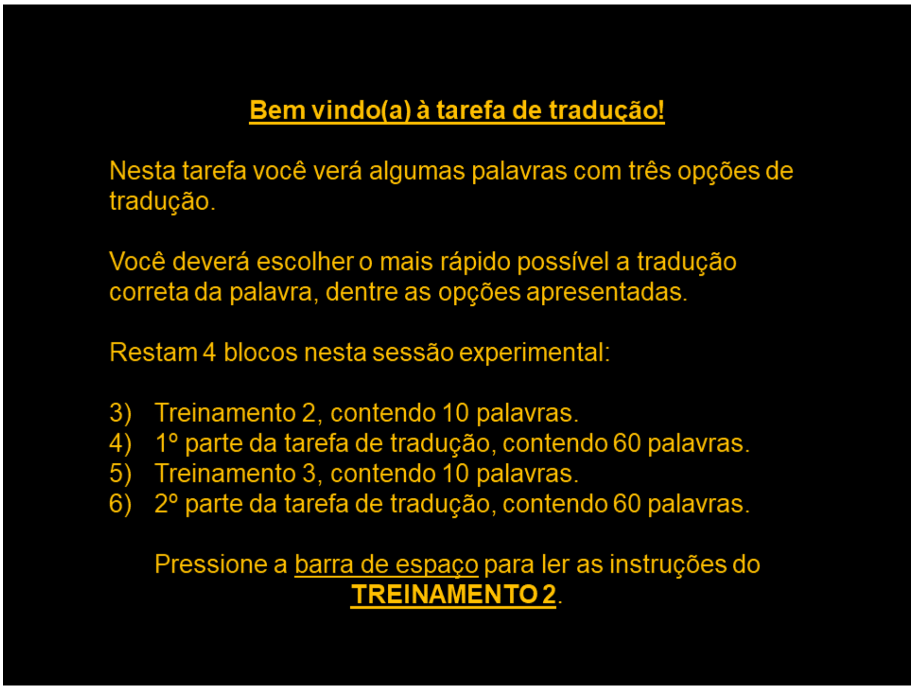


Source: own authorship.

3.7.2 Experiment 2 – Multiple Choice Translation Task

The translation task required participants to choose the correct translation for the presented words. Just like Experiment 1, there were training trials to familiarize the participants with the procedures and stimuli were preceded by a fixation cross flashing on the screen for 500 milliseconds. In this case, however, participants had up to five seconds to answer the trials, 2 more seconds in relation to Experiment 1. As illustrated in Figure 7, after pressing the space bar key at the end of the language decision task, the screen showed the welcoming instructions for the second task reminding the remaining steps of the experiment.

Figure 7 - Experiment 2 - Welcoming screen for the translation task



Source: own authorship.

Experiment 2 had the translation task divided in two parts. Experiment 2A required participants to translate L2 English words to Portuguese, and Experiment 2B required the reverse translation (L1 Portuguese words to L2 English). Differently from experiment 1, all Participants responded to both blocks 2A and 2B of experiment 2. The order of which part appeared first was randomly assigned to each participant by the PsyToolKit software.

For a better understanding of the experimental design, Table 8 depicts the number of words (stimuli trials) in each task of the study for each condition of words. Including the three training sessions, each participant responded to 210 trials in total (30 practice words and 180 critical stimuli, including studied words that appeared previously in experiment 1. In Experiment 2A, half of the words were seen in the previous language decision task (15 studied English homophones and 15 studied English controls – conditions SHFE and SCTE). The other half were not seen in the previous experiment (15 non-studied English homophones and 15 non-studied English controls – conditions NHFE and NCTE).

The same distribution was given to Experiment 2B with Portuguese words: 15 studied Portuguese homophones, 15 studied Portuguese controls, 15 non-studied Portuguese homophones, and 15 non-studied Portuguese controls (conditions SHFP, SCTP, NHFP, and NCTP). This design was built to verify repetition priming effects for interlingual homophones and control words.

Table 8 - Number of trials in each task

Condition	**Experiment 1 (linguistic decision)**	**Experiment 2 – block A (EN to BP translation)**	**Experiment 2 – block B (BP to EN translation)**
Practice	10	10	10
SHFE	15	15	-
SCTE	15	15	-
SHFP	15	-	15
SCTP	15	-	15
NHFE	-	15	-
NCTE	-	15	-
NHFP	-	-	15
NCTP	-	-	15
Total	70	70	70

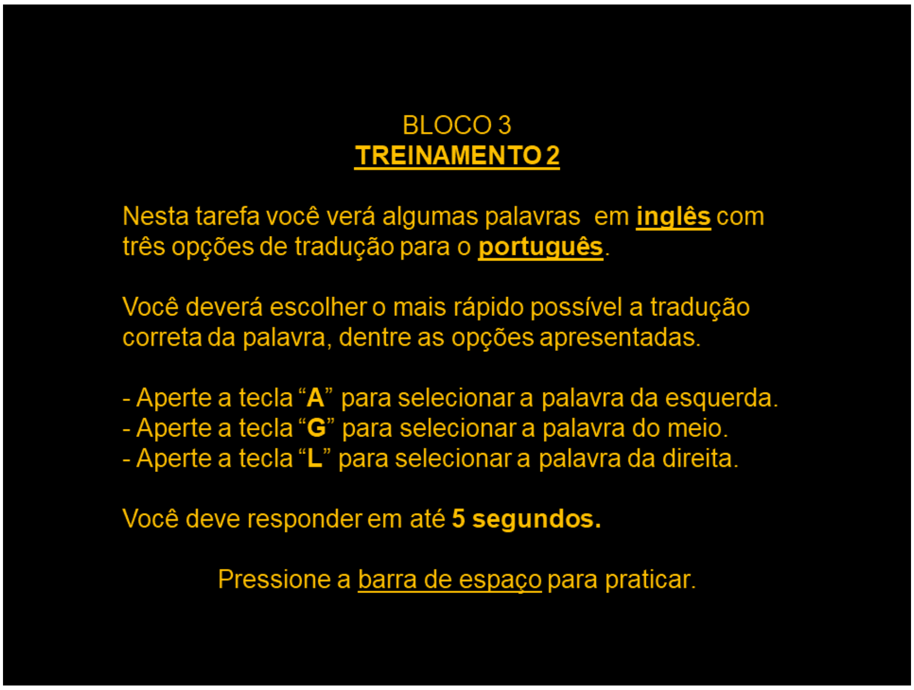
Source: own authorship.

To illustrate that words were equally distributed across the participants' languages, Table 8 specifies this distinction for word conditions ending with letter E (English) and P (Portuguese). However, the descriptive and inferential statistics compared only four conditions:

SHF (studied interlingual homophones), NHF (non-studied interlingual homophones), SCT (studied controls), and NCT (non-studied controls).

Moving forward, the training session instructions of Experiment 2 are depicted in Figure 8. In Experiment 2, participants had to indicate the correct translation of words by pressing the keys “A” for the word on the left side of the screen, “G” for the word on the middle, and “L” for the word on the left side. A trial example with a word stimulus and their options of translation are illustrated in Figure 9.

Figure 8 - Experiment 2 - Training instructions



Source: own authorship.

Figure 9 - Experiment 2 - example trial

Source: own authorship.

Both experiments 2A and 2B had a training session of 10 words, shown in Table 9. Block 2A consisted of making translation decisions to English words (L2 – L1 translation), and Block 2B had the reverse direction (L1 – L2 translation). Participants responded to both blocks of Experiment 2 in random order.

Table 9 - Experiment 2 - practice words

Experiment 2A training trials	**Experiment 2B training trials**
sell	chute
pass	lona
shoot	pés
loner	sol
throw	floco
loans	macio
cake	paz
pain	chave
step	lobo
flag	canção

Source: own authorship.

After the training session, the instructions reappeared to start the actual translation task. When the first part finished, another training was provided, followed by the second part with another translation order. The key each participant pressed was recorded by the PsyToolKit software and converted into the numbers 1, 2, and 3 for analysis. Reaction times and accuracy rates provided insights into the reading and translation processing cost of these individual words.

This second experiment took about 10 minutes to be done. Participants could make small pauses between blocks if they wished to. It is important to mention that four block orders were designed for participants to take the experimental tasks, as specified in Table 10. Each of the 4 block orders was assigned to 11 of the 44 participants.

Table 10 - Block orders and number of participants

Block order	Tasks	Number of participants
1	1A + 2A + 2B	11
2	1A + 2B + 2A	11

3	1B + 2A + 2B	11
4	1B + 2B + 2A	11

Source: own authorship.

3.7.3 English Receptive Vocabulary test

In order to evaluate participants' L2 proficiency, they were required to take the English Receptive Vocabulary test provided by the Research and Development Institute at the University of Leipzig in Germany. The test is available online and free of charge on their own blog homepage (Institute for Test Results and Test Development - https://itt-leipzig.de/about-the-vocabulary-tests-2/?lang=en).

The Institute for Test Results and Test Development offers receptive and productive language tests for 15 different languages. Since the participants do not need to write or speak in the present study, the receptive version of the test was used. The test is timed on its own website and lasts up to 30 minutes. Participants received and accessed the link of the test through the PsyToolKit software.

The tests assess reading proficiency by evaluating the vocabulary size of participants into 5 different levels based on high frequency vocabulary lists: 1000, 2000, 3000, 4000, and 5000. The results of the participants in the 5 different levels can be compared to the results of the Common European Framework of Reference for Languages (CEFR) as follows: success in the levels 1000 and 2000 indicate a reading proficiency of A2, knowing the most frequent 3000 words suggest a reading proficiency of B1, and knowledge of the most frequent 4000 words and the most frequent 5000 words suggest a reading proficiency of at least B2.

3.7.4 Biographical and Linguistic Questionnaire

Right after participants agreed with the consent form and create their identification code, they answered an individual questionnaire. First, at the bibliographic information section, they answered questions regarding their age, gender, place of birth, nationality, occupation, and their dominant hand (right or left).

Next, they answered questions about their linguistic experience. These concerned their education level, age when they started learning English, the context and place of their L2 acquisition process (whether it happened through immersion, with friends, at home, at school, at work or self-learning) and current language use. These characteristics are presented in the Pasrticipants section of the present study.

Since the experiments were carried out online through their own personal computers, participants also answered questions about their technological information, such as the type of machine that was being used, operating system, browser, mousepad, and keyboard type. This information was salved for later control of possible technical issues. In the following subsection the data procedures of this research are specified in detail.

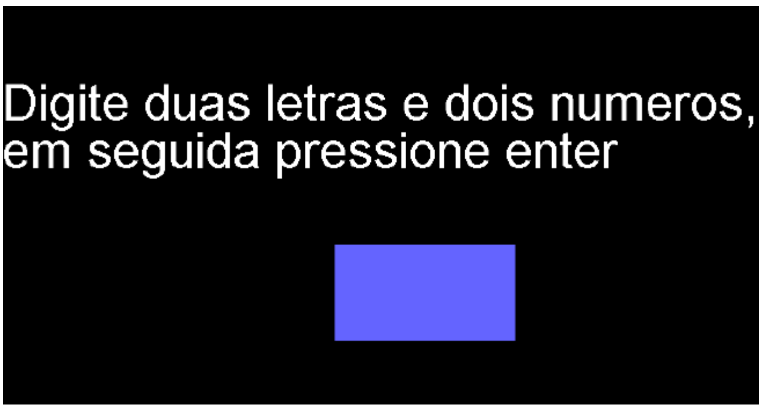
3.8 Data collection procedures

The present study has a quantitative experimental methodology applied in real time. In order to validate the research instruments and the experimental design, a pilot experiment of this research was conducted with members from the Laboratory of Phonetics and Multilingualism (LabFoM) from Universidade Federal do Ceará (UFC). A few graphic adjustments were made based on the feedback from the pilot study participants.

The experimental participants were recruited through private invitations, messages on social media, and via email. The experiments were carried out entirely online through a link from the PsyToolKit software (Stoet, 2010, 2017), that each participant received.

The first step the participants had to do consisted of accepting the Consent Form (Termo de Consentimento Livre e Esclarecido – TCLE). After agreeing to participate on the research voluntarily and anonymously, the second step consisted of the creation of an identification code with two letters and two numbers for posterior control of the collected data, as illustrated in Figure 7. All written instructions were given in Portuguese. The whole experiment took around 1 hour to 1 hour and a half to be completed.

Figure 10 - Identification code



Source: own authorship.

In the sequence, the third step of the research was answering the biographical and linguistic questionnaire, as described in subsection 3.7.4 *Biographical and Linguistic Questionnaire*. After filling in the questionnaire, participants could start the experimental tasks.

The fourth step consisted of completing the language decision task – Experiment 1. Participants had a training session with 10 words to familiarize themselves with the procedures of the task and then start the actual language decision experiment. In this task, they had to decide as quickly as possible the language of the presented words, as described in subsection 3.7.1 *Experiment 1 – Language Decision Task*. The words presented in this experiment were from four conditions: interlingual homophones in English (HFE), interlingual homophones in Portuguese (HFP), control words in English (CTE), and control words in Portuguese (CTP).

The fifth step was the completion of the translation task - Experiment 2. In this experiment, participants had to choose the correct translation of the presented words among three options that appeared on the screen, as described in subsection 3.7.2 *Experiment 2 – Multiple Choice Translation Task*. Experiment 2 was divided in two blocks, each one with a different order of translation. All participants responded to both blocks in randomized order.

At last, participants took the Receptive English Vocabulary test, as described in subsection 3.7.3 *English Receptive Vocabulary Test*. They accessed the link of the Test through the PsyToolKit software (Stoet, 2010, 2017). When they finished the test, a result certificate was provided, which participants needed to save and send to the researcher via email. Two participants didn't conclude this last step, so they were not considered in the results analysis. One may ask why the proficiency task was left for the last stage. This happened in order to avoid possible priming effects in experiments 1 and 2, considering the proficiency test was also a vocabulary task.

3.9 Data processing and analysis procedures

This research can be classified as a quantitative study. The dependent variables of interest from experiments 1 and 2 are the reaction time (RT) and the accuracy of the participants in the language decision and translation tasks. Despite not disregarding the influence of many other predictors such as participants and word characteristics, the independent variables of interest to respond the research questions of this study are particularly the conditions of words in each experiment. The PsyToolKit software compiled the responses of each participant in numerical values, which were imported to two excel files for statistical analysis.

It is worth recalling that each participant responded to 60 words in experiment 1, so each line of the excel table for experiment 1 is equivalent to a trial with a stimulus word that received the participants' response. Response data for the practice words in the training sessions were not computed. To get a general idea and better map out the present investigation, the table from experiment 1 contained 2641 lines with the following data for each of the 44 remaining participants:

a) BLOCKORDER – number of the block order that was designated to participants randomly, divided in 4 combinations of tasks, as specified in Table 10 - *Block orders and number of participants*.
b) TASKNAME – The name of the task participants did regarding the keyboard keys they needed to use to make language decisions. Participants had to press "A" for English and "L" for Portuguese in Task1A, while the reverse order was used in Task1B. These tasks were assigned randomly, and participants did only one of them, as explained in subsection 3.7.1 *Experiment 1 – Language Decision*.
c) COD – an anonymous code with two letters and two numbers created by the participants for their identification and data control. These were later renamed as P1, P2, P3, etc.
d) TABLEROW – a number indicating the line in the word list from which the software randomly selected the stimuli to display on screen. In other studies, this may be referred to as "ID".
e) WORD – the stimulus word that appeared on screen for participants to decide which language it belonged to.
f) CONDITION – the condition of the stimulus words, divided into the categories of interlingual homophones in English (HFE), control words in English (CTE), interlingual homophones in Portuguese (HFP), and control words in Portuguese (CTP).
g) LETTERS – number of letters of each word.
h) ZIPF_EN – frequency on Zipf scale for the English words.
i) ZIPF_PT - frequency on Zipf scale for the Portuguese words.
j) TABLEKEY – the correct answer for the trial stimulus with the numbers 1 and 2 indicating the keyboard keys "A" and "L" or vice-versa in tasks 1A and 1B.

k) KEY – The keyboard key the participants pressed to make language decisions indicated by the numbers 1 and 2 for "A" and "L" or vice-versa.
l) STATUS – categorical number specifying if the participant's answer to the stimulus word of that trial was correct (status 1), incorrect (status 2) or exceeded the time limit of 3 seconds (status 3).
m) RT – time in milliseconds that each participant took to respond to the stimulus word displayed on screen.

