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SANDRO ALMEIDA BORÉM

THE TRANSLATION PROCESS OF BRAZILIAN PORTUGUESE-ENGLISH COGNATE WORDS

FORTALEZA

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SANDRO ALMEIDA BORÉM

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Dissertação apresentada ao Programa de Pós-Graduação em Estudos da Tradução da Universidade Federal do Ceará, como requisito parcial à obtenção do título de mestre em Estudos da Tradução. Área de concentração: Tradução: linguagem, cognição e recursos tecnológicos.

Orientadora: Profa. Dr. Pâmela Freitas Pereira Toassi.

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BANCA EXAMINADORA

____

Profa. Dra. Pâmela Freitas Pereira Toassi (Orientadora)
Universidade Federal do Ceará (UFC)

____

Profa. Dra. Lídia Amélia de Barros Cardoso
Universidade Federal do Ceará (UFC)

____

Profa. Dra. Ana Beatriz Arêas da Luz Fontes
Universidade Federal do Rio Grande do Sul (UFRGS)

____

Prof. Dr. Justin Lauro
Barry University (BU)

To God and myself.

To my wife, Jéssica Bezerra Ventura Borém, and everyone who supported me in achieving this task.

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"If I speak in the tongues of men or of angels, but do not have love, I am only a resounding gong or a clanging cymbal" (1 CORINTHIANS 13:1, the Holy Bible).

RESUMO

O presente estudo delimitou-se aos Estudos de Tradução sob a perspectiva da Psicolinguística. Ele faz parte de um projeto maior que realiza e divulga estudos experimentais no processamento de linguagem para bilingues e multilíngues, aproximando os Estudos de Tradução e a Psicolinguística. O presente estudo teve como objetivo investigar, sob uma perspectiva psicolinguística, os processos cognitivos envolvidos no reconhecimento de palavras e acesso lexical em uma tarefa de decisão linguística e determinar se a exposição repetida às mesmas palavras em diferentes línguas em uma tarefa de tradução pode levar a traduções mais rápidas e precisas. Esse objetivo geral foi dividido em dois objetivos específicos: 1) Avaliar o custo de processamento de palavras cognatas português-inglês em comparação com palavras não cognatas em uma tarefa de decisão linguística. 2) Investigar se houve efeitos de priming de repetição de palavras cognatas no processo de tradução. Estudos que foram realizados por Laviosa (2014), Toassi (2016, 2020), Ferreira, Schwieter e Gile (2015), de Groot (2011), Dijkstra *et al.* (2002, 2005, 2018), Basnight-Brown (2014), Hall *et al.* (2009), Grosjean (2010), entre outros autores, deram suporte teórico ao presente estudo. O estudo usou uma metodologia experimental quantitativa aplicada em tempo real, que forneceu informações sobre o tempo de reação e a acurácia dos participantes quando eles realizaram uma tarefa de decisão linguística e uma tarefa de tradução. As tarefas foram realizadas usando o software PsyToolkit (STOET, 2010, 2017). O corpus deste estudo consistiu em 208 palavras no total: 26 palavras cognatas escritas em português brasileiro (CGP), 26 palavras cognatas escritas em inglês (CGE), 26 palavras de controle em português brasileiro (CTP) e outras 26 palavras de controle em inglês (CTE). Também havia 52 palavras distratoras e outras 52 palavras confundidoras. Duas hipóteses foram levantadas: H1 - O custo de processamento de palavras cognatas é maior quando comparado ao custo de processamento de palavras não cognatas em uma tarefa de decisão linguística e H2 - Existem efeitos de priming de repetição de palavras cognatas no processo de tradução. Os resultados da tarefa de decisão linguística mostraram que as palavras de controle em inglês foram processadas mais rapidamente e com maior acurácia do que as palavras nas outras condições. Este resultado pode ser usado para identificar diferenças nos tempos de processamento e precisão para cognatos e não-cognatos. Pode ser que as palavras de controle em inglês tiveram maior acurácia e tempos de resposta mais curtos do que as palavras nas outras condições porque o inglês dos participantes estava altamente ativado. No que diz respeito à tarefa de tradução, os resultados mostraram que os efeitos de priming de repetição foram evidentes, portanto, a hipótese H2 pôde ser confirmada.