The items above specify the columns of the table generated by the PsyTooKit software for the results of Experiment 1. The table generated with the data from experiment 2, on the other hand, contained a total of 5281 lines, considering that each of the 44 remaining participants responded to 120 words. Just like the table from experiment 1, responses to practice words from the training session were not computed. Also, each line of the table for experiment 2 is equivalent to a word trial with information regarding all the previous variables discussed in items a) to n) above, with a few differences and additions, specified as follows:

a) BLOCKORDER – number of the combination order of tasks, just like experiment 1 and specified in Table 10.
b) TASKNAME – the name of the task participants did for the specific word trial line, divided into Task2A (English to Portuguese translation) and Task2B (Portuguese to English Translation). Unlike experiment 1, participants did both blocks in experiment 2, with randomized order of which was assigned first.
c) COD – anonymous code created by the participants for their identification and data control, just like experiment 1. These were later renamed as P1, P2, P3, etc.
d) TABLEROW – a number indicating the line in the word list from which the software randomly selected the stimuli to display on screen. This word list was not the same as experiment 1. Each experiment had its own word list. In other studies, this variable is commonly named "ID".
e) WORD – the stimulus word which participants had to translate by selecting one of the 3 available options on screen.
f) CONDITION – the condition of the stimulus word to be translated, which was divided into four categories: studied interlingual homophones (SHF), studied controls (SCT), non-studied interlingual homophones (NHF), and non-studied controls (NCT). Studied and non-studied words refer to words that were present or not in the first experiment, as specified in subsection 3.7.2 – *Experiment 2 – Translation Task*.

g) LETTERS – number of letters of the stimulus word that required a translation choice.
h) ZIPF – frequency in Zipf scale of the stimulus word that required a translation choice.
i) OPT1 – the first response option, which was displayed on the bottom left side of screen.
j) COND1 – the condition of the first option word, divided into four categories: translation (the correct response), confounder (a confounding word), distractor (a distractor word), and homophone (interlingual homophone counterpart).
k) OPT2 – the second response option, which was displayed on the bottom central side of screen.
l) COND2 – the condition of the second option word, divided into four categories: translation, confounder, distractor, or homophone.
m) OPT3 – the third response option, which was displayed on the bottom right side of screen.
n) COND3 – the condition of the third option word, divided into four categories: translation, confounder, distractor, or homophone.
o) TABLEKEY – the correct answer for the trial stimulus with the numbers 1, 2, and 3, indicating the keyboard keys "A", "G", and "L". Participants needed to press these keyboard keys to choose among the response options on the left, central, or right bottom side of screen.
p) KEY – The keyboard key the participants pressed to make translation decisions indicated by the numbers 1, 2 and 3 for "A", "G", and "L".
q) STATUS – categorical number specifying if the participant's answer to the stimulus word was correct (status 1), incorrect (status 2) or exceeded the time limit of 5 seconds (status 3).
r) RT – time in milliseconds that each participant took to select a translation option to the stimulus word on screen.

After all the data was saved, the excel files provided by the PsyToolKit software were treated and analyzed via R (R CORE TEAM, 2023) using mixed-effects regression models within the lme4 package (BATES *et al.*, 2015). The next chapter details the results and data analysis of this study.

4 RESULTS AND DISCUSSION

This chapter provides the results analysis concerning the cognitive processes involved in recognizing BP-En interlingual homophones in two experimental tasks from a psycholinguistic perspective. The present study aimed to investigate how BP-En bilinguals process and respond to words that share high phonological overlap across their first and second languages in comparison to control words which have no interlingual overlap in phonology across languages. Specifically, the data analysis was carried out to respond to three research questions:

- RQ1 – What is the processing cost of reading isolated BP-En interlingual homophones in relation to control words in a language decision task?
- RQ2 – Is there a repetition priming effect for isolated BP-En interlingual homophones in a translation task?
- RQ3 – Is there a difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2?

By including matched control words that were selected to be as close as possible in characteristics such as number of letters and word frequency, the analysis aimed at comparing responses to critical experimental stimuli and their matched controls to verify whether any difference in reaction times (RTs) or accuracy could be attributed to the interlingual ambiguity of these words. It is worth noting that the scope of this analysis is limited to the comparative analysis of accuracy rates and reaction times (RTs) across interlingual homophones in comparison to control words.

Using an online experimental methodology in real time through the PsyToolKit software (Stoet, 2010, 2017), this study examined how bilinguals who have Brazilian Portuguese and English as their L1 and L2 deal with interlingual homophones between these two languages in two different experimental tasks: a language decision task (Experiment 1) and a multiple-choice translation task (Experiment 2). In the first experiment, participants had to decide as quickly and as accurately as possible if the language of the presented word was English or Portuguese by pressing the keyboard keys “A” and “L”. This first task had four conditions of words: HFE (interlingual homophones in English), HFP (interlingual homophones in Portuguese), CTE (control words in English), and CTP (control words in Portuguese).

In the second experiment, participants had to select the best translation option for the presented word using the keys “A”, “G”, and “L”. In this task, half of the words that required a translation choice had already been seen in experiment 1 and the other half were new words that had not been presented previously. These words from Experiment 2 were categorized as SHF (studied homophones), SCT (studied controls), NHF (non-studied homophones), and NCT (non-studied controls).

To recapitulate, a total of 48 participants (49 observations with one repeated answer) submitted their responses to the two experiments of this research, but only 44 participants remained for the final analysis, as explained in subsection 3.5 *Participants*. The data of two participants were excluded because they did not send their proficiency test results, one participant wasn't Brazilian, and another exceeded the time limit to conclude the tasks. A few participants had proficiency scores that were below average, but their data was maintained for the sake of potential exploratory analysis that are beyond the scope of the present paper but can be investigated in the future. In the progress of the analysis, it was observed that one of the remaining participants had an atypical behavior in Experiment 1, which implicated in the exclusion of their data for the accuracy analysis, but not for the RT analysis.

The detailed analysis of the obtained results for accuracy and reaction time (RT) in the two experiments is presented in the following subsections of this chapter. The next subsection addresses the visual and descriptive inspection of the dependent variable of accuracy.

4.1 Results of Experiment 1 – Language Decision Task

This subsection details the description and results analysis of the first experiment: Language Decision Task. In this experiment, participants had to decide which language the presented stimulus belonged to by pressing the keys "A" and "L" on the computer keyboard. The PsyToolKit software provided a text table file with 2640 observations, each one indicating responses from all participants to 60 stimulus words that were divided into for conditions: HFE (interlingual homophones in English), HFP (interlingual homophones in Portuguese), CTE (control words in English), and CTP (control words in Portuguese). The 10 practice trials were not registered nor considered for analysis.

The PsyToolkit software registered reaction times (RTs) in milliseconds and status of participants' responses as the categorical numbers 1, 2 and 3, indicating correct answers, incorrect answers, and time-out answers, respectively. The following subsection presents the descriptive analysis of the first dependent variable of interest from Experiment 1: Accuracy.

4.1.1 Descriptive analysis - Accuracy

The text table file obtained from PsyTooKit with the data for Experiment 1 was converted into an excel file and loaded into the software RStudio to carry out the analysis (R Core Team (2024). The initial steps of the analysis involved using descriptive statistics and data visualization to understand the data distribution, inspect trends, and identify possible associations, which could be tested for statistical significance subsequently.

The excel file from Experiment 1 loaded in RStudio had 2640 lines, each equivalent to a trial from the experimental task of language decision. Recall that 44 participants responded to 60 words in Experiment 1. From the total observations, only 4 trials exceeded the time limit of 3 seconds to respond to the stimulus word and only 142 trials had incorrect answers. Table 10 depicts the quantity of response trials for each categorical status: correct answers (status 1), incorrect answers (status 2), and time-out answers (status 3). The fact that most of the participants' responses were accurate indicates that the experimental task was well designed and free of technical problems to save the data properly.

Table 11 - Experiment 1 - Data status

1	**2**	**3**
2494	142	4

Source: own authorship.

After verifying the data status, a subset only with correct (1) and incorrect answers (2) was created to start the analysis of the accuracy variable. Thus, 2636 observations remained to be examined. Transformed into proportion, it is possible to observe that the total accuracy rate for experiment 1 was 94.61% of correct answers, in comparison to 5.39% of errors.

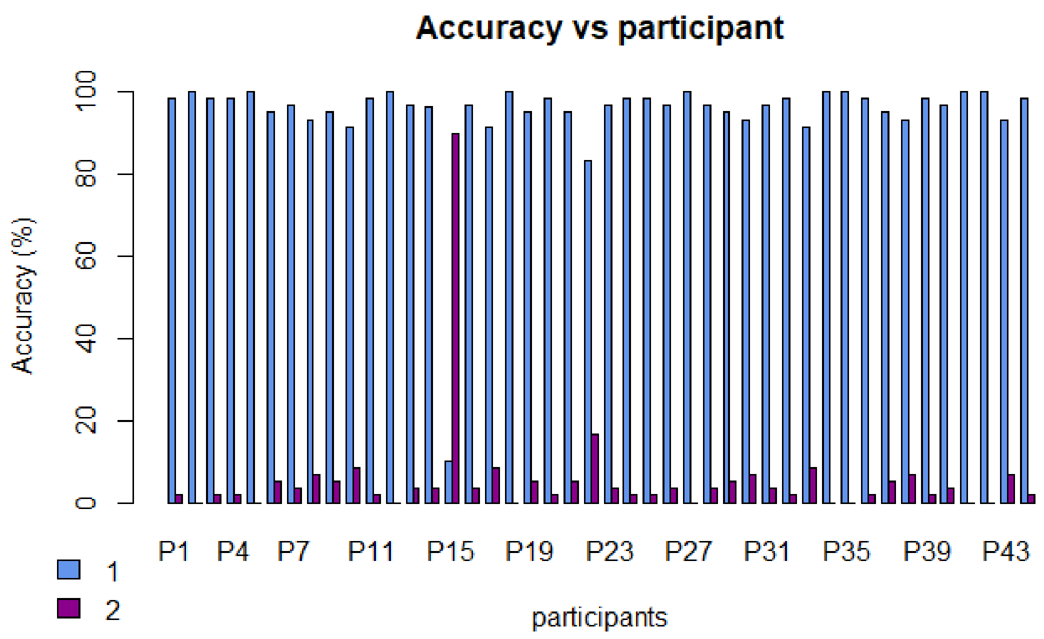
Table 12 - Experiment 1 - Status proportion

1	**2**
94.61	5.39

Source: own authorship.

Having detailed the overall accuracy rates for all the responses of experiment 1, it is also important to check how this dependent variable changes across participants. According to Graph 3, participant P15 had much more incorrect answers than correct ones. Considering that the proficiency score of this participant was 95% and their reaction times did not have extreme values, it was assumed that they misinterpreted the instructions of the first experimental task and used the incorrect keyboard keys to make the language decisions for the presented words.

Graph 3 - Experiment 1 - Accuracy per participants

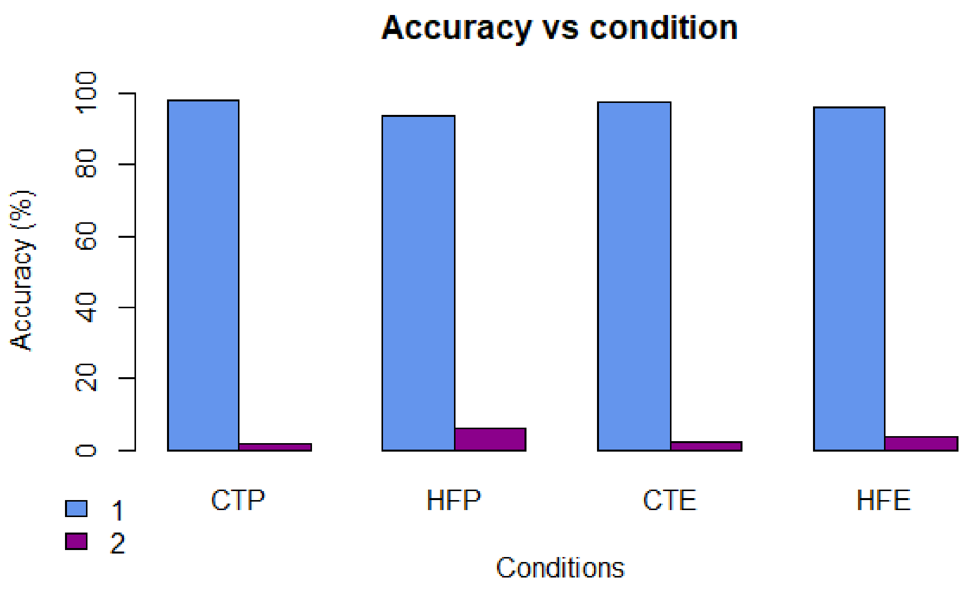


Source: own authorship.

Because of this problem with the responses of Participant P15, their data was discarded for the accuracy analysis of Experiment 1 but maintained for the RT analysis of Experiment 1 and the accuracy and RT analyses of Experiment 2. Taking this into account, another subset data was created without the responses of Participants P15. Thus, the new data table contained a total of 2,576 observations.

Having excluded time-out answers and the trials of participant P15 for accuracy, the status variable could then be inspected per condition of words. Graph 4 shows the accuracy percentage for each of the four conditions of Experiment 1. It is possible to observe that control words generally had higher accuracy rates than interlingual homophones, and this difference appear to be more salient for Portuguese words than for English words. The graph shows the percentages of correct answers (status 1) and errors (status 2).

Graph 4 - Experiment 1 - Accuracy per condition



Source: own authorship.

Evidently, there were more correct responses than errors in all stimulus conditions in Experiment 1. The exact proportions can be better visualized in Table 13. It is possible to observe an advantage for control words in Portuguese (CTP) with a total of 632 correct answers (98.29%), followed by control words in English (CTE) with a total of 631 correct answers (97.83%). From all conditions, Portuguese interlingual homophones (HFP) had the lowest accuracy percentage with a total of 604 correct answers (93.79%), followed by English interlingual homophones (HFE) with a total of 621 correct answers (96.43%). Interestingly, the accuracy rates across languages are closer for control words than for interlingual homophones across languages.

Table 13 - Experiment 1 - Accuracy percentage per condition

	CTP	**HFP**	**CTE**	**HFE**
1	98.29	93.79	97.83	96.43
2	1.71	6.21	2.17	3.57

Source: own authorship

HFPs evidently had less correct answers in relation to the other conditions, possibly suggesting that linguistic decisions for Portuguese interlingual homophones were more difficult in relation to their controls and English words. CTPs had 28 more correct answers than HFPs, a difference of 4.5%, and CTEs had 10 more correct answers than HFEs, a difference of only 1,4%.

Taking these values and comparisons into account, it appears that interlingual homophones had indeed a greater processing cost in relation to control words when it comes to the dependent variable of accuracy. However, only inferential statistics can tell if these differences across conditions are significant or not. The next subsection delves deeper in the exploration of these results conducting inferential analysis on the dependent variable of accuracy from Experiment 1.

4.1.2 Inferential statistical analysis - Accuracy

In order to examine the relationships between the accuracy of conditions of words from Experiment 1 more objectively, the inferential statistical analysis was conducted through Generalized Linear Mixed Effects Models. The choice of running this type of model to analyze accuracy across conditions was taken considering that Status of participant's answers is a binary variable in this study, with factors 1 and 2 for correct and incorrect answers, respectively. Moreover, the data obtained in the present study is the result of repeated measures by items and participants, whose variability is taken into account in mixed effects models.

Aiming to evaluate possible associations between the dependent and independent variables of interest in Experiment 1, a generalized mixed model (glmer) was employed in RStudio using the "lme4" package (BATES *et al*., 2015). The model was fitted with the formula "m1 <- glmer (data = dd, STATUS ~ CONDITION + (1|COD) + (1|WORD), family = binomial (link = "logit"))". In this formula, "dd" corresponds to the dataset of experiment 1 without time-out answers and without the data of participant P15. "STATUS" corresponds to the binary accuracy variable, specified as 1 (correct answer) or 2 (incorrect answer). "CONDITION" corresponds to the independent variable of interest, and the arguments "(1|COD) + (1|WORD)" correspond to participants and words included as random effects.

It is important to note that adding random slopes for participants or words in the model failed convergence, so the presented code is the final formula that was used. Before running the model, the condition CTP was set as the intercept or reference level condition, meaning that the accuracy estimates for the other three conditions were calculated in comparison to CTP. After running the model, the following table was provided summarizing its results.

Table 14 - Experiment 1 – Generalized mixed model (CTP as intercept)

	STATUS		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	0.01	0.00 – 0.02	**<0.001**
CONDITION [HFP]	3.67	1.14 – 11.78	**0.029**
CONDITION [CTE]	1.43	0.41 – 4.91	0.574
CONDITION [HFE]	2.09	0.63 – 6.95	0.229
Random Effects			
σ^2	3.29		
τ_{00} WORD	1.30		
τ_{00} COD	0.54		
ICC	0.36		
N COD	43		
N WORD	60		
Observations	2576		
Marginal R^2 / Conditional R^2	0.043 / 0.386		

Source: own authorship.

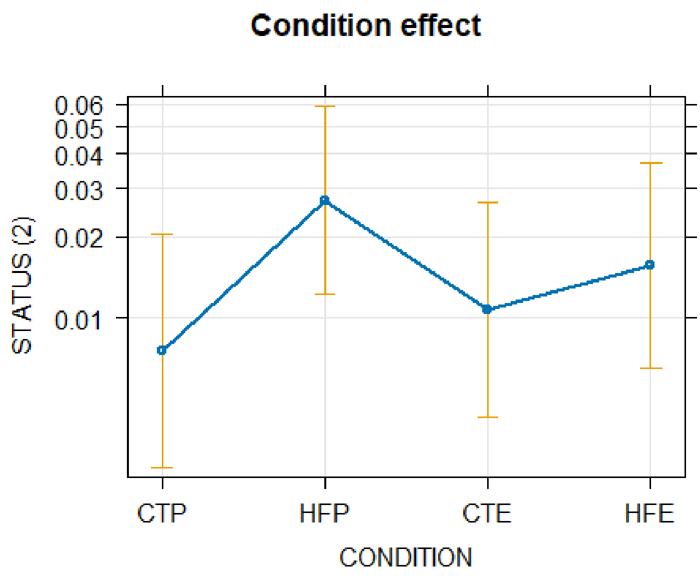
To properly understand the values brought in the summary of the model (Table 14), it is worth noting that the odds ratios correspond to a probability measure of the response variable being 2 (incorrect) in comparison to 1 (correct) as a function of the stimulus conditions. This is how generalized regression models function by default with binary response variables (Godoy, 2019). In log scale, odd ratios between 0 and 1 represent a negative association between predictors and response variables, while odds ratios greater than 1 indicate a positive association.

Thus, the odds ratio of 0.01 for the intercept condition (CTP) indicates a very low association between this condition and the occurrence of incorrect answers (status 2). This means CTPs increase the likelihood of correct answers and have high accuracy rates in comparison to the other conditions. However, these differences only reached significance between CTP and HFP, as evidenced by the p-value <0.05.

When condition changes from the baseline CTP to HFP, the odds ratio of an incorrect response increases to 3.67 in a wide confidence interval (CI) ranging from 1.14 to 11.78. Despite the uncertainty of the wide CI, its values did not cross zero and therefore the odds of an incorrect answer are significantly higher for HFP than CTP, i.e. CTPs had significantly higher accuracy than HFP.

On the other hand, when the predictor condition changes from CTP to CTE or HFE, there's a slight increase in the odds of an incorrect answer, but the CIs and the p-values indicate no significant difference for accuracy between CTP and these other conditions for English words. Graph 5 plots the condition effect size from the model with CTP as the intercept.

Graph 5 - Experiment 1 - Condition effect on response status



Source: own authorship.

Recall that the values indicate the likelihood of incorrect answers (status 2) across conditions. From the plot, it is observable that the biggest effect size occurred for the HFP condition, indicating that interlingual homophones in Portuguese had significantly more errors (less accuracy) than the baseline condition of control words in Portuguese (CTP). Moreover, the slight increase in error rates observed when condition changes from CTP to CTE or HFE was not statistically significant.

Analyzing these associations, the model also suggests that the difference between CTE and HFE for accuracy is not significant, but it is worth testing it in a more straightforward way. Therefore, the same generalized mixed effects model was run one more time with the condition HFE as the baseline intercept. This allows more objective comparisons between interlingual homophones in the two languages (HFP and HFE), and between English controls and homophones (CTE and HFE). The comparisons contrasts were changed in RStudio using the “levels” function so that the intercept condition could be HFE instead of CTP, and then the model was run with the same formula. The results are shown in Table 14.

Table *15* - Experiment 1 – Generalized mixed model (HFE as intercept)

	STATUS		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	0.02	0.01 – 0.04	**<0.001**
CONDITION [HFP]	1.76	0.60 – 5.14	0.304
CONDITION [CTE]	0.68	0.22 – 2.16	0.514
CONDITION [CTP]	0.48	0.14 – 1.59	0.229
Random Effects			
σ^2	3.29		
τ_{00} WORD	1.30		
τ_{00} COD	0.54		
ICC	0.36		
N COD	43		
N WORD	60		
Observations	2576		
Marginal R^2 / Conditional R^2	0.043 / 0.386		

Source: own authorship.

Again, the odds ratio of 0.02 indicates the intercept condition (HFE) had a negative association with the occurrence of incorrect answers in Experiment 1. This is also true for the control conditions both in English and in Portuguese. Consistent with descriptive statistics discussed previously, these values show that the conditions HFE, CTP and CTE had high accuracy rates (low occurrences of incorrect answers) as shown in Table 13 - *Experiment 1 - Accuracy percentage per condition*. Importantly, the model predicts no significant difference for accuracy between HFE and CTE in experiment 1, even though HFP was statistically different from CTP.

The random effects show little variation between participants and between words among the 2576 observations concerning accuracy. The Marginal R2 which considers the total variance of the fixed effects reached a score of 0.043, thus explaining 4% of these effects, while the conditional R2 which indicates the total variance with the fixed and random effects together showed a score of 0.386, thus explaining approximately 38% of the interactions.

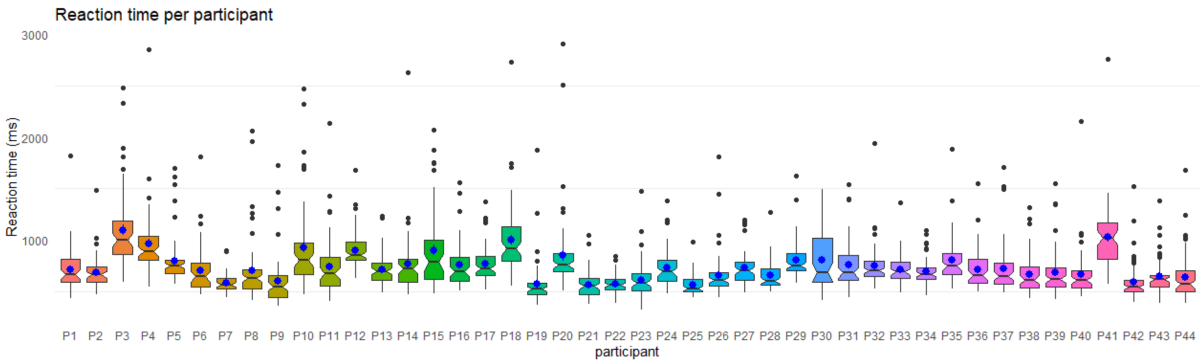
Although the word conditions may be processed differently, the results of the generalized mixed model presented in this section suggest that there is no significant difference between conditions concerning accuracy in this particular language decision task, except between Portuguese interlingual homophones and Portuguese controls (HFP and CTP). Interestingly, the accuracy rates of English interlingual homophones and controls (HFE and CTE) were not significantly different. In addition, interlingual homophones (HFP and HFE) and control words (CTP and CTE) did not significantly differ in accuracy across languages.

These findings partially support the first hypothesis of this study, which predicted higher processing cost for interlingual homophones in comparison to control words, and are against hypothesis 3, which predicted stronger inhibition effects for interlingual homophones from the participants' L2 (English). Yet, it is important to analyze another factor in order to draw robust conclusions on this matter. The next subsection delves deeper in the investigation of the effect of interlingual homophones by analyzing the dependent variable of reaction time (RT) in Experiment 1.

4.1.3 Descriptive analysis – Reaction time

This analysis considered reaction times both for correct and incorrect answers. Given the problem with the accuracy data of participant P15 discussed in subsection 4.1.1 *Descriptive analysis - Accuracy*, this investigation started by inspecting RTs per participant.

Graph 6 - Experiment 1 - RT per participant



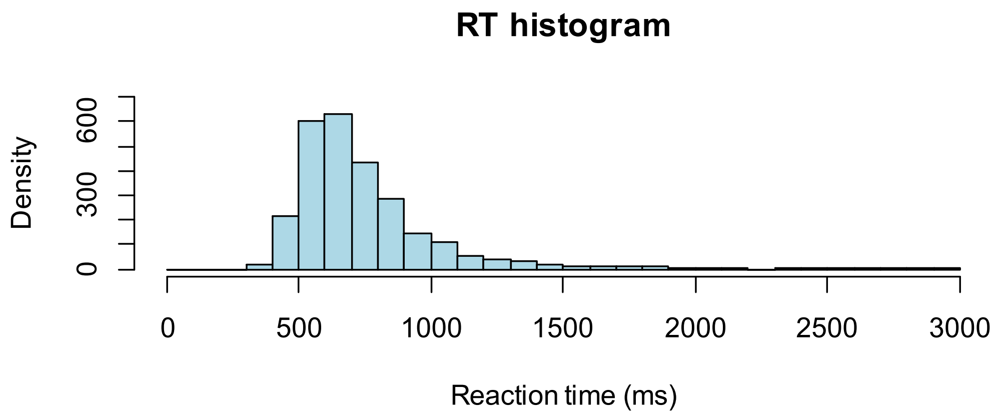
Source: own authorship.

Graph 6 shows that the RTs of participant P15 did not have extreme values or any discrepant behavior in comparison to the rest of participants, so it was assumed that they used the wrong keys to answer the trials. If participant P15 misinterpreted the instructions of Experiment 1 and used the wrong keys for to respond to all the trials, their correct answers would have been registered with status 2 instead of 1. Nevertheless, this mistake would not have affected their reaction time data. For this reason, participant P15 remained in the dataset for the present RT investigation.

Still from Graph 6, it is possible to observe that most of the RT data was below the time interval of 1000 milliseconds, although there were some RTs almost reaching the limit of 3 seconds which participants had to answer the trials from Experiment 1. In addition, considerable variability can be observed among and within participants in the RT data. Recall that the 4 trials which exceeded the time limit of 3 seconds were excluded from the dataset previously.

The following histogram illustrates the distribution of reaction times for all the 2636 observations of Experiment 1, including the data of participant P15 and both correct and incorrect answers.

Graph 7 - Experiment 1 - Histogram of reaction time

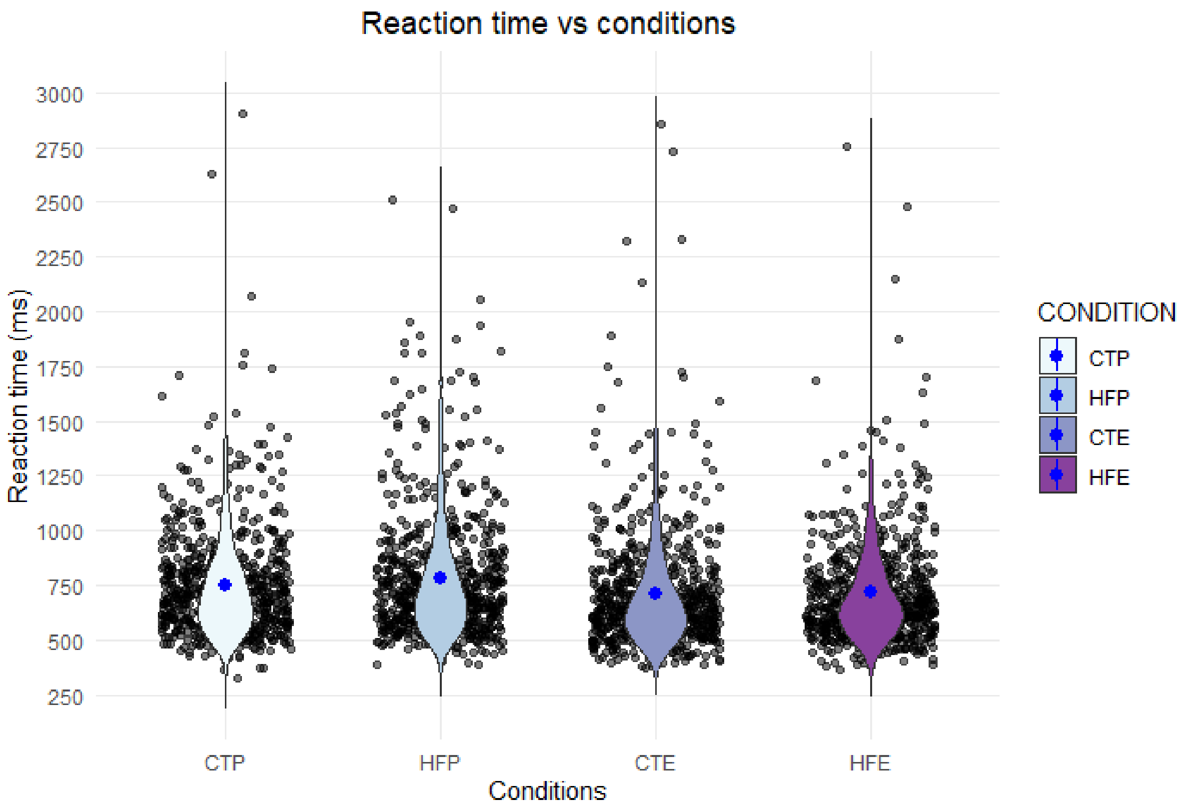


Source: own authorship.

As can be observed, the histogram shows more specifically that most of the RT data was between 500 and 700 milliseconds. There was a predominance of reaction times within the range of 1000 ms, gradually decreasing until the limit of 3000 ms. Only a few data points were above the distribution of 2000 ms. Graph 7 provides an overview of the distribution of reaction times for all the trials of Experiment 1. However, it is necessary to inspect how these data points behave by condition of words to better understand the results of the experimental stimuli in relation to control words.

Graph 8 illustrates the distribution of reaction times across the different word conditions. In this raincloud plot, outliers (points outside the curve) are observed in all conditions. Visually inspecting the data, it appears that there was only a slight difference between Portuguese interlingual homophones and Portuguese controls. Also, English words appear to have faster RTs than Portuguese words, though this difference is not very noticeable between CTE and HFE in the plot.

Graph 8 - Experiment 1 - Reaction time per condition



Source: own authorship.

Table 16 offers a more precise comparison by providing a summary of the descriptive statistics of reaction times across all conditions. Overall, the mean and median RT values indicate that Portuguese words (both controls and interlingual homophones) had longer RTs in comparison to their English counterparts. HFP had the highest mean and median reaction time values, followed by the CTP condition. This suggests that participants were slower to respond to Portuguese than to English words.

Table 16 - Experiment 1 – Reaction time per condition

Condition	Mean	Median	SD	Minimum	Maximum	Range
CTP	750.09	697.50	255.62	323	2906	2583
HFP	785.24	707.00	289.59	390	2509	2119
CTE	711.49	647.50	272.36	374	2855	2481
HFE	715.60	661.00	239.87	367	2758	2391

Source: own authorship.

Moreover, the range of RTs is wider for CTP than for the rest of conditions, indicating more variability in reaction time for Portuguese controls. Nevertheless, HFPs had the biggest mean and median values, indicating that participants took longer to respond to Portuguese interlingual homophones. Even though the greater standard deviation (SD) value for HFP indicates that its RTs were more dispersed in relation to its mean reaction time, the numbers suggest that interlingual homophones in Portuguese were more cognitively demanding to respond in the language decision task than the other conditions.

On the other hand, English controls (CTE) had the lowest mean and median RT scores, suggesting this condition was less demanding than the others in the language decision task. However, CTEs also had a great SD and a wide range, which may complicate a direct comparison between these controls and their English homophone pairs based on raw measures of central tendency. In fact, the mean RT values for English controls and English homophones were actually quite close.

These comparison uncertainties require a more straightforward analysis with inferential statistics for the RT data, which is covered in the following subsection.

4.1.4 Inferential statistical analysis – Reaction time

The condition HFP was set as the intercept baseline condition to check for the inferential analysis of the reaction time data from Experiment 1. Primarily, the objective of this investigation was to examine the influence of the word conditions on reaction times in the language decision task.

To start the investigation, a simple linear model was run in RStudio with the formula "lm2 <- lm(data = d2, RT ~ CONDITION)" to check for significant effects of word conditions on the dependent variable of reaction time. The results of the linear model presented in Table 17 showed significant differences between HFP and all conditions of words, although it is important to note that this type of regression model does not include random effects for subjects or items. Nevertheless, the linear regression model provides a preliminary understanding of how different word conditions impact reaction times.

Table *17* - Experiment 1 - Linear regression model (HFP as intercept)

	RT		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	785.24	764.99 – 805.48	**<0.001**
CONDITION [CTP]	-35.15	-63.78 – -6.51	**0.016**
CONDITION [HFE]	-69.63	-98.26 – -41.00	**<0.001**
CONDITION [CTE]	-73.75	-102.36 – -45.13	**<0.001**
Observations	2636		
R^2 / R^2 adjusted	0.013 / 0.011		

Source: own authorship.

In the linear regression summary, the intercept indicates the estimated RT (785.24 milliseconds) when condition is the baseline HFP. When the predictor variable changes to the CTP condition, the RT estimate significantly decreases by 35.15 ms. The HFE and the CTE conditions decrease RTs by 69.63 and 73.75 ms, respectively, indicating English words were faster than Portuguese words.

Just as in the descriptive statistics, the RT estimates from HFE and CTE are quite close in the linear regression summary, which may suggest no significant difference between English interlingual homophones and English controls. However, the R2 values indicate the linear regression explains only a small proportion of the RT variance. This simple linear model was employed in order the have a first understanding of the influence of word conditions on RTs, but studies with repeated measures by subjects and items such as the present research should have analyses using mixed-effects models.

A linear mixed effects model was subsequently run in RStudio to check for significance in the comparison of reaction time across conditions in Experiment 1. Mixed models account for both fixed and random effects and allows the incorporation of variability within subjects, items and across different conditions. Considering this, a linear mixed model was employed with the formula "m6.0 <- lmer(data = d2, RT ~ CONDITION + (1|COD) + (1|WORD))" with HFP as the reference condition. In this formula, "d2" refers to the data subset with both correct and incorrect answers including the data of participant P15, “RT” corresponds to the dependent variable of reaction times of each trial in milliseconds, “CONDITION” corresponds to the independent variable of interest specifying all four categories of words, and the arguments “(1|COD) + (1|WORD)” correspond to participants and words included as random effects. Adding random slopes for participants or words failed convergence.

In the final formula of the linear regression model, the response variable RT is modeled as a function of a fixed effect (condition) and the random effects of participants and words. The results summary of the mixed model is presented in Table 18.