O presente estudo sugeriu que uma baixa proficiência em inglês pode afetar o tempo de reação e a acurácia, e que o efeito de priming de repetição pode diminuir com o aumento da proficiência. Estas conclusões podem ser usadas para fomentar os estudos de tradução e fornecer evidências sobre quais estratégias são mais eficazes para bilingues ao acessar itens lexicais em diferentes línguas. Sugere-se que bilingues podem experimentar competição entre palavras em diferentes línguas e que o aumento da exposição à língua e estratégias para inibir cognatos podem beneficiar a compreensão da língua. Os resultados do estudo mostraram que a acurácia na tarefa de tradução foi acima de 95% em todas as condições, indicando que o uso de cognatos na sala de aula poderia ajudar os alunos a melhorar o aprendizado de idiomas.

Palavras-chave: Estudos da Tradução; psicolinguística; léxico; cognatos; priming; bilinguismo.

ABSTRACT

The present study delimited itself to Translation Studies from the perspective of Psycholinguistics. It is part of a larger research project that carries out and disseminates experimental studies in language processing for bilinguals and multilinguals, bridging the gap between Translation Studies and Psycholinguistics. The present study aimed to investigate, from a psycholinguistic perspective, the cognitive processes involved in word recognition and lexical access in a language decision task and to determine whether repeated exposure to the same words in different languages in a translation task can lead to faster and more accurate translations. This general objective was divided into two specific objectives: 1) To evaluate the processing cost of Brazilian Portuguese-English cognate words compared to non-cognate words in a language decision task. 2) To investigate if there were repetition priming effects of cognate words in a translation task. The studies carried out by Laviosa (2014), Toassi (2016, 2020), Ferreira, Schwieter, and Gile (2015), de Groot (2011), Dijkstra *et al.* (2002, 2005, 2018), Basnight-Brown (2014), Hall *et al.* (2009), Grosjean (1982, 1989, 2010, 2019), among other authors, provided theoretical support for the present study. A quantitative experimental methodology was applied in real time, which provided information about the reaction time and accuracy of the participants when they performed a language decision task and a translation task. Both tasks were conducted using the PsyToolkit software (STOET, 2010, 2017). The corpus of this study consisted of 208 words in total: 26 cognate words written in Brazilian Portuguese (CGP), 26 cognate words written in English (CGE), 26 control words in Brazilian Portuguese (CTP), and another 26 control words in English (CTE). There were also 52 distracting words and another 52 confounding words. Two hypotheses were raised: H1 - The processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task and H2 – There are repetition priming effects of cognate words in the translation process. The results of the language decision task showed that English control words were processed faster and more accurately than the words in the other conditions. This result can be used to identify differences in processing times and accuracy for cognates and non-cognates. It might be that the control words in English had higher accuracy and shorter response times than the words in the other conditions because the participants' English was highly activated. Concerning the translation task, the results showed that repetition priming effects of cognate words were evident, therefore, hypothesis H2 was confirmed. The present study also suggested that low proficiency in English can affect reaction time and accuracy, and that the repetition priming effect may decrease with increasing proficiency. These findings can be used to foment translation studies and provide evidence of which strategies are most effective for bilinguals when accessing lexical items in different languages. It is proposed that bilinguals can experience competition between words in different languages and that increasing language exposure and strategies to inhibit cognates can benefit language comprehension. The results of the present study showed that accuracy in the translation task was above 95% in all conditions, indicating that using cognates in the classroom could help students improve language learning.

Keywords: Translation Studies; Psycholinguistics; lexicon; cognates; priming; bilingualism.