Table *18* - Experiment 1 – Linear mixed model (HFP as intercept)

		RT	
Predictors	*Estimates*	*CI*	*p*
(Intercept)	785.17	733.42 – 836.92	**<0.001**
CONDITION [CTP]	-34.84	-86.25 – 16.57	0.184
CONDITION [HFE]	-69.31	-120.71 – -17.91	**0.008**
CONDITION [CTE]	-73.68	-125.08 – -22.28	**0.005**
Random Effects			
σ^2	51333.37		
$\tau_{00\ WORD}$	3985.65		
$\tau_{00\ COD}$	15526.65		
ICC	0.28		
N_{COD}	44		
N_{WORD}	60		
Observations	2636		
Marginal R^2 / Conditional R^2	0.012 / 0.284		

Source: own authorship.

Comparing tables 17 and 18, it is possible to observe that the addition of random effects did not considerably change the RT estimates across conditions of words but affected the confidence intervals and the p-values of the comparison between HFP and CTP. Thus, the RT estimates for HFP were still slower than all the other conditions, but these differences were not significant between Portuguese homophones and Portuguese controls considering the variability of participants and words. The random effects for words and participants show that there's a great variability in RT based on differences between items and subjects (COD), suggesting that including random effects significantly improves the model's explanatory power. The marginal R2 indicates that the mixed model explains only 1.2% of the RT variance considering fixed effects alone (word conditions), while the conditional R2 indicates that 28% of the RT variance is explained by the combined fixed and random effects.

The results from Table 18 show that all conditions, except CTP, had significantly different reaction times when compared to the reference condition HFP, indicating a greater inhibition effect on RT for Portuguese interlingual homophones compared to English words (HFE and CTE), but not compared to its control counterparts (CTP).

Based on these estimates, however, it is not possible to directly tell if there was any significant difference between the effects of HFE and CTE or of CTE and CTP. With this in mind, the same formula model was run one more time with the condition CTE as the intercept baseline to check for significance in other comparisons. The new results summary is presented in Table 19.

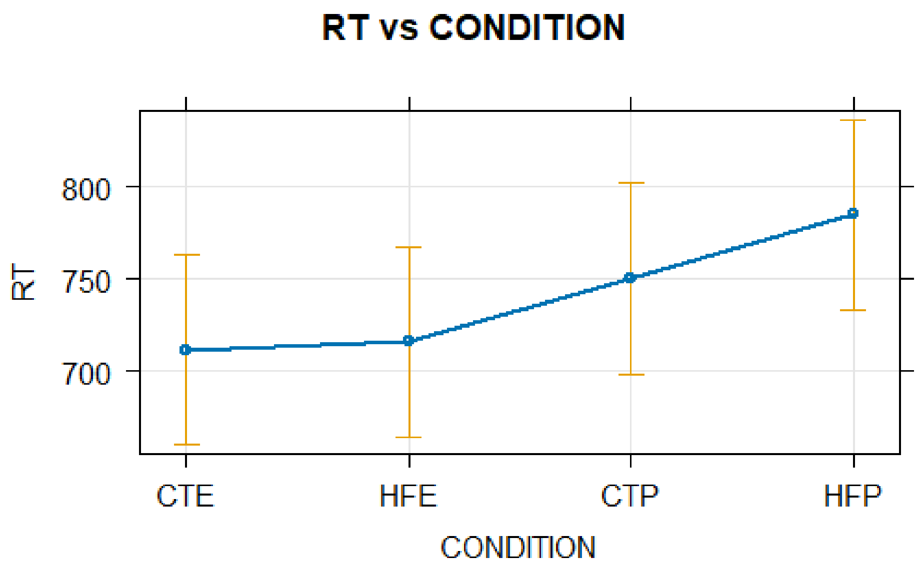
Table 19 - Experiment 1 – Linear mixed model (CTE as intercept)

	RT		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	711.49	659.74 – 763.23	**<0.001**
CONDITION [HFE]	4.37	-47.03 – 55.77	0.867
CONDITION [CTP]	38.84	-12.56 – 90.25	0.139
CONDITION [HFP]	73.68	22.28 – 125.08	**0.005**
Random Effects			
σ^2	51333.37		
τ_{00} WORD	3985.65		
τ_{00} COD	15526.65		
ICC	0.28		
N COD	44		
N WORD	60		
Observations	2636		
Marginal R^2 / Conditional R^2	0.012 / 0.284		

From table 19, it is possible to observe how reaction times change across conditions when they are compared to the baseline CTE. The results indicate no significant differences between English control words and English interlingual homophones (CTE and HFE) or between English and Portuguese controls (CTE and CTP).

Although there was a significant difference between interlingual homophones and controls in the Portuguese language in the accuracy data, RTs for interlingual homophones were not significantly different from their controls neither in Portuguese nor in English. Graph 9 illustrates the predicted effects of word conditions on reaction times.

Graph 9 – Experiment 1 - Condition effect on reaction time



Source: own authorship.

Graph 9 highlights the significant increase in RTs for Portuguese interlingual homophones when compared to the reference condition CTE. From the plot, it is possible to observe a slight increase in RTs for interlingual homophones in English (HFE) and a moderate increase for control words in Portuguese (HFP) when compared to CTE, although neither of these last two comparisons reached significance.

The inferential analysis for reaction time as a function of word condition that was carried out in this subsection did not indicate significant differences between interlingual homophones and control words in neither of the participant’s languages, that is, between conditions HFP and CTP or between HFE and CTE. Nevertheless, the results indicated that RT estimates were significantly higher for HFP in comparison to HFE and CTE, indicating that participants were slower to respond to interlingual homophones in Portuguese, thus suggesting that this condition required more cognitive effort in the language decision task in relation to English words.

Having concluded the results analysis of Experiment 1 – Language Decision Task, the next subsection addresses the descriptive and inferential statistics for the results of the second experiment of this study, the translation task.

4.2 Results of Experiment 2 – Multiple Choice Translation Task

This subsection details, illustrates and explains the results obtained from Experiment 2, a multiple-choice translation task. In this experiment, participants had to select the best translation equivalent for the presented stimulus words by pressing the keys “A”, “G”, and “L” on their computers. The task was divided in two blocks, each one for a specific translation direction, with randomized orders of which task was assigned first.

Just as for experiment 1, the PsyTooKit software compiled the data of participants’ responses for all 120 words and provided a text table with 5280 observations, each one indicating responses from all 44 participants to the 120 words. This experiment was designed in order to check for priming effects for interlingual homophones and control words. Half of the words were previously seen in Experiment 1 and the other half were completely new to the participants. The task required that participants selected the correct translation equivalent to interlingual homophones and control words. For the results analyses, the stimulus words were categorized in four conditions: SHF (studied interlingual homophones), SCT (studied controls), NHF (non-studied interlingual homophones), and NCT (non-studied controls).

As in the first experiment, The PsyToolkit software registered reaction times (RTs) in milliseconds and status of participants’ responses with the categorical numbers 1, 2 and 3 indicating correct answers, incorrect answers, and time-out answers, respectively. The next subsection presents the descriptive statistics for accuracy in Experiment 2.

4.2.1 Descriptive analysis - Accuracy

The text table with the data of all trials from Experiment 2 provided by the PsyTooKit software was transformed into an excel file and uploaded on RStudio for analysis. The variables were changed into categorical factors or numeric variables as necessary, so the analysis could start by inspecting the status of responses. Table 20 depicts the quantity of answers for each categorical status.

Table *20* - Experiment 2 - Data status

1	**2**	**3**
4912	322	46

Source: own authorship.

From all the 5280 observations of Experiment 2, only 46 trials exceeded the time limit of 5 seconds to select the translation equivalent to the stimulus words and 322 answers were incorrect, remaining 4912 trials with correct answers. As in Experiment 1, participants were accurate to respond to the majority of words, indicating the task design was coherent and effectively saved the data without technical issues.

The next step of this descriptive analysis consisted of the exclusion of time-out answers (status 3) to start the investigation of response status per condition. Thus, a new data subset was created only with correct and incorrect trials (status 1 and 2). This new dataset had 5234 observations left. Transformed into proportion, correct answers were equivalent to 93.85% of the total trials, while errors accounted for 6.15% of the accuracy data.

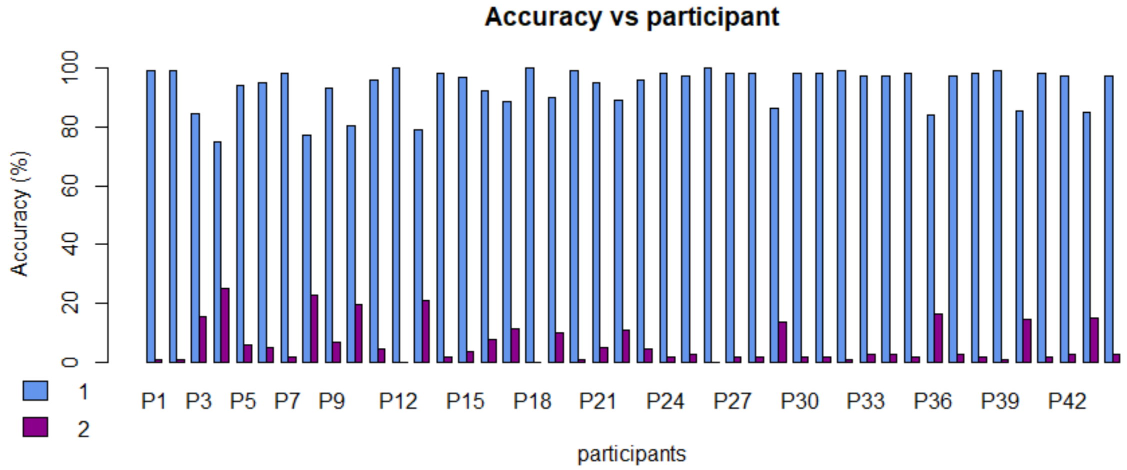
Table 21 - Experiment 2 - Status proportion

1	**2**
93.85	6.15

Source: own authorship.

Having detailed the overall accuracy rates of experiment 2, the status data was also inspected across participants. Unlike the first Experiment, Graph 10 shows no participant had an extreme divergent behavior regarding accuracy rates in Experiment 2. Previously, the status data of participant P15 needed to be excluded from the accuracy analysis of Experiment 1 because 90% of their answers were incorrect. Since this participant had a high proficiency score, it was assumed he or she misinterpreted the task instructions and used the wrong keys to respond to the words in the language decision task. As Graph 10 illustrates, this issue did not occur in the translation task.

Graph 10 - Experiment 2 – Accuracy per participants



Source: own authorship.

Next, the status data was inspected by language to verify whether participants had more difficulty in a specific translation direction. Different from experiment 1, the word conditions used in this analysis (SHF, SCT, NHF, NCT) do not specify the language of the stimulus words, so it is pertinent to verify whether accuracy rates change between English and Portuguese. Half of the total 5234 observations of Experiment 2 were trials which required a translation choice to a Portuguese word, while the other half required a translation choice to an English word. Table 21 shows the distribution of correct and incorrect responses for each language.

Table 22 - Experiment 2 - Status per language

	English	**Portuguese**
1	2456	2456
2	161	161

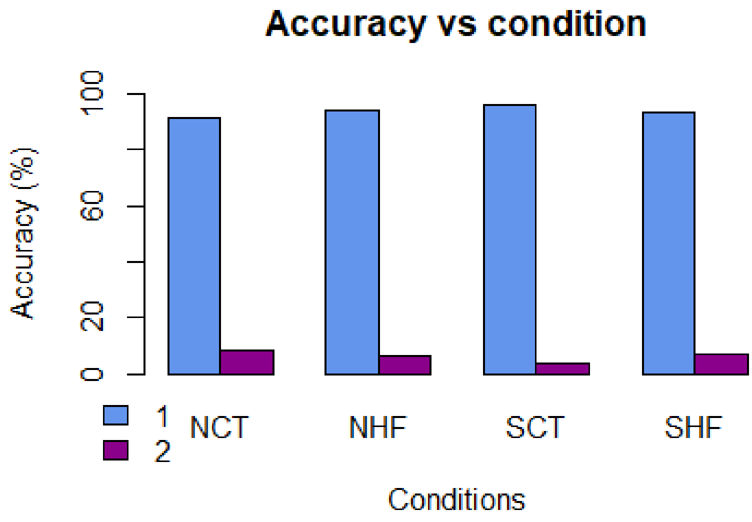
Source: own authorship.

Interestingly, English and Portuguese words had the exact same count of correct and incorrect answers, as evidenced in Table 21. The numbers indicate the participants' performance was consistent across both languages, suggesting neither translation direction was more difficult than the other in terms of accuracy rates.

Moving forward, the accuracy data was inspected by word condition. Graph 11 illustrates the percentage of response status for each of the four word conditions of Experiment

2: non-studied controls (NCT), non-studied interlingual homophones (NHF), studied controls (SCT), and studied interlingual homophones (SHF).

Graph 11 - Experiment 2 – Accuracy per condition



Source: own authorship.

Visually inspecting the data, it appears that participants were more accurate to respond to SCT in comparison to the other conditions, suggesting that there was a facilitative priming effect for control words, but not for interlingual homophones. As in Experiment 1, there were more correct than incorrect answers in the translation task. Table 22 provides the accuracy percentage for each condition.

Table 23 - Experiment 2 - Accuracy percentage per condition

	NCT	NHF	SCT	SHF
1	91.67	93.96	96.48	93.28
2	8.33	6.04	3.52	6.72

Source: own authorship.

SCTs were 4.81% more accurate than NCTs, while SHFs were 0.68% less accurate than NHFs, although this small difference between SHF and NHF is probably non-significant. Studied control words (SCT) had the highest accuracy percentage, while non-studied controls (NCT) had the lowest. Comparing non-studied words, interlingual homophones were 2.29%

more accurate than their matched controls. This is an unexpected finding, considering hypothesis H1 predicted a higher processing cost for interlingual homophones. For studied words which had been seen in the first experiment, participants were 3.2% less accurate to respond to interlingual homophones than their matched control words.

Overall, the numbers suggest a facilitative priming effect for control words and a small inhibitory priming effect for interlingual homophones that might not reach significance. The next subsection addresses the inferential statistics for the dependent variable of accuracy in Experiment 2.

4.2.2 Inferential statistical analysis - Accuracy

In order to check for significance in the comparisons made in the descriptive statistics subsection, this part of the paper delves deeper in the inferential statistical analysis for accuracy in Experiment 2. Just as in Experiment 1, the inferential analysis was carried out through Generalized Linear Mixed Effects Models in RStudio using the "lme4" package (BATES *et al.*, 2015).

A glmer model was employed with the formula "mod2 <- glmer(data = Exp22, STATUS ~ STUDIEDNONSTUDIED + (1|COD), family=binomial(link = "logit"))". In the formula, "Exp22" refers to the second experiment's dataset with correct and incorrect answers for all the 44 participants (5234 observations), the argument "STATUS ~ STUDIEDNONSTUDIED" specifies that the response variable status is being modeled as a function of word condition, and "(1|COD)" corresponds to participants included as random effects. Adding words as random effects or adding random slopes for subjects or items made the model fail to converge.

In order to verify whether the small difference between NHF and SHF observed in descriptive statistics was significant or not, the model was firstly run with NHF set as the intercept baseline condition. This configuration also allows for a direct comparison between NHF and NCT, since their accuracy percentages did not have an overt difference. The results obtained from the presented formula are depicted in Table 23.

For the interpretation of the results summary, it is worth recalling how generalized regression models function with binary response variables by default. Godoy (2019) explains that this type of regression compares the proportion of occurrence of the non-reference level with the reference level of the response variable for a given baseline condition (the intercept). In the intercept of the model presented in Table 24, the regression is therefore comparing the rates of status 2 with the rates of the reference level of the response variable, status 1, for the

NHF condition. Thus, the odds ratios correspond to a probability measure of the response variable being 2 (incorrect) in comparison to 1 (correct) as a function of the stimulus conditions.

Table 24 - Experiment 2 – Generalized mixed model (NHF as intercept)

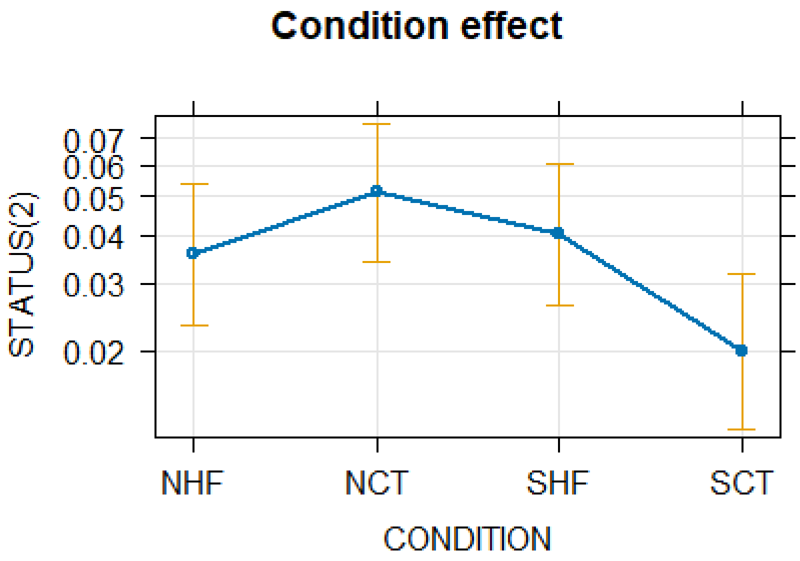
	STATUS		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	0.04	0.02 – 0.06	**<0.001**
STUDIEDNONSTUDIED [NCT]	1.46	1.07 – 1.98	**0.016**
STUDIEDNONSTUDIED [SHF]	1.13	0.82 – 1.55	0.462
STUDIEDNONSTUDIED [SCT]	0.55	0.38 – 0.80	**0.002**
Random Effects			
σ^2	3.29		
$\tau_{00\ COD}$	1.36		
ICC	0.29		
N_{COD}	44		
Observations	5234		
Marginal R^2 / Conditional R^2	0.027 / 0.311		

Source: own authorship.

From Table 24, it is evident that the accuracy rates of NHF were significantly different from NCT and SCT, but not from SHF, as indicated by the p-values < 0.05. This demonstrates that the small inhibitory priming effect noted in descriptive statistics for studied interlingual homophones (SHF) was not significant in comparison to NHF. The positive odds ratios of 1.46 for NCT indicates that non-studied control words had a significant increase on the occurrence of incorrect answers (status 2) in comparison to NHF, while the negative odds ratio of 0.55 for SCT indicate that studied controls had significantly fewer errors (more accuracy) than NHF. Graph 12 plots the effect size of word conditions on the dependent variable of accuracy in Experiment 2.

As discussed in the descriptive statistics section, the higher error probability for non-studied controls in comparison to non-studied homophones illustrated in Graph 12 was an unexpected finding. Hypothesis H1 predicted a higher processing cost for interlingual homophones in comparison to control words, thus creating an expectation that participants would respond to control words more accurately and faster in comparison to interlingual homophones.

Graph 12 - Experiment 2 - Condition effect on response status



Source: own authorship.

Despite the previous results, the relationship between homophones and controls for non-studied words did not align with that observed for studied words (words previously seen in Experiment 1). For studied words, it was observed that interlingual homophones had less accuracy than controls, in line with hypothesis H1.

To verify significance for such relationship between studied words, the generalized linear model was run one more time with SCT as the intercept baseline condition. This way, it was possible to directly compare accuracy between studied controls and studied homophones (SCT and SHF) and to check for priming effects for control words comparing studied and non-studied controls (SCT and NCT). The results are presented in Table 25.

Table 25 - Experiment 2 - Generalized mixed model (SCT as intercept)

	STATUS		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	0.02	0.01 – 0.03	**<0.001**
STUDIEDNONSTUDIED [SHF]	2.05	1.41 – 2.96	**<0.001**

STUDIEDNONSTUDIED [NCT]	2.64	1.85 – 3.78	**<0.001**
STUDIEDNONSTUDIED [NHF]	1.81	1.25 – 2.64	**0.002**
Random Effects			
σ^2	3.29		
$\tau_{00\ COD}$	1.36		
ICC	0.29		
N_{COD}	44		
Observations	5234		
Marginal R^2 / Conditional R^2	0.027 / 0.311		

Source: own authorship.

Table 25 shows accuracy estimates for SCT were significantly different from all conditions. The conditional R2 value of 0.311 indicates the combined fixed and random effects explains around 31% of the response status variance. The positive odds ratios indicate an increase in the occurrence of incorrect answers to all conditions in comparison to the intercept baseline SCT, which was indeed the condition with the highest percentage of correct answers in descriptive statistics.

In terms of accuracy, the results suggest that there was a significant repetition priming effect for control words but not for interlingual homophones in Experiment 2, in the sense that studied controls (SCT) had significantly more accuracy than non-studied controls (NCT), but no significant difference was found between studied and non-studied homophones (SHF and NHF).

Moreover, interlingual homophones were significantly less accurate than their matched controls for studied words (SHF and SCT), but this was not the case for non-studied words (NHF and NCT). In fact, non-studied homophones (NHF) had significantly more accuracy than non-studied controls (NCT), as illustrated by the error rates in Graph 12. This was an unexpected finding.

These results are against hypothesis H2, which predicted repetition priming effects for interlingual homophones (SHF compared to NHF), and partially contradict hypothesis H1, which predicted a higher processing cost for interlingual homophones in comparison to control words (NHF compared to NCT and SHF compared to SCT). It was expected that homophones would have less accuracy than controls both for studied and non-studied words in the translation task.

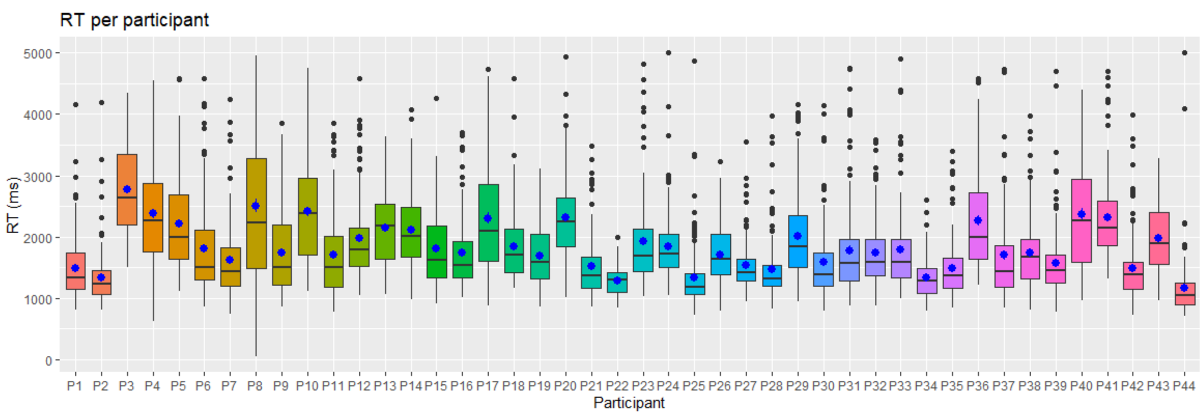
So far, it seems interlingual homophones have an inhibitory effect in translation accuracy in comparison to its controls only with prior exposure to stimuli (with studied words). Possible explanations for the obtained results are elaborated in the discussion section. The next subsection provides further insights to the present investigation by analyzing reaction times in Experiment 2.

4.2.3 Descriptive analysis – Reaction time

Following the accuracy analysis, this subsection starts a detailed examination of reaction times (RTs) in Experiment 2, explaining and illustrating the data compiled by the free software PsyToolKit (Stoet, 2010, 2017), so that it can later be assessed through inferential statistics.

Just as in Experiment 1, the analysis of RTs in Experiment 2 considered both correct and incorrect answers. Consistent with the previous descriptive analyses, the first step involved the visual inspection of RTs per participants. Graph 13 illustrates the RT distribution for each individual participant.

Graph 13 - Experiment 2 - RT per participant



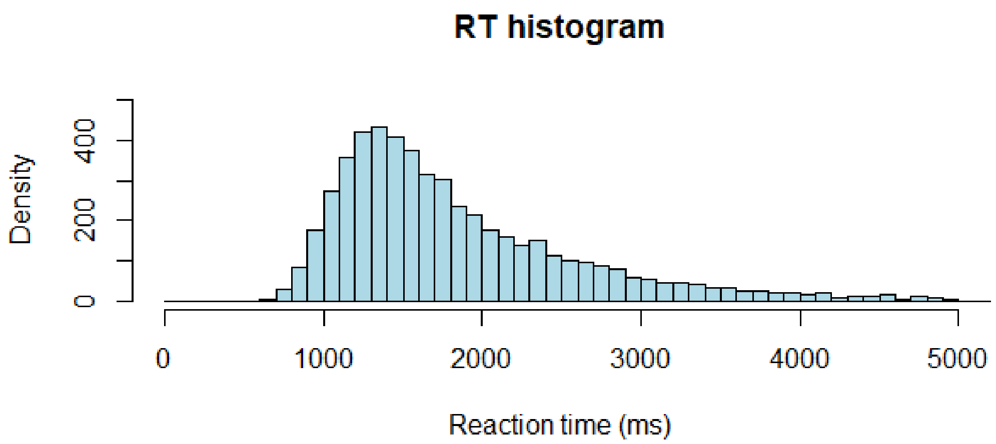
Source: own authorship.

From the boxplot illustrated in Graph 13, a greater variability can be observed for participants' reaction times in Experiment 2 in relation to Experiment 1. It is also possible to observe a greater difference of mean reaction times across participants, greater individual ranges on the RT distribution, and more outliers than in the first experiment. Importantly, Graph 13 highlights an issue with the RT data of participant P8, who presented an extremely low RT of 42 milliseconds.

Considering that all the other RTs were over 550 ms, this specific outlier strongly suggested that participant P8 did not respond to the stimulus word of this trial, but instead, had a delayed keypress for the previous stimulus. This assumption was checked by manually verifying the dataset table of Experiment 2, which made it possible ascertain that the key used to respond to the outlier trial was the same as that of the previous trial. Since the previous trial had been responded to correctly, it was assumed that participant P8 double pressed the key on the previous trial, making the software display the word after the next, without the participant realizing that one stimulus had been skipped. Consequently, the outilier RT of 42 ms was excluded from the analysis dataset.

Graph 14 presents the histogram of the RT distribution for all the 5233 remaining trials of Experiment 2, without time-out answers and without the 42 ms outlier.

Graph 14 - Experiment 2 - Histogram of reaction time



Source: own authorship.

The histogram shows that most of the RTs in Experiment 2 were between 1000 and 2000 ms. RTs beyond the predominant interval were more frequent than in Experiment 1. It is evident that the translation task demanded more time for response decisions in comparison to the language decision task, indicating that the time limit of 5 seconds was an appropriate measure for Experiment 2. The histogram shows a general pattern of the participants' responses in all conditions of words. To better understand the results, RTs were subsequently inspected by language and by word conditions.

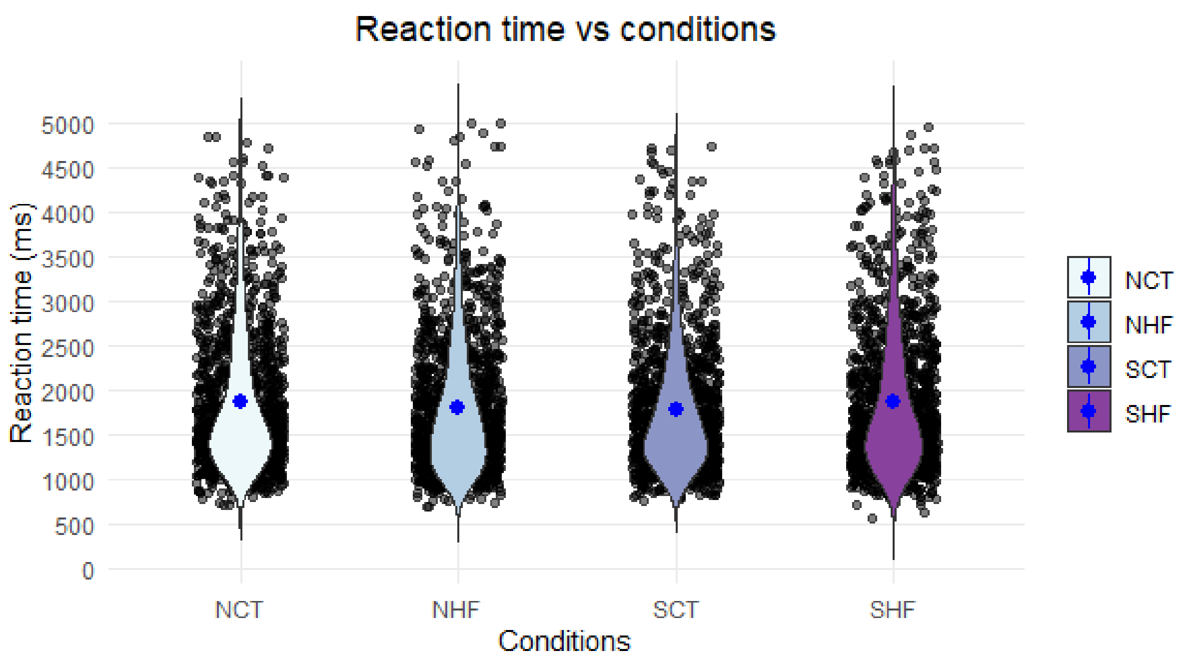
Table 26 - Experiment 2 - Reaction time per language

Language	Mean	Median	SD	Minimum	Maximum	Range
English	1769.61	1559	740.48	699	4944	4245
Portuguese	1896.89	1693	775.65	550	5010	4460

Although no difference was found between languages for the accuracy data, Table 26 shows that, overall, Portuguese words had greater mean and median RT scores than English words in the translation task. The Portuguese language also had a higher standard deviation and a higher range in comparison to English, indicating a greater variability in reaction times for the participants' L1. These results suggest that participants took longer to choose a translation equivalent to words that were displayed in their first language in comparison to words that appeared in their second language. In other words, the data suggests that making decisions that involved the forward translation direction (L1 – L2 translation) was more cognitively demanding than the backward direction (L2 – L1 translation).

Next, Graph 15 illustrates the RT distribution across word conditions in Experiment 2. Visually inspecting the raincloud plot, studied control words (SCT) appear to have faster RTs compared to the other conditions, while studied homophones (SHF) show slower RTs.

Graph 15 - Experiment 2 - Reaction time per condition



Source: own authorship.

A descriptive statistical summary of RTs across conditions is provided in Table 27 for further understanding of the data.

Table 27 - Experiment 2 - Reaction time per condition

Condition	Mean	Median	SD	Minimum	Maximum	Range
NCT	1860.21	1622.50	769.19	723	4862	4139
NHF	1813.04	1631.00	751.41	699	5010	4311
SCT	1790.27	1602.00	717.34	757	4749	3992
SHF	1869.44	1636.00	801.07	550	4956	4406

Source: own authorship.

Consistent with the observations from the visual inspection of the data, the mean and median RT scores show that SCT had the fastest RTs and SHF had the slowest. Studied interlingual homophones (SHF) also had the greatest standard deviation and range, indicating the RT data for SHF was more dispersed compared to the other conditions. Non-studied words, on the other hand, had intermediate mean RT scores compared to studied words. In comparison to non-studied homophones (NHF), non-studied controls (NCT) had a higher mean RT score but a slightly lower median RT score. NCT also had a greater standard deviation but a lower range.

While these central tendency measures suggest that participants were faster to translate controls than interlingual homophones for words that had been seen in Experiment 1 (SCT and SHF), this difference is not as pronounced between controls and homophones that only appeared in Experiment 2 (NCT and NHF). To make definite conclusions on these comparisons, the RT inferential statistics is presented in the next subsection.

4.2.4 Inferential statistical analysis – Reaction time

To examine the influence of word conditions on reaction times of Experiment 2, this analysis considered RTs for both correct and incorrect answers. It is important to note that one outlier trial of 42 milliseconds was excluded from analysis, as explained in the descriptive statistics section of Experiment 2.

To start the inferential statistical analysis, SCT was set as the intercept baseline condition and a simple linear model was run in RStudio to have a preliminary understanding of the associations. The linear model was employed with the formula "lm.RT <- lm(data = Exp22, RT ~ STUDIEDNONSTUDIED)".

Table 28 - Experiment 2 - Linear regression model (SCT as intercept)

	RT		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	1790.27	1749.04 – 1831.51	**<0.001**
STUDIEDNONSTUDIED [SHF]	79.16	20.88 – 137.44	**0.008**
STUDIEDNONSTUDIED [NCT]	69.94	11.64 – 128.24	**0.019**
STUDIEDNONSTUDIED [NHF]	22.76	-35.54 – 81.06	0.444
Observations	5233		
R^2 / R^2 adjusted	0.002 / 0.001		

Source: own authorship.

Table 28 shows the results of the simple linear model, indicating that studied controls (SCT) had significantly different RTs from all conditions except non-studied homophones (NHF). Without accounting for random effects, this model estimated a significant increase in reaction times for SHF and NCT but not NHF in comparison to SCT. The simple linear model only accounts for fixed effects and the R2 value indicates it has a weak explanatory power.

Next, Table 29 shows the results when random effects for participants and words are considered. A linear mixed model was employed with the formula "lmer.RT <- lmer(data = Exp22, RT ~ STUDIEDNONSTUDIED + (1|COD) + (1|WORD))". Adding random slopes for participants or items was not possible due to convergence issues.

Table 29 - Experiment 2 - Linear mixed model (SCT as intercept)

	RT		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	1797.62	1628.65 – 1966.59	**<0.001**
STUDIEDNONSTUDIED [SHF]	78.37	-101.97 – 258.70	0.394
STUDIEDNONSTUDIED [NCT]	71.38	-108.95 – 251.72	0.438
STUDIEDNONSTUDIED [NHF]	23.44	-156.89 – 203.78	0.799

Random Effects	
σ^2	331156.07
τ_{00} WORD	119329.85
τ_{00} COD	140715.52
ICC	0.44
N COD	44
N WORD	120
Observations	5233
Marginal R^2 / Conditional R^2	0.002 / 0.441

Source: own authorship.

Although the addition of random effects did not considerably change the RT estimates, the results of the mixed model show no significant difference on reaction times across conditions in Experiment 2. Considering the variability of participants and words, an increase on reaction times could still be observed comparing other conditions to SCT, but these differences did not reach significance. The results of random effects show a great variability in RT based on differences between participants and words, and the marginal and conditional R2s suggest that the addition of random effects considerably increases the explanatory power of the model (conditional R2=0.441).