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LIST OF ABBREVIATIONS AND ACRONYMS

BIA	Bilingual Interactive Activation
BIMOLA	Bilingual Model of Lexical Access
BLDT	Bilingual Lexical Decision Task
CGE	Cognates in English
CGP	Cognates in Portuguese
CI	Confidence Interval
CLA	Cross-Linguistic Similarities Awareness
CTE	Controls in English
CTP	Controls in Portuguese
DFM	Distributed Feature Model
EEG	Electroencephalography
ERP	Event-Related Potentials
E.g.	Example
fMRI	Functional Magnetic Resonance Imaging
fNIRS	Functional Near-Infrared Spectroscopy
fpmw	Frequency per million words
H1	Hypothesis 1
H2	Hypothesis 2
LabFoM	Phonetics and Multilingualism Laboratory
L1	First or Mother Language
L2	Second or Foreign Language
MT	Machine Translation
ms	Milliseconds
NCG	New Cognates
OCG	Old Cognates
PET	Positron Emission Tomography
RHM	Revised Hierarchical Model
RT	Reaction Time
SLA	Second Language Acquisition
TAP	Think-Aloud-Protocol
TRDI	Test Research and Development Institute

SYMBOLS LIST

< Less than

% Percentage

= Equals

| Pipe

~ Tilde

SUMMARY

1 INTRODUCTION

Translation is increasingly present in our lives. It is used in various domains such as politics, culture, education, social media, and business. In politics, translation is used to help bridge the gap between different cultures and nations. It is used to facilitate diplomatic relations and to build greater understanding between different countries. In culture, translation helps to spread and share information, ideas, and beliefs among those who speak different languages. It also helps to preserve and promote cultural heritage and diversity. In education, translation is used to provide access to educational materials, publications, and websites in different languages. In social media, translation helps to connect people around the globe, allowing them to communicate and share information in different languages. In business, translation is increasingly important in a globalized economy and is used to facilitate international trade, communication, and marketing (MUNDAY, 2012). The advent of bilingualism is another interesting point in the use of translation.

According to Grosjean (2010), bilingualism occurs when people are able to use two languages with equal proficiency, or when they are able to manipulate and use a language in a way that is native-like. This may be a result of having been exposed to two languages from a young age, or from having learned a language as an adult. Verspoor (2015) added that bilingualism can have a number of advantages, such as increased cognitive ability and improved communication skills. Bilingualism can also be beneficial in terms of translation, as it can allow for a more accurate interpretation of the text, as well as a better understanding of the culture in which the text was written (BAKER, 2006).

Bilingualism is so widespread that it is possibly the global norm now, and as pointed out by Harris (1976), being bilingual means being a ‘natural’ translator. Being bilingual means being able to translate from one language naturally and easily to another as if it was a natural ability. In my point of view, Harris (1976) meant that being bilingual means being able to switch between two languages easily and naturally without having to think too much about it. Many other authors agree with this viewpoint, such as Cook and Bassetti (2014) who argue that bilinguals "are able to switch effortlessly between two languages." However, other authors hold a divergent perspective. For example, Grosjean (1982) argued that “the very notion of a ‘natural translator’ is a myth.” Grosjean (1982) argued that bilinguals must still think and process information in order to produce translation, and that translation is not a natural or effortless process.

Even though translation may not be considered a natural or effortless process, monolingual speakers can generally make reasonable sense of foreign-language texts or compose texts in languages unknown to them, with the aid of free machine translation (MT) tools like Google Translate or Microsoft Translator, or a bilingual concordancer like Linguee (Schmitt, 2017). Speech-to-speech translation systems (such as Skype Translator, Google Translate, and iTranslate) are also facilitating communication, thanks to a combination of automatic speech recognition, MT, and speech synthesis, mediated across the cloud and integrated in popular apps (KOEHN, 2019). These systems are already working well enough to support many basic personal communication needs, e.g., for tourist purposes, without prior burdensome training. There are also apps (Waygo, Google Translate) which use a smartphone camera to scan and translate written text, for instance a text written in Chinese characters (Murakami, 2018). Thus, even though we may not be 'natural' translators, we can all be 'geek' translators. Internet users are already accustomed to being able to access translation services for free through online systems.

The present study takes interest in the cognitive process involved in translation. From a psycholinguistic perspective. Christoffels (2004) explains that translation is “used in a broad sense, to refer to any way in which a fragment of source language can be turned into the analogous target language fragment, irrespective of input and output modality.”

Christoffels (2004) expands the concept of translation to include not only written texts, but also spoken words and gestural expressions. This broader definition of translation recognizes the fact that language can be expressed in a variety of ways. Furthermore, it acknowledges that all forms of communication, whether verbal, gestural, or written, are subject to translation, and that translation is an essential part of communication. In addition to verbal and gestural expressions, translation can be applied to visual stimuli including images, videos, and physical objects. According to Christoffels (2004), translation is “the process whereby a fragment of source language is transformed into a target language fragment, regardless of the input and output modality” (p. 3). As such, translation can be applied to any form of communication, including images, videos, and physical objects. This expanded definition of translation takes into account the fact that language is context-dependent, and that translation can be used to bridge cultural and linguistic gaps.