Comparing SCT to NCT, the results suggest no significant priming effect on reaction times for control words in Experiment 2. Comparing SCT to SHF and NHF, the model does not predict an inhibition effect for studied interlingual homophones compared to control words in the translation task, which contradicts hypothesis H1. In order to check for significance with other comparisons, the model was run one more time with NHF as the intercept baseline condition. This configuration allows for more objective comparisons between studied and non-studied interlingual homophones, and between studied homophones and their studied controls.

Table 30 – Experiment 2 – Linear mixed model (NHF as intercept)

		RT	
Predictors	*Estimates*	*CI*	*p*
(Intercept)	1821.06	1652.09 – 1990.04	**<0.001**
STUDIEDNONSTUDIED [SHF]	54.92	-125.41 – 235.25	0.550
STUDIEDNONSTUDIED [NCT]	47.94	-132.40 – 228.28	0.602

STUDIEDNONSTUDIED [SCT]	-23.44	-203.78 – 156.89	0.799
Random Effects			
σ^2	331156.07		
τ_{00} WORD	119329.85		
τ_{00} COD	140715.52		
ICC	0.44		
N COD	44		
N WORD	120		
Observations	5233		
Marginal R^2 / Conditional R^2	0.002 / 0.441		

Source: own authorship.

Table 30 shows the results of the mixed model when NHF is the intercept baseline condition. In comparison to NHF, slight RT increases of 54.92 and 47.94 are estimated for SHF and NCT, while SCT had a slight decrease of -23.44. However, these differences were not significant. Comparing NHF and SHF, the model does not suggest there is a priming effect for interlingual homophones in the translation task, which is against hypothesis H2. Likewise, no significant difference between RTs of NHF and NCT suggest that there was no inhibition or higher cost effect for interlingual homophones compared to its matched controls, which opposes hypothesis H1.

The next subsection provides a discussion of the results from Experiments 1 and 2, aiming to answer the research questions posed by this study.

4.3 Results discussion

This subsection discusses the data results of Experiments 1 and 2 of the present study, which had as its main objective the investigation of the effect of interlingual homophones on bilingual lexical access with the language pair of Brazilian Portuguese and English, to examine the interlingual interaction of phonological features and bilingual cognitive processes involved in silent reading at the word level. Next, subsection 4.3.1 discusses the findings of Experiment 1, followed by subsection 4.3.2 which addresses the findings of Experiment 2.

4.3.1 Experiment 1

Experiment 1 was primarily designed to investigate the processing cost of BP-En interlingual homophones in relation to control words in a language decision task that involved silent reading at the word level. Another objective for this experimental task was verifying whether there was any difference in the processing cost of reading isolated interlingual homophones from the L1 or the L2.

For these purposes, the dependent variables of accuracy and reaction time (RT) were analyzed both through descriptive and inferential statistics. It is worth mentioning that this type of experimental task focused both on recognition and language switching processes, since participants had to make language decisions to words that were displayed individually and could be both from their L1 or L2.

The status analysis of Experiment 1 revealed that participants accurately responded to 94.61% of the trials, so 5.39% of the answers were incorrect. However, it was assumed that one of the participants (P15) misinterpreted the instructions of the task and used the wrong keys to answer the trials, which may have contributed to this error rate. The data of this participant was excluded for the accuracy analysis per condition of words, but maintained for the RT analysis, because using the wrong keys would not have affected their reaction times. Time-out answers that exceeded the time limit of 3 seconds, on the other hand, were discarded for all analyses. Overall, participants took around 500 to 700 milliseconds to answer most of the trials from Experiment 1, which is consistent with previous studies that used the same task paradigm (Gadelha, Toassi, 2021; Batista, 2022; Borém, 2023).

Comparing word conditions, the results revealed that participants were less accurate and slower to make language decisions to interlingual homophones in Portuguese (HFP), indicating that this condition presented the greatest inhibition effect in Experiment 1. Although the condition HFP was not significantly different from interlingual homophones in English (HFEs) in the accuracy data, inferential statistics showed that HFPs had significantly slower RTs than HFEs. More importantly, HFPs had significantly less accuracy than its matched control counterparts (CTP), but the RT analysis showed no significant difference between these conditions.

When participants encountered Portuguese words that resembled English words in sound similarity, the phonological information of the other language (English) was also activated, which hindered language decisions due to a form ambiguity in lexical access for interlingual homophones in Portuguese, in comparison to control words in Portuguese. This explanation covers the significant difference observed between HFPs and CTPs in the accuracy data, although the RT increase for HFP was not significant in comparison to CTP. On the other hand, HFEs were not significantly different from their matched control counterparts in English (CTEs) neither in the accuracy nor in the RT analysis, even though descriptive statistics showed a small advantage for CTEs in comparison to HFEs in accuracy and RT rates.

In short, the results indicate that control words (CTP and CTE) had higher accuracy rates and faster RTs than interlingual homophones (HFP and HFE), but this difference only reached statistical significance for the Portuguese language – Participants' L1 – in the accuracy data. Furthermore, although the estimates of interlingual homophones (HFP and HFE) did not differ across languages in the accuracy data, inferential statistics for the RT analysis showed that participants were significantly slower to make language decisions to HFPs than HFEs.

Still examining differences across languages, while control words in Portuguese (CTP) had the highest accuracy, control words in English (CTE) had the fastest RTs in descriptive statistics. However, in contrast to the comparison of accuracy and RT between HFP and HFE, inferential analyses indicated that there were no significant differences between control words (CTP and CTE) across languages neither for accuracy nor for reaction time.

These results diverge from previous studies which reported significantly faster and more accurate responses to control words in English in comparison to control words in Portuguese (Toassi *et al*., 2023; Borém, 2023). However, this difference across languages for control words in the previous studies may be attributed to differences in word frequency, since CTEs were more frequent than CTPs in those studies. In the present study, such difference was not as pronounced between frequencies of English and Portuguese control words.

The findings of the present study also highlight an asymmetry in the effect of interlingual homophones in the language decision task, that seems to depend on the language of the target word: whether it is the dominant L1 or the non-dominant L2. As discussed in the theoretical framework of this study, Haigh and Jared (2007) also reported an asymmetry in the effect of phonological overlap in word recognition with an English lexical decision task. In the case of their study, it was observed that participants activated phonological information from both of their languages when they read interlingual homophones in their L2, but not in their L1. That is, interlingual homophone effects were only observed in the (L2 – L1) direction. In the case of the present study, however, the reverse asymmetry was observed.

Thus, the results of this experiment suggest that participants activated phonological representations from both languages when they read interlingual homophones in Portuguese, their L1, but not in English, their L2, in a language decision task. Nevertheless, the findings of the present study may not align with those of Haigh and Jared (2007) for other reasons. First, it is important to note that another task paradigm was used in this research. Secondly, Haigh and

Jared (2007) tested two groups of bilinguals with the same lexical decision task that had only English as the target language. In their study, one group performed the task in the L1, while the other performed in the L2. In the present study, participants made part of only one group of bilinguals who had the same L1 and L2, and they encountered target words from both of their languages in the language decision task.

A possible explanation for the observed differences of the interlingual homophone effect across languages in the language decision task of this study may be the same rationale given by Toassi *et al.* (2023) to explain differences between English and Portuguese controls in their experiments. The authors argued that facilitation effects towards the L2 could be attributed to the nature of the language decision task, which demands high code-switching from participants. In this bilingual context, participants may find themselves in the need to inhibit their L1, which leads to greater L2 activation (Toassi *et al.*, 2023). In the present study, the greater L2 activation could explain why English interlingual homophones had significantly faster RTs than Portuguese interlingual homophones. On the other hand, it may be possible that English homophones did not significantly differ from English controls because the activation of both English conditions were similarly high.

The first hypothesis raised by this study predicted higher processing cost for interlingual homophones in comparison to matched control words in a language decision task, reflected on longer reaction times for HFPs and HFEs in comparison to CTPs and CTEs. This hypothesis is partially supported by the results of Experiment 1, which found an inhibitory homophone effect for the Portuguese language, participants' L1, in the accuracy data, but not in the RT data. In addition, no significant homophone effect was observed for the English language, participants' L2.

Conversely, the research findings discussed in this subsection are against hypothesis H3, which predicted greater inhibitory phonological effects for interlingual homophones in English, participants' L2, in comparison to interlingual homophones in Portuguese, participants' L1. Contrary to what was predicted, participants actually had an advantage in recognizing interlingual homophones in English in comparison to interlingual homophones in Portuguese, as evidenced by the RT data of the language decision task.

4.3.2 Experiment 2

The objective of Experiment 2 was to investigate whether isolated BP-En interlingual homophonic words have repetition priming effects in a subsequent multiple choice translation task, after participants' previous performance in a language decision task.

Based on this specific objective, hypothesis H2 was raised, which stated that there are repetition priming effects for interlingual homophones in a subsequent translation task, evidenced by faster and more accurate responses for interlingual homophones previously seen in Task 1, as compared to control words and interlingual homophones that were not present in task 1.

Half of the critical stimuli of Experiment 2 were words previously seen in Experiment 1 (studied words), while the other half were completely new to participants (non-studied words). For the descriptive and inferential analyses that were carried out, these words were divided in four categories: SCT (studied controls), SHF (studied homophones), NCT (non-studied controls), and NHF (non-studied homophones). Each condition was formed by 15 words in English and 15 words in Portuguese. In addition to the predictions of hypothesis H2 and in accordance with hypothesis H1, it was also expected that interlingual homophones would present a higher processing cost in relation to control words in the translation task.

The results revealed that, overall, 93.85% of the trials had correct answers, while 6.15% had incorrect ones, which indicates that responses from Experiment 2 were slightly less accurate than responses from Experiment 1. The greater variability in the RT data also suggests a greater difficulty level for this specific task. It is worth noting that time-out answers and an outlier trial of 42 milliseconds were excluded from analyses of Experiment 2.

An interesting finding was that accuracy rates were exactly the same across languages in Experiment 2, but the RT data showed that participants were faster to make translation choices to English words, in comparison to Portuguese words. Two observations can be made based on this finding. First, faster translation choices for English words may indicate that participants' L2 was more activated in comparison to their L1, which would be consistent with the previous observations of Experiment 1. Secondly, it may indicate that backward translation (L2 – L1) was somewhat easier than forward translation (L1 – L2) in this multiple choice task.

This last observation could be accounted for by the assumptions of the Revised Hierarchical Model (RHM) proposed by Kroll and Stewart (1994). According to RHM, the bilingual memory has asymmetric mappings of words to concepts across languages. In this context, L1 words are more strongly connected to its concepts than L2 words. Kroll and Stweart proposed that, at least for initial stages of L2 learning, L2 words were only connected to its semantic representations through mediation of lexical links with the L1. These lexical links between languages were assumed to be stronger in the L2 – L1 direction than in the L1 – L2 direction (Kroll; Stewart, 1994). In this sense, forward (L1 – L2) translation may be slower due to the need of a concept mediation route, while backward (L2 – L1) translation would be faster because of a stronger and more direct lexical link from the L2 to the L1.

Duyck (2005) conducted a relevant translation priming study with Dutch-English bilinguals that could also provide further explanations for the observed faster RTs to English targets in the present experiment. The author found that identification of L2 targets (e.g. "corner") was facilitated by L2 primes (e.g. "hook") that were homophonic to the target's L1 translation equivalent (Dutch word "hoek"). However, identification of L1 targets (e.g. Dutch word "dag") was not facilitated by L1 primes (e.g. Dutch word "dij") which were homophonic to the L2 translation equivalent (e.g. "day").

Based on these results, Duyck (2005) argued that the mapping of an ambiguous phonological representation has weaker connections to the L2 meaning than to the L1 meaning. In the present experiment, thus, it is possible that participants were faster to respond to English stimuli, i.e. trials with backward translation, because interlingual homophones would activate the L1 translation equivalent faster. Interestingly, however, the inferential analyses showed no significant differences in the RT data across conditions in Experiment 2, although differences were observed in descriptive statistics.

Advancing the discussion, the comparison of word conditions in Experiment 2 pointed out that participants' responses were more accurate and faster for SCT than to all the other conditions. Although these differences only reached significance in the accuracy data, the significant increase in error rates for NCT in comparison to SCT strongly suggests a facilitation effect due to repetition priming for control words in the translation task.

The same pattern of results was not observed for interlingual homophones. While studied controls were more accurate and faster than non-studied controls, studied homophones were actually less accurate and slower than non-studied homophones. SHF had 0.68% more errors and a 56 ms increase in mean RT in comparison to NHF, suggesting a small inhibitory repetition effect for interlingual homophones in the translation task. However, these differences between NHF and SHF were not significant neither for the accuracy nor for the RT analyses.

These findings are against hypothesis H2 of this study, which predicted repetition priming effects for interlingual homophones. Contrary to hypothesis H2, a possible repetition priming effect only occurred for control words, as evidenced by the significant accuracy differences between SCT and NCT. Despite the incongruency with this research hypothesis, these results align with another previous study from LabFoM (UFC) which used the same task paradigms with interlingual homographs instead of homophones.

Similarly to the present findings, Gadelha and Toassi (2021) reported repetition priming effects for control words but not for interlingual homographs in the multiple choice translation task. Toassi *et al*. (2023) argued that interference of the non-target meaning of the homograph led to reduction of the priming effect for those critical stimuli. Likewise, it could be argued that the lack of facilitative priming for interlingual homophones in the present study is a consequence of a semantic conflict. Considerably, previous research has provided evidence that ambiguous phonological representations activate both L1 and L2 meanings (Christtofels *et al*., 2016; Duyck, 2005). As mentioned earlier, an inhibition trend was observed for studied homophones in relation to non-studied homophones both in the accuracy and in the RT analyses of descriptive statistics, but it did not reach significance in inferential statistics.

It is important to note, however, that great variability was found between and within participants in the RT analyses of the present study, and other factors besides the discussed ones may have influenced the results. In another study from the same laboratory, Borém (2023) observed that priming effects tended to disappear as participants' proficiency increased. Considering most participants were highly proficient in the present study but a few had very low proficiency scores, this aspect should be further investigated in future analyses. The current version of the present text did not address these matters in data analysis due to time constraints.

Another relevant observation resulting from Experiment 2 was an inconsistency of the homophone effect across Experiments 1 and 2, and also across studied and non-studied words. While interlingual homophones had an inhibition effect compared to control words in accuracy of for Portuguese words in Experiment 1, and with the accuracy data of studied words in Experiment 2 (SHF and SCT), the same was not observed for non-studied words in Experiment 2 (NHF and NCT). Unexpectedly, non-studied homophones (NHF) were significantly more accurate than non-studied controls (NCT). However, NHF was still less accurate than SCT, which was the condition with the most correct trials. In addition, although RT comparisons were not significant, NHF also had a faster mean RT than NCT.

Although hypothesis H1 was raised concerning the language decision task of Experiment 1, it was also expected that Experiment 2 would provide evidence that the same occurred both for studied and non-studied words in the translation task. However, this lack of homophone effect between NHF and NCT is contrary to the first predictions. A possible explanation for this unexpected finding may be the task context that participants were exposed to, which required participants to rely on semantics.

Considering the results of both experiments, it may be the case that the phonological ambiguity of interlingual homophones only have an effect on accuracy for the recognition of Portuguese words in the language decision task and for the translation of words with repeated exposure (with previously studied stimuli: SHF and SCT). In a translation task, participants had to rely more on semantics than phonological features to select the correct answer. Thus, the phonological overlap could not have a significant effect over semantics in the translation of non-studied words. On the other hand, although no priming effect was observed between studied and non-studied interlingual homophones, studied words may have had an interlingual homophone effect in relation to its controls precisely because they were previously seen in Experiment 1, that is, due to repetition priming. In other words, inhibitory effects of homophones compared to its controls may have depended on prior exposure to maintain their phonological information activated.

In short, the results of Experiment 2 showed evidence for a repetition priming effect for control words in the accuracy data, but not for interlingual homophones. In addition, some noteworthy findings were observed: inferential statistics showed no significant effect of word conditions on reaction times, participants were faster to make translation choices for English words, and homophone effects were not consistent across experimental tasks. The results were contrary to the previously raised hypotheses H1 and H2 but were comparable with other findings of previous studies. Tentative explanations based on previous studies were provided for the observed data, but other factors that were not present in the analyses may have influenced the present findings and should be investigated in future research.

5 FINAL REMARKS

This chapter provides the final considerations for the present research and its respective contributions. The section starts by restating the objectives and the methodology that was used, then the major findings of the study are summarized addressing the research hypothesis, and at last the study’s limitations are discussed along proposals for future research.

The present study aimed at investigating the effect of interlingual homophones on bilingual lexical access in silent reading at the word level. This general objective was motivated by research gaps in the literature of bilingual lexical access, which generally focus on investigating homographs and cognate words in visual word cognition. This focus ends up resulting in lack of evidence for the understanding of the influence of phonological aspects in bilingual lexical access, especially on what concerns non-European bilinguals. This study is believed to be the pioneering investigation into bilingual lexical access of interlingual homophones with the language pair of Brazilian Portuguese and English.

For its main purpose, this study counted on the elaboration of a corpus which had interlingual homophones and control words in the mentioned languages as the critical stimuli, carefully selected to be comparable in word Frequency and word length. No cognates nor homographs were part of the word lists. This research was carried out with a quantitative experimental methodology applied in real time through the online and free software PsyToolKit (Stoet, 2010, 2017), which allowed the data collection for two experiments: a language decision task, and subsequent multiple choice task.

In Experiment 1, participants encountered L1 and L2 words in random order to decide which language the presented stimulus belonged to by pressing “A” and “L” on their keyboards. It was predicted that interlingual homophones would have a higher processing cost in relation to control words in the language decision task, reflected on longer reaction times (hypothesis - H1), and that inhibitory effects would be stronger for interlingual homophones from participants’ L2 in comparison to participants’ L1 (Hypothesis H3).

The results of the first task showed significant homophone effects in comparison to matched controls only for the condition of Portuguese interlingual homophones (HFP) in the accuracy data, but not in the RT data. Interlingual homophones and controls in the English language (HFE and CTE) did not differ significantly neither in the accuracy nor in the RT analyses. In addition, even though they did not significantly differ in accuracy rates, language decisions to HFPs were significantly slower than to HFEs. These findings partially support hypothesis H1, because homophones did not have significant effects for the English language; and reject hypothesis H3, because L1 homophones actually had an advantage in RTs of language decisions compared to L2 homophones.

In Experiment 2, participants had to select the correct translation equivalent to the presented words choosing one of three available options. This multiple choice translation task was designed in order to check for repetition priming effects. According to hypothesis H2, it was predicted that interlingual homophones that were previously seen in Experiment 1 would present a repetition priming effect in comparison to control words and interlingual homophones that were not present in Experiment 1. For the results analysis of this second task, the words were divided into four conditions: studied homophones (SHF), non-studied homophones (NHF), studied controls (SCT), and non-studied controls (NCT).

The results of experiment 2 only showed significant repetition priming effects for control words in the accuracy data, evidenced by the fact that SCTs were significantly more accurate but not significantly faster than NCTs. In fact, inferential analyses showed no significant differences in the RT data across conditions in Experiment 2. Regarding the comparison of studied and non-studied interlingual homophones (SHF and NHF), the results revealed no significant differences for accuracy or RT. Only a small inhibitory trend due to prior exposure of these homophones was observed in descriptive statistics of the translation task. Considering such results, however, hypothesis H2 could not be confirmed.

Despite the lack of support for the raised hypotheses, the experimental tasks of this research provided noteworthy results that were comparable to previous studies, and also some unexpected findings that strongly contribute to the understanding of bilingual lexical access with ambiguous stimuli in word reading and translation. Different from previous studies of the same laboratory, for example, there was no significant difference between English and Portuguese controls in the language decision task. Previous studies from LabFoM (UFC) had shown that participants were faster to respond to English controls, which was argued as evidence of higher L2 activation or a frequency effect. In the present study, however, CTPs were not significantly different from CTEs neither in accuracy nor in RT. This may have happened because both control conditions were highly matched in word frequency, which did not occur in the previous studies (Gadelha, 2021; Batista, 2022; Borém, 2023.).

On the other hand, language decisions to English homophones were significantly faster than those to Portuguese homophones in Experiment 1, suggesting that the ambiguity cost of phonological overlap was greater when interlingual homophones were presented in the participants' L1. In addition, Interlingual homophones were significantly less accurate than their matched controls for the Portuguese language, but not for the English language. These findings suggest that accuracy of language decisions is affected by the presentation of L1 words that resemble L2 homophonic counterparts, but not by L2 words that resemble L1 homophonic counterparts

More specifically, when ambiguous phonological words are visually presented for recognition in the participants' L1, the L2 phonological information is also activated, which leads to the semantic retrieval of that L2 homophonic counterpart and hinders the chance of correctly responding to that trial. In the reverse direction, L2 phonologically ambiguous words may also have activated their L1 homophonic counterparts, but not strongly enough to reach statistical significance. These results were against the ones of Haigh and Jared (2007), who found interlingual homophone effects in the L2-L1 direction only. It was argued that the present results did not align with Haigh and Jared (2007) due to task type and grouping of participants.

In addition, since the words were visually presented, it is possible that orthographic sub-lexical cues influenced participants not to make as many mistakes for interlingual homophones presented in English in Experiment 1 of the present study. All these implications are supported by the Multilink model of bilingual word recognition and translation (Dijkstra *et al.*, 2018), which assumes that written input activates associated language membership representations from both languages in a non-selective way.

Experiment 2 also provided some other interesting findings that were beyond the objectives of this study but are relevant for bilingual language processing. It was observed that participants were faster to make translation decisions to English words than to Portuguese words, which indicated that backward (L2 – L1) translation was easier than forward (L1 – L2) translation. The translation task also revealed that homophone effects were not consistent across experiments 1 and 2, which suggested that these effects were modulated by task nature and also by prior exposure.

As for the limitations of the present research, some factors should be considered. First, some variables such as family size and neighborhood density could not be controlled in the preparation of the corpus due to the difficulty of selecting interlingual homophones between Brazilian Portuguese and English. The used corpora databases used for word selection did not provide comparable measures of such variables across these languages. It is worth noting, as well, that the selection of confounding and distracting words of the translation task was controlled for frequency and word length, but semantic or orthographic overlap were subjectively judged by the researcher. Quantitatively measuring similarities for all words of this study was not possible due to time constraints in implementing such calculations automatically. Future research could investigate how these variables in word lists influence the results that were observed.

Second, also due to time constraints, the analyses that were carried out for Experiments 1 and 2 in the present paper were very short and only included the predictors that were directly related to the independent variables of interest to answer the research questions of this study: word conditions. However, other factors and interactions should be investigated in future studies to assess, for example, the influence of proficiency, language, and word frequency on the observed results. In fact, the lack of significant RT comparisons and the inconsistency of homophone effects across experiments in this study strongly suggest that other factors may have greater impact on the results.

Third, although this inspection was not carried out in the present paper, further analyses could also be conducted with the incorrect trials of the translation task in order to assess which word options participants selected as incorrect translation equivalents for homophones and control words. It would be interesting to examine if interlingual homophone counterparts were more mistakenly chosen in comparison to distractor words, for example.

In order to add up to the present investigation of the effect of interlingual homophones on bilingual lexical access, some proposals for future research can be suggested. Future studies could replicate this research with auditory instead of visual stimuli. Moreover, the present studied focused on the investigation of interlingual homophones in silent reading at the word level. Future research should extend the investigation by examining these stimuli in the sentence level, and also in tasks that involve productive instead of receptive skills.

Since some findings were not aligned to previous evidence, the same word lists of the present research could be used with other experimental paradigms to verify whether the observed findings were task specific or not. Likewise, the same methodology of this study could be used in research with other language pairs in order to verify whether the observed findings were a consequence of the peculiar orthographic and phonological differences between Brazilian Portuguese and English or whether it could be comparable to other language combinations.

In conclusion, the present study provides further evidence supporting the language non-selective hypothesis predicted by recent models of bilingual lexical access (Dijkstra et al., 2018), but also agree with empirical evidence which highlights that effects can be modulated by task requirements (Toassi et al., 2023) and language dominance (Haigh; Jared, 2007; Van

Assche; Duyck; Brysbaert, 2020). The obtained results also support the distinction between a language identification system and a task/decision system incorporated in bilingual access models such as the BIA+ (Dijkstra; Van Heuven, 2002), and demonstrate the impact of the phonological aspect on bilingual lexical access in silent reading at the word level for Portuguese-English bilinguals.

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APPENDIX A – PYTHON SCRIPT FOR INTERLANGUAGE NORMALIZED LEVENSHTEIN DISTANCE (InLD)

```
import openpyxl


def cost_calc(a, b):
    graph_ptbr_symbols = {"á", "à", "ã", "â", "é", "ê", "í", "ó", "ô", "õ", "ú", "ç", "'"}
    if a == b:
        return 0
    if a != b and a in graph_ptbr_symbols or b in graph_ptbr_symbols:
        return 0.5
    if a != b and a not in graph_ptbr_symbols and b not in graph_ptbr_symbols:
        return 1


def levenshtein_distance(s1, s2):
    # Inicializa uma matriz com zeros
    matrix = [[0 for x in range(len(s2) + 1)] for y in range(len(s1) + 1)]
    # Inicializa a primeira linha e a primeira coluna com os índices
    for i in range(len(s1) + 1):
        matrix[i][0] = i
    for j in range(len(s2) + 1):
        matrix[0][j] = j
    # Preenche a matriz usando a fórmula do algoritmo de Levenshtein
    for i in range(1, len(s1) + 1):
        for j in range(1, len(s2) + 1):
            cost = cost_calc(s1[i - 1], s2[j - 1])
            matrix[i][j] = min(matrix[i - 1][j] + 1,      # Remoção
                               matrix[i][j - 1] + 1,      # Inserção
```

```
                               matrix[i - 1][j - 1] + cost)  # Substituição
    # O valor na célula inferior direita da matriz é a distância de edição
    return matrix[len(s1)][len(s2)]

def calculate_and_save_levenshtein(input_file_path, sheet_name, output_file_path):
    # Load the workbook and select the sheet
    workbook = openpyxl.load_workbook(input_file_path)
    sheet = workbook[sheet_name]

    # Read strings from the first two columns
    strings_col1 = []
    strings_col2 = []
    for row in sheet.iter_rows(min_row=2, max_col=2, values_only=True):
        strings_col1.append(row[0])
        strings_col2.append(row[1])

    # Calculate Levenshtein distances between pairs of strings
    distances = []
    for i in range(len(strings_col1)):
        dist = levenshtein_distance(strings_col1[i], strings_col2[i])
        norm_dist = 1 - (dist / max(len(strings_col1[i]), len(strings_col2[i])))
        distances.append((strings_col1[i], strings_col2[i], dist, norm_dist))
    # for str1 in strings_col1:
    #     for str2 in strings_col2:
    #         dist = levenshtein_distance(str1, str2)
    #         distances.append((str1, str2, dist))

    # Create a new workbook and add the original data
    new_workbook = openpyxl.Workbook()
    new_sheet = new_workbook.active
    new_sheet.title = sheet_name
```

```
    # Copy headers
    new_sheet.cell(1, 1).value = sheet.cell(1, 1).value
    new_sheet.cell(1, 2).value = sheet.cell(1, 2).value
    new_sheet.cell(1, 3).value = "Levenshtein Distance"
    new_sheet.cell(1, 4).value = "Normalized Levenshtein Distance"

    # Copy original data and add distances
    for i, (str1, str2, dist, norm_dist) in enumerate(distances, start=2):
        new_sheet.cell(i, 1).value = str1
        new_sheet.cell(i, 2).value = str2
        new_sheet.cell(i, 3).value = dist
        new_sheet.cell(i, 4).value = norm_dist

    # Save the new workbook
    new_workbook.save(output_file_path)


def merge_workbooks(input_file_paths, output_file_path):
    # Create a new workbook
    new_workbook = openpyxl.Workbook()
    new_workbook.remove(new_workbook.active)  # Remove the default sheet

    for file_path in input_file_paths:
        # Load the current workbook
        workbook = openpyxl.load_workbook(file_path)

        for sheet_name in workbook.sheetnames:
            # Get the sheet from the current workbook
            sheet = workbook[sheet_name]
```

```
            # Create a new sheet in the new workbook with the same name
            new_sheet = new_workbook.create_sheet(title=sheet_name)

            # Copy the data from the current sheet to the new sheet
            for row in sheet.iter_rows(values_only=True):
                new_sheet.append(row)

    # Save the new workbook
    new_workbook.save(output_file_path)


if __name__ == '__main__':
    # Exemplo de uso
    s1 = "'ali"
    s2 = "a'li"
    dist = levenshtein_distance(s1, s2)
    print("Normalized Levenshtein distance between '{}' and '{}': {}".format(s1, s2, 1 - (dist / max(len(s1), len(s2)))))
    print("Distância de edição entre '{}' e '{}': {}".format(s1, s2, levenshtein_distance(s1, s2)))

    #uncomment below to run with files

    # calculate_and_save_levenshtein("wordss.xlsx", "HFExHFP", "res1.xlsx")
    # calculate_and_save_levenshtein("wordss.xlsx", "HFExCTE", "res2.xlsx")
    # calculate_and_save_levenshtein("wordss.xlsx", "HFPxCTP", "res3.xlsx")
    # input_file_paths = ["res1.xlsx", "res2.xlsx", "res3.xlsx"]
    # output_file_path = "results.xlsx"
    # merge_workbooks(input_file_paths, output_file_path)

    # #phon similarity ------------------

    # #rename entry excel file (1st argument)
```

```
# calculate_and_save_levenshtein("wordss.xlsx", "HFExHFP", "res4.xlsx")
# calculate_and_save_levenshtein("wordss.xlsx", "HFExCTE", "res5.xlsx")
# calculate_and_save_levenshtein("wordss.xlsx", "HFPxCTP", "res6.xlsx")
# input_file_paths = ["res4.xlsx", "res5.xlsx", "res6.xlsx"]
# output_file_path = "results_phon.xlsx"
# merge_workbooks(input_file_paths, output_file_path)
```

Source: adapted from André (2024), following the methodology of Post da Silveira and Van Leussen (2015).

APPENDIX B – WORD LIST OF EXPERIMENT 2A

WORD	ID	COND	LET	ZIPF	OPT1	COND1	LET1	ZIPF1	OPT2	COND2	LET2	ZIPF2	OPT3	COND3	LET3	ZIPF3	KEY
"can"	1	"SHFE"	3	6,72	"quem"	"homophone"	4	5,85	"quais"	"distractor"	5	5,24	"poder"	"translation"	5	5,39	3
"city"	2	"SHFE"	4	5,23	"cidade"	"translation"	6	5,72	"siri"	"homophone"	4	2,93	"seco"	"distractor"	4	4,02	1
"color"	3	"SHFE"	5	4,60	"cola"	"homophone"	4	3,70	"colo"	"distractor"	4	3,94	"cor"	"translation"	3	4,72	3
"cow"	4	"SHFE"	3	4,41	"gel"	"distractor"	3	3,35	"vaca"	"translation"	4	3,89	"cal"	"homophone"	3	3,39	2
"hoper"	5	"SHFE"	5	1,77	"esperançoso"	"translation"	11	2,29	"roupa"	"homophone"	5	4,53	"trama"	"distractor"	5	4,45	1
"lay"	6	"SHFE"	3	4,76	"lado"	"distractor"	4	5,58	"lei"	"homophone"	3	5,59	"deitar"	"translation"	6	3,47	3
"match"	7	"SHFE"	5	4,69	"mete"	"homophone"	4	3,40	"gere"	"distractor"	4	3,37	"partida"	"translation"	7	5,32	3
"mean"	8	"SHFE"	4	6,09	"muita"	"distractor"	5	5,14	"significar"	"translation"	10	3,99	"mim"	"homophone"	3	5,03	2
"mice"	9	"SHFE"	4	3,82	"como"	"distractor"	4	6,56	"ratos"	"translation"	5	4,04	"mais"	"homophone"	4	6,53	2
"paint"	10	"SHFE"	5	4,57	"pintar"	"translation"	6	3,95	"pente"	"homophone"	5	3,13	"pesar"	"distractor"	5	3,59	1
"pie"	11	"SHFE"	3	4,46	"torta"	"translation"	5	2,69	"pai"	"homophone"	3	5,22	"pão"	"distractor"	3	4,31	1
"sail"	12	"SHFE"	4	4,14	"seio"	"homophone"	4	4,12	"surgir"	"distractor"	6	4,18	"velejar"	"translation"	7	2,66	3
"sat"	13	"SHFE"	3	4,46	"sentado"	"translation"	7	3,97	"sete"	"homophone"	4	5,23	"criado"	"distractor"	6	4,69	1
"sigh"	14	"SHFE"	4	3,53	"sai"	"homophone"	3	4,98	"seca"	"distractor"	4	4,18	"suspiro"	"translation"	7	3,50	3
"view"	15	"SHFE"	4	4,59	"vista"	"translation"	5	4,89	"viu"	"homophone"	3	4,86	"vaga"	"distractor"	4	4,79	1
"are"	16	"SCTE"	3	6,72	"foi"	"confounder"	3	6,51	"diz"	"distractor"	3	6,02	"são"	"translation"	3	6,22	3
"ship"	17	"SCTE"	4	5,21	"sinal"	"confounder"	5	4,80	"carne"	"distractor"	5	4,80	"navio"	"translation"	5	4,45	3
"candy"	18	"SCTE"	5	4,43	"canto"	"confounder"	5	4,54	"doce"	"translation"	4	4,16	"porte"	"distractor"	5	4,53	2
"cap"	19	"SCTE"	3	4,27	"cabos"	"confounder"	5	4,28	"missa"	"distractor"	5	4,28	"boné"	"translation"	4	3,76	3
"sizer"	20	"SCTE"	5	1,77	"medidor"	"translation"	7	3,18	"sapeca"	"confounder"	6	2,21	"albino"	"distractor"	6	2,47	1
"low"	21	"SCTE"	3	4,77	"cheio"	"confounder"	5	4,43	"rural"	"distractor"	5	4,52	"baixo"	"translation"	5	4,69	3
"mercy"	22	"SCTE"	5	4,64	"emergência"	"confounder"	10	4,47	"misericórdia"	"translation"	12	3,31	"suficiente"	"distractor"	10	4,70	2
"make"	23	"SCTE"	4	6,14	"fazer"	"translation"	5	5,82	"mexer"	"confounder"	5	4,06	"ouvir"	"distractor"	5	4,77	1
"melt"	24	"SCTE"	4	3,71	"mandar"	"confounder"	6	4,33	"anunciar"	"distractor"	8	4,43	"derreter"	"translation"	8	2,77	3
"pride"	25	"SCTE"	5	4,44	"prédios"	"confounder"	7	4,41	"quantia"	"distractor"	7	4,25	"orgulho"	"translation"	7	4,22	3
"pen"	26	"SCTE"	3	4,39	"pano"	"confounder"	4	4,05	"caneta"	"translation"	6	3,86	"mania"	"distractor"	5	4,01	2
"slap"	27	"SCTE"	4	4,10	"tapa"	"translation"	4	3,61	"estréia"	"confounder"	7	4,06	"segredo"	"distractor"	7	4,46	1
"spy"	28	"SCTE"	3	4,30	"espião"	"translation"	6	3,02	"esposa"	"confounder"	6	4,04	"célula"	"distractor"	6	4,22	1
"sung"	29	"SCTE"	4	3,54	"sonoro"	"confounder"	6	3,62	"cantado"	"translation"	7	3,53	"oposto"	"distractor"	6	3,78	2
"suck"	30	"SCTE"	4	4,54	"chupar"	"translation"	6	2,87	"suco"	"confounder"	4	4,17	"tocar"	"distractor"	5	4,59	1
"day"	31	"NHFE"	3	5,90	"dom"	"distractor"	3	4,47	"dia"	"translation"	3	6,08	"dei"	"homophone"	3	4,04	2
"fail"	32	"NHFE"	4	4,39	"malhar"	"distractor"	6	2,72	"falhar"	"translation"	6	3,38	"feio"	"homophone"	4	4,01	2
"hood"	33	"NHFE"	4	4,19	"capuz"	"translation"	5	2,87	"rude"	"homophone"	4	3,38	"sino"	"distractor"	4	3,36	1
"lack"	34	"NHFE"	4	4,25	"leque"	"homophone"	5	3,74	"grana"	"distractor"	5	3,74	"falta"	"translation"	5	5,39	3
"last"	35	"NHFE"	4	5,86	"leste"	"homophone"	5	4,81	"cartão"	"distractor"	6	4,81	"último"	"translation"	6	5,48	3
"sue"	36	"NHFE"	3	4,47	"processar"	"translation"	9	4,16	"sul"	"homophone"	3	5,27	"possui"	"distractor"	6	4,81	1
"mail"	37	"NHFE"	4	4,57	"corpo"	"distractor"	5	5,21	"correio"	"translation"	7	4,25	"meio"	"homophone"	4	5,22	2
"never"	38	"NHFE"	5	6,13	"neva"	"homophone"	4	2,36	"nadas"	"distractor"	5	2,21	"nunca"	"translation"	5	5,41	3
"past"	39	"NHFE"	4	5,09	"pastas"	"distractor"	6	3,74	"passado"	"translation"	7	5,48	"peste"	"homophone"	5	3,80	2
"vain"	40	"NHFE"	4	3,81	"vão"	"translation"	3	4,16	"vem"	"homophone"	3	1,51	"voe"	"distractor"	3	2,72	1
"sauce"	41	"NHFE"	5	4,19	"molho"	"translation"	5	4,07	"sós"	"homophone"	3	3,53	"goma"	"distractor"	4	3,53	1
"say"	42	"NHFE"	3	6,21	"sair"	"distractor"	4	5,09	"dizer"	"translation"	5	5,40	"sei"	"homophone"	3	5,05	2
"seller"	43	"NHFE"	6	3,34	"cela"	"homophone"	4	3,99	"luneta"	"distractor"	6	4,00	"vendedor"	"translation"	8	4,14	3