The paragraph about the definition of translation seamlessly transitions into the concept of the present study, which is the processing of cognates. Translation plays a significant role in bridging linguistic and cultural gaps, as discussed in the previous paragraph. Now, let us explore the particular area of focus of this study, which is the definition and concepts related to cognates. To better understand this topic, we can refer to the online Etymology Dictionary, which presents the etymology and meaning of the term "cognate." According to the dictionary, cognate means "allied by blood, connected or related by birth, of the same parentage, descended from a common ancestor." It is derived from the Latin word "cognatus," which means "of common descent." The word "cognate" is also present in Spanish and Italian languages. The etymology of the term "cognate" is rooted in the Proto-Indo-European root *gene-, which means "give birth, beget." Of things, "related in origin, traceable to the same source, " by 1640s; specifically of words, "coming from the same root or original word but showing differences due to subsequent separate phonetic development," by 1782; of languages, "from the same original language," by 1799.

From a psycholinguistic point of view, cognates are words that share a common origin and have similar meanings in two or more languages. (GASS and SELINKER, 2008). When the L1–L2 translation pairs share meaning and form they are called “cognates”. We highlight the Brazilian Portuguese-English cognate words, which is the object of the present study. As an example, we highlight the word *HOSPITAL*. This word is a noun in both Brazilian Portuguese and English and it has the same meaning for both languages as well. Therefore, it is called a cognate although the pronunciation of this same word is different, /'hɑspɪtəl/ in standard American accent and /oʃpi'taw/ in Brazilian Portuguese. The processing and access of phonological features of a word is not part of this study, therefore we will not address this matter for the time being.

Based on etymological relatedness Nash (1976, cited in CARROLL, 1992) distinguished between “true cognates”, “deceptive cognates”, “false cognates”, and “accidental cognates” (DE GROOT, 2011, p.121). However, Carroll (1992) argued against using traditional extensional definitions based on etymology and genetic relatedness. The author argues for defining cognates in terms of their structural representations and the processes which activate and select them. She defines cognates as lexical items from different languages which are identified by bilinguals as somehow being ’the same’. She applies the Cohort Model (MARSLEN-WILSON, 1987) to explain at least four properties of cognates, which are structural units, words, semantically identical words, and formal resemblance. The Cohort Model can be used to explain the activation of multiple lexical candidates in parallel, the activation of multiple lexical candidates in a serial fashion, the inhibition of lexical candidates that are not the target word, and the facilitation of lexical candidates that are the target word. The model proposes that when a word is encountered, a set of lexical candidates (or "cohorts") are activated in parallel, based on the similarity of the encountered word to the lexical candidates. The activation of the lexical candidates is then evaluated in a serial fashion, with the most similar lexical candidate being selected as the target word. Inhibition of lexical candidates that are not the target word occurs as the activation of the target word increases. Additionally, the Cohort Model proposes that the target word is facilitated by the activation of its lexical cohorts, which occurs as the activation of the target word increases and helps to ensure that the target word is selected as the correct word. According to Carroll (1992), these four cognate properties are: 1) Structural Units: A structural unit is a single unit of language that can stand alone and be easily identified. Examples of structural units include phonemes, syllables, morphemes, and words. Structural units are used to create the larger units of language, such as sentences and paragraphs. 2) Words: A word is a meaningful unit of language that can stand alone. Words are composed of smaller units, such as phonemes, morphemes, and syllables. Words are the building blocks of language and can be used to convey meaning. 3) Semantically Identical: Semantically identical words are words that have the same meaning. These words are usually synonyms or antonyms. For example, the words “happy” and “joyous” are semantically identical because they have the same meaning, but they could also be considered semantically identical because they convey the same idea or concept. Similarly, "happy" and "unhappy" are antonyms, but they could also be considered semantically identical in the sense that they both convey some notion of emotional state. 4) Formal Resemblance: Formal resemblance is the similarity between two words in terms of their spelling, pronunciation, or syntax. For example, the words “cat” and “bat” are similar in terms of their spelling and pronunciation but differ in terms of their syntax. The author uses the Cohort Model to explain how the four properties of cognates affect the activation and selection of lexical candidates during word recognition. For instance, formal resemblance, which refers to similarity in spelling, pronunciation, or syntax, can lead to the parallel activation of multiple lexical candidates as several words with similar form are activated simultaneously. Semantic identity, which is when words have the same meaning, can facilitate the selection of the correct target word as activation of semantically related words can ensure that the correct word is selected.

Although these properties are inherent to language, the author uses the Cohort Model to illustrate how they are related to the processes of lexical access and word recognition in bilingual individuals. The application of the Cohort Model to these properties enables a better understanding of how the brain recognizes and processes words.

In summary, the passage discusses how the Cohort Model can be used to explain the recognition and processing of words in the brain, and how it can be applied to define cognates based on their structural representations and activation processes. Another factor that influences bilingual word recognition is the degree of form similarity between words in a bilingual's two languages. Studies have shown that when a word in one language is similar in form to a word in the bilingual's other language, they are more likely to recognize the word in their second language than when the words are not similar in form, as demonstrated by Dijkstra et al. (1999). They found that when a bilingual is presented with a word in one language that is similar in form to a word in their other language, they are more likely to recognize the word in their second language than when the words are not similar in form. Furthermore, studies have shown that the degree of meaning similarity between words in a bilingual's two languages can also have an effect on bilingual word recognition. For example, Gollan *et al.* (2007) found that when a bilingual is presented with a word in one language that shares a similar meaning to a word in their other language, they are more likely to recognize the word in their second language than when the words do not share a similar meaning. The influence of these two factors on bilingual word recognition has also been studied in terms of the bilingual lexical decision task (BLDT). The BLDT is a task that requires a bilingual to quickly identify a target word in their second language while ignoring distractor words in their first language. Studies have shown that when the target word and distractor word share a similar form or a similar meaning, the bilingual is more likely to mistakenly identify the distractor word as the target word (GOLLAN *et al*., 2007). This suggests that form and meaning similarity can both interfere with a bilingual's ability to accurately identify target words in their second language. The influence of form and meaning similarity on bilingual word recognition can also be studied in terms of the bilingual lexical access process. Studies have shown that when a bilingual is presented with a word in one language that shares a similar form or a similar meaning to a word in their other language, the bilingual is more likely to access the related word in their other language (GOLLAN *et al*., 2007). This suggests that form and meaning similarity can both facilitate a bilingual's ability to accurately access words in their second language. In addition to the influence of form and meaning similarity on bilingual word recognition, research has also examined how contextual factors such as the bilingual's language proficiency, language dominance, and language switching can influence the bilingual lexical access process. For example, studies have shown that language proficiency and language dominance can both affect a bilingual's ability to accurately recognize and access target words in their second language (DE GROOT, 2011). Additionally, studies have shown that language switching can also have an influence on bilingual word recognition, with bilinguals being more likely to access and recognize target words in their second language when they are in a language-switching environment (DE GROOT, 2011).

The psycholinguistic literature on bilingual word processing has provided insight into how bilinguals recognize and access words in their second language. It has been demonstrated that both form and meaning similarity can affect word recognition, along with contextual factors such as language proficiency and language dominance.

One factor that can facilitate comprehension in a second language is the presence of cognates. Cognates are words that are similar in form and meaning across languages, and research by O'Connor et al. has shown that cognates can be processed more quickly and easily than non-cognates. Understanding how cognates are recognized and processed can provide insight into the cognitive processes involved in accessing multiple languages.

However, the impact of cognates extends beyond just lexical access. Cognates can also influence the learning of new vocabulary and the development of language proficiency. By recognizing and utilizing cognates, bilinguals can more effectively learn new words and improve their overall language skills. It is important to look into the role cognates may play in the development of pragmatic competence in L2 English. Moreover, it is worth considering the impact of cognates on the distinct aspects of language proficiency, such as grammar, pronunciation, and writing. In this regard, further research can be done to explore the role of cognates in the development of multilinguals' language proficiency.

The previous paragraphs discussed the impact of various factors on bilingual word recognition, including form and meaning similarity, language proficiency, language dominance, and the presence of cognates. The psycholinguistic literature has shown that these factors can affect the bilingual lexical access process, with research using methodologies such as lexical decision, word and picture naming, priming (BALOTA *et al.*, 2007), and eye movement recording (EYSENCK; KEANE, 2015) to investigate reading processes.

Building upon this previous research, the present study utilized priming and a language decision task to further investigate bilingual word processing. These methodologies allow for the examination of cognitive effort and processing time, providing insight into how bilinguals access and recognize words in their second language. By studying these processes, we can better understand the underlying cognitive mechanisms involved in interlingual access and language learning.

Priming is a phenomenon whereby exposure to one stimulus influences a response to a subsequent stimulus, without conscious guidance or intention (WEINGARTEN *et al.*, 2016). The priming method facilitates the processing of, and response to, a target through the prior presentation of a related stimulus (EYSENCK; KEANE, 2015). This approach has been employed in various studies to investigate different cognitive processes, including those related to language processing (BALOTA *et* al., 2007). By using priming tasks, researchers can gain insight into the underlying mechanisms involved in bilingual word recognition and language learning. In a priming task, the prime word, related to the target word in either spelling, meaning or sound, or all features together, is presented quickly before the target word. In this case, one observes the effects of the prime in the processing or in the response of/ to the target word. (EYSENCK; KEANE, 2015). In the experiments of the present study, the cognate target words of Experiment 1 served as prime for Experiment 2. Detailed explanation is given in the subsection 3.7.2.

The investigation of cognate words as stimuli for two tasks - language decision (Experiment 1) and translation (Experiment 2) - was the focus of this study. In addition, the study analyzed reaction time and accuracy data to determine whether a repetition priming effect was present in Experiment 2. Translation is a valuable tool for developing metalinguistic skills, as it requires careful analysis of language structures and meaning. Laviosa (2014, p. 42) notes that translation can facilitate discussions on a range of linguistic topics, including difficult translation decisions, linguistic nuances, cultural differences, and “untranslatable expressions such as puns or wordplay.” These discussions can help individuals to develop a deeper understanding of both the source and target languages, as well as the process of translation itself. There are no perfect equivalences between two different languages. "No two languages are ever sufficiently similar to be considered as representing the same social reality. The worlds in which different societies live are distinct worlds, not merely the same world with different labels attached" (NIDA and TABER, 1969, p. 12). However, by resorting to the translation process we are making a comparative approach between languages, which can favor both the reflection on linguistic differences and similarities, as well as the discursive, pragmatic, and cultural reflections of a language (BAPTISTA, 2012).

As already mentioned, the critical words of the present study were cognate words systematically selected from the Brazilian Portuguese-English pair. When considering the composition of a sample, Zanettin (2011, p. 15) asserts that “The overall size of a corpus and the delicacy of textual categorization will differ depending on the scope of a corpus, so that a very specialized corpus may be smaller and less stratified than a general corpus." With this in mind, the corpus of this study consisted of 208 words in total: 26 cognate words written in Brazilian Portuguese, 26 cognate words written in English, 26 control words in Brazilian Portuguese, and another 26 control words in English. They followed a pattern in terms of form, frequency, and the degree of orthographic similarity. The 208 words that comprised the final list of stimuli in the present study had between four and twelve letters, all of them from the same grammatical class, nouns.

Toassi (2016) pointed out that it is pertinent to continue studies concerning the comprehension of interlingual homograph words in the understanding of English as a target language. She stated that "It would be an investigation on the interference of these critical words in the comprehension of English, instead of facilitation." (TOASSI, 2016, p. 210). Interlingual homograph words share form, but not meaning between languages. We believe that the study of cognates, words that share form and meaning, is also pertinent to deepen this discussion.

Furthermore, it is important to point out that few studies have focused on this investigative perspective that can fill a theoretical and practical gap with regard to the understanding of cognate words, as suggested by Toassi (2016), from a bilingual translation perspective through the repetition priming effect. Thus, we emphasize that the proposal of this quantitative experimental research, which is part of the study field of experimental psycholinguistic research and its cognitive effects on the understanding of cognate words, aims to contribute to the understanding of the processing of the bilingual mental lexicon.

The present study is part of a larger project of the Laboratory of Phonetics and Multilingualism (LabFoM), a laboratory founded by professors Ronaldo Lima and Pâmela Toassi, both from the Federal University of Ceará. The main objective of LabFoM is to carry out and disseminate experimental studies in phonetics and in language processing for bilinguals and multilinguals. Toassi (2020) has been investigating the Brazilian Portuguese - English bilingual lexicon under different perspectives and with different experimental stimuli. The aim of the umbrella project "The Brazilian Portuguese - English bilingual lexicon", which embraces the present study, is to investigate the cognitive processes involved in reading at the word level, the processes of word recognition and lexical access. The instrument used for the mentioned project is an on-line experimental methodology which provides information on the accuracy and response time of participants when performing a language decision task and a translation task (TOASSI, 2020). The present study is part of it, and it is focused on the cognate effect in a language decision and in a translation task.

Toassi's project (2020) includes a larger study on the lexical access of bilinguals, where Sousa (2021, 2022) investigates the effect of interlingual homophones on the lexical access of English as a second language. Her study has the specific purpose of identifying whether there is a difference in the processing cost of interlingual homophones and control words in the Brazilian Portuguese-English language pair. Additionally, she will examine the influence of orthographic similarity, and evaluate the effect of the bilingual's order of language acquisition (L1/L2) on the language decision task. The results of her study will add to the understanding of bilingual lexical processing.

Sousa (2022) is looking into the effect of interlingual homophones, while Gadelha (2021) and Gadelha and Toassi (2021) investigated the cognitive processes- specifically at the word level- involved in translation through repetition priming effect and lexical recognition and access in translation with interlingual homographs. Having 23 teachers as participants of the study and using PsyToolkit software (STOET, 2010, 2017), they studied 34 interlingual homographic words, 34 control words in Brazilian Portuguese, and 34 control words in English. Their research indicated a higher processing cost for interlingual homographs and a repetition priming effect only for “old” control words (non-homographs). Her study has provided insight into the organization of mental lexical processing of bilinguals, since interlingual homographs have lexical representations in both languages of the bilingual and these representations, as her study suggested, are activated even when the task is directed only to the second language (L2). This dual representation leads to a greater cost in lexical processing than that of non-homograph words. The results may indicate that frequency may be a more determining factor in lexical access than the status of the native language (L1) and the foreign language (L2), as homographs and their respective control words were more frequent in the L2 than in the L1 and were activated more quickly (GADELHA, 2021, p. 9).

Batista (2022) conducted a study with 11 participants to investigate the effect of English-Portuguese false cognates on bilingual lexical access and their control words in a language decision task using PsyToolkit (STOET, 2010, 2017). The words were divided into four groups of conditions to observe which of those conditions were processed faster in the bilinguals’ brain. The four groups were: false cognate in English; control in English; false cognate in Portuguese; and control in Portuguese. Her experiment consisted of 120 words, which formed two lists. Each list had 30 words being false cognates and 60 being the control words – two control words for each false cognate. The data showed that in the conditions involving the native language the participants had a higher percentage of accuracy when compared to the ones featuring the L2. The final analysis showed that false cognates in

Portuguese had the highest rate of both accuracy and reaction time. Although the number of participants of the study was small, it contributes to the evidence on the effect of English-Portuguese false cognates on bilingual lexical access. Batista's (2022) study are in line with the study of Gadelha (2021) who investigated reaction time in interlingual homographs and Portuguese-English control words and concluded that participants were also faster to identify English control words in comparison with Portuguese control words and homographs.

As part of the work carried out by the members of LabFoM, Nogueira (2022) conducted a study that investigated the effect of cognate words on a language decision task and found that five participants had shorter reaction times with the control words in English. Her results may indicate that shorter reaction times could be attributed to an expectation for the experiment to be in the English language. Furthermore, the reaction time was longer for English-Portuguese cognate words than control words in Portuguese. Therefore, the cognate facilitation effect was not evident in the word recognition task. Nogueira's (2022) study had its limitations due to the few participants, requiring further experiments with a larger number of participants, therefore it is being considered as a pilot study for the present one.

The aforementioned