"under"	44	"NHFE"	5	5,42	"sócio"	"distractor"	5	4,38	"debaixo"	"translation"	7	4,12	"anda"	"homophone"	4	4,42	2
"value"	45	"NHFE"	5	4,33	"valor"	"translation"	5	5,50	"velho"	"homophone"	5	4,89	"visto"	"distractor"	5	4,83	1
"dad"	46	"NCTE"	3	5,70	"par"	"confounder"	3	4,30	"rei"	"distractor"	3	4,69	"pai"	"translation"	3	5,22	3
"flip"	47	"NCTE"	4	4,15	"virar"	"translation"	5	4,46	"fixar"	"confounder"	5	4,24	"ceder"	"distractor"	5	4,08	1
"bend"	48	"NCTE"	4	4,18	"botar"	"confounder"	5	3,94	"impor"	"distractor"	5	4,29	"dobrar"	"translation"	6	3,96	3
"flag"	49	"NCTE"	4	4,24	"bandeira"	"translation"	8	4,49	"falado"	"confounder"	6	3,97	"folclore"	"distractor"	8	3,72	1
"left"	50	"NCTE"	4	5,68	"legislação"	"confounder"	10	4,83	"esquerda"	"translation"	8	4,48	"apenas"	"distractor"	6	5,89	2
"lesson"	51	"NCTE"	6	4,51	"lição"	"translation"	5	4,22	"lances"	"confounder"	6	4,14	"janela"	"distractor"	6	4,42	1
"meal"	52	"NCTE"	4	4,46	"meia"	"confounder"	4	4,95	"refeição"	"translation"	8	3,96	"esquema"	"distractor"	7	4,37	2
"after"	53	"NCTE"	5	5,83	"falta"	"distractor"	5	5,39	"depois"	"translation"	6	5,93	"algum"	"confounder"	5	5,18	2
"poor"	54	"NCTE"	4	5,11	"povo"	"confounder"	4	5,05	"zona"	"distractor"	4	5,47	"pobre"	"translation"	5	4,62	3
"vows"	55	"NCTE"	4	3,81	"votos"	"translation"	5	5,17	"veias"	"confounder"	5	3,54	"lojas"	"distractor"	5	5,14	1
"strip"	56	"NCTE"	5	4,20	"trigo"	"confounder"	5	4,18	"nariz"	"distractor"	5	4,18	"tira"	"translation"	4	4,26	3
"had"	57	"NCTE"	3	6,22	"havia"	"confounder"	5	5,55	"era"	"distractor"	3	5,98	"tinha"	"translation"	5	5,59	3
"elbows"	58	"NCTE"	6	3,39	"elevam"	"confounder"	6	3,39	"cotovelos"	"translation"	9	2,94	"lanterna"	"distractor"	8	3,59	2
"hands"	59	"NCTE"	5	5,37	"horas"	"confounder"	5	5,35	"mãos"	"translation"	4	4,99	"sabe"	"distractor"	4	5,28	2
"wives"	60	"NCTE"	5	4,19	"nuvens"	"confounder"	6	4,13	"multas"	"distractor"	6	4,37	"esposas"	"translation"	7	2,91	3

Source: own authorship.

APPENDIX C – WORD LIST OF EXPERIMENT 2B

WORD	ID	COND	LET	ZIPF	OPT1	COND1	LET1	ZIPF1	OPT2	COND2	LET2	ZIPF2	OPT3	COND3	LET3	ZIPF3	KEY
"quem"	1	"SHFP"	4	5,85	"can"	"homophone"	3	6,72	"was"	"distractor"	3	6,75	"who"	"translation"	3	6,346	3
"siri"	2	"SHFP"	4	2,93	"crab"	"translation"	4	3,84	"city"	"homophone"	4	5,23	"club"	"distractor"	4	4,994	1
"cola"	3	"SHFP"	4	3,70	"color"	"homophone"	5	4,60	"echo"	"distractor"	4	3,84	"glue"	"translation"	4	3,770	3
"cal"	4	"SHFP"	3	3,39	"cough"	"distractor"	5	3,94	"chalk"	"translation"	5	3,56	"cow"	"homophone"	3	4,406	2
"roupa"	5	"SHFP"	5	4,53	"clothing"	"translation"	8	4,04	"hoper"	"homophone"	5	1,77	"package"	"distractor"	7	4,357	1
"lei"	6	"SHFP"	3	5,59	"leg"	"distractor"	3	4,75	"lay"	"homophone"	3	4,76	"law"	"translation"	3	5,065	3
"mete"	7	"SHFP"	4	3,40	"match"	"homophone"	5	4,69	"cook"	"distractor"	4	4,66	"put"	"translation"	3	5,918	3
"mim"	8	"SHFP"	3	5,03	"my"	"distractor"	2	6,83	"me"	"translation"	2	6,97	"mean"	"homophone"	4	6,094	2
"mais"	9	"SHFP"	4	6,53	"miss"	"distractor"	4	5,67	"more"	"translation"	4	6,11	"mice"	"homophone"	4	3,818	2
"pente"	10	"SHFP"	5	3,13	"comb"	"translation"	4	3,78	"paint"	"homophone"	5	4,57	"spell"	"distractor"	5	4,564	1
"pai"	11	"SHFP"	3	5,22	"dad"	"translation"	3	5,70	"pie"	"homophone"	3	4,46	"lad"	"distractor"	3	4,159	1
"seio"	12	"SHFP"	4	4,12	"sail"	"homophone"	4	4,14	"frame"	"distractor"	5	4,15	"breast"	"translation"	6	3,953	3
"sete"	13	"SHFP"	4	5,23	"seven"	"translation"	5	5,02	"sat"	"homophone"	3	4,46	"size"	"distractor"	4	4,664	1
"sai"	14	"SHFP"	3	4,98	"sigh"	"homophone"	4	3,53	"boost"	"distractor"	5	3,66	"leave"	"translation"	5	5,748	3
"viu"	15	"SHFP"	3	4,86	"saw"	"translation"	3	5,60	"view"	"homophone"	4	4,59	"owe"	"distractor"	3	4,870	1
"qual"	16	"SCTP"	4	5,56	"when"	"confounder"	4	6,31	"wife"	"distractor"	4	5,54	"which"	"translation"	5	5,678	3
"ceia"	17	"SCTP"	4	3,61	"singer"	"confounder"	6	4,20	"shower"	"distractor"	6	4,61	"supper"	"translation"	6	4,287	3
"coca"	18	"SCTP"	4	3,72	"cats"	"confounder"	4	4,29	"coke"	"translation"	4	4,27	"ease"	"distractor"	4	4,281	2
"cru"	19	"SCTP"	3	3,57	"icy"	"confounder"	3	3,43	"tan"	"distractor"	3	3,94	"raw"	"translation"	3	4,008	3
"rosto"	20	"SCTP"	5	4,64	"face"	"translation"	4	5,46	"lost"	"confounder"	4	5,44	"such"	"distractor"	4	5,464	1
"luz"	21	"SCTP"	3	5,01	"white"	"confounder"	5	5,23	"black"	"distractor"	5	5,22	"light"	"translation"	5	5,217	3
"moro"	22	"SCTP"	4	3,54	"meet"	"confounder"	4	5,55	"run"	"translation"	3	5,54	"live"	"distractor"	4	5,537	3
"mal"	23	"SCTP"	3	5,01	"badly"	"translation"	5	4,42	"mostly"	"confounder"	6	4,42	"truly"	"distractor"	5	4,555	1
"como"	24	"SCTP"	4	6,56	"only"	"confounder"	4	6,03	"one"	"distractor"	3	6,49	"how"	"translation"	3	6,485	3
"parto"	25	"SCTP"	5	3,97	"party"	"confounder"	5	5,37	"highlight"	"distractor"	9	3,19	"childbirth"	"translation"	10	3,189	3
"pra"	26	"SCTP"	3	4,78	"from"	"confounder"	4	6,31	"for"	"translation"	3	6,84	"with"	"distractor"	4	6,703	2
"saia"	27	"SCTP"	4	3,97	"skirt"	"translation"	5	4,00	"pants"	"confounder"	5	4,77	"buttons"	"distractor"	7	3,940	1
"seis"	28	"SCTP"	4	5,41	"six"	"translation"	3	5,30	"third"	"confounder"	5	4,87	"ten"	"distractor"	3	5,161	1
"som"	29	"SCTP"	3	4,93	"soon"	"confounder"	4	5,41	"sound"	"translation"	5	5,16	"sort"	"distractor"	4	5,172	2
"vir"	30	"SCTP"	3	4,65	"come"	"translation"	4	6,50	"see"	"confounder"	3	6,41	"take"	"distractor"	4	6,276	1
"dei"	31	"NHFP"	3	4,04	"came"	"distractor"	4	5,67	"gave"	"translation"	4	5,39	"day"	"homophone"	3	5,903	2
"feio"	32	"NHFP"	4	4,01	"pure"	"distractor"	4	4,40	"ugly"	"translation"	4	4,62	"fail"	"homophone"	4	4,390	2
"rude"	33	"NHFP"	4	3,38	"rough"	"translation"	5	4,57	"hood"	"homophone"	4	4,19	"rare"	"distractor"	4	4,328	1
"leque"	34	"NHFP"	5	3,74	"lack"	"homophone"	4	4,25	"toy"	"distractor"	3	4,23	"fan"	"translation"	3	4,545	3
"leste"	35	"NHFP"	5	4,81	"last"	"homophone"	4	5,86	"cost"	"distractor"	4	4,74	"east"	"translation"	4	4,695	3
"sul"	36	"NHFP"	3	5,27	"south"	"translation"	5	4,81	"sue"	"homophone"	3	4,47	"silly"	"distractor"	5	4,756	1
"meio"	37	"NHFP"	4	5,22	"miles"	"distractor"	5	4,95	"middle"	"translation"	6	4,95	"mail"	"homophone"	4	4,566	2
"neva"	38	"NHFP"	4	2,36	"never"	"homophone"	5	6,13	"swims"	"distractor"	5	3,16	"snows"	"translation"	5	3,111	3
"peste"	39	"NHFP"	5	3,80	"peach"	"distractor"	5	3,80	"plague"	"translation"	6	3,92	"past"	"homophone"	4	5,092	2
"vem"	40	"NHFP"	3	5,44	"come"	"translation"	4	6,50	"vain"	"homophone"	4	3,81	"time"	"distractor"	4	6,291	1
"sós"	41	"NHFP"	3	3,53	"alone"	"translation"	5	5,49	"sauce"	"homophone"	5	4,19	"close"	"distractor"	5	5,341	1
"sei"	42	"NHFP"	3	5,05	"tell"	"distractor"	4	6,24	"know"	"translation"	4	6,76	"say"	"homophone"	3	6,214	2
"cela"	43	"NHFP"	4	3,99	"seller"	"homophone"	6	3,34	"mall"	"distractor"	4	4,28	"cell"	"translation"	4	4,735	3

"anda"	44	"NHFP"	4	4,42	"hands"	"distractor"	5	5,37	"walks"	"translation"	5	4,26	"under"	"homophone"	5	5,418	2
"velho"	45	"NHFP"	5	4,89	"old"	"translation"	3	5,78	"value"	"homophone"	5	4,33	"wet"	"distractor"	3	4,593	1
"dou"	46	"NCTP"	3	4,04	"diet"	"confounder"	4	4,19	"spoil"	"distractor"	5	4,07	"give"	"translation"	4	6,067	3
"fiel"	47	"NCTP"	4	4,14	"loyal"	"translation"	5	4,08	"lawyer"	"confounder"	6	4,90	"lovely"	"distractor"	6	4,978	1
"reto"	48	"NCTP"	4	3,24	"strong"	"confounder"	6	4,94	"scared"	"distractor"	6	5,12	"straight"	"translation"	8	5,087	3
"lápis"	49	"NCTP"	5	3,76	"pencil"	"translation"	6	3,99	"phrase"	"confounder"	6	3,96	"polish"	"distractor"	6	3,986	1
"lucro"	50	"NCTP"	5	4,81	"prior"	"confounder"	5	3,92	"profit"	"translation"	6	4,04	"lungs"	"distractor"	5	4,025	2
"sob"	51	"NCTP"	3	5,42	"beneath"	"translation"	7	4,07	"beside"	"confounder"	6	4,18	"onto"	"distractor"	4	4,564	1
"medo"	52	"NCTP"	4	4,93	"afraid"	"confounder"	6	5,39	"fear"	"translation"	4	4,84	"holy"	"distractor"	4	4,833	2
"neve"	53	"NCTP"	4	4,12	"sneak"	"distractor"	5	4,23	"snow"	"translation"	4	4,50	"snake"	"confounder"	5	4,349	2
"pesos"	54	"NCTP"	5	3,90	"weirdo"	"confounder"	6	3,50	"tyres"	"distractor"	5	3,43	"weights"	"translation"	7	3,429	3
"ver"	55	"NCTP"	3	5,46	"see"	"translation"	3	6,41	"say"	"confounder"	3	6,21	"let"	"distractor"	3	6,383	1
"nus"	56	"NCTP"	3	3,57	"nasty"	"confounder"	5	4,35	"loose"	"distractor"	5	4,62	"naked"	"translation"	5	4,594	3
"ser"	57	"NCTP"	3	6,36	"do"	"confounder"	2	6,79	"have"	"distractor"	4	6,79	"be"	"translation"	2	6,759	3
"copo"	58	"NCTP"	4	3,98	"copy"	"confounder"	4	4,72	"glass"	"translation"	5	4,78	"knife"	"distractor"	5	4,670	2
"arma"	59	"NCTP"	4	4,58	"army"	"confounder"	4	4,93	"weapon"	"translation"	6	4,67	"shirt"	"distractor"	5	4,666	2
"vagas"	60	"NCTP"	5	4,72	"variables"	"confounder"	9	3,02	"volcanoes"	"distractor"	9	2,96	"vacancies"	"translation"	9	2,883	3

Source: own authorship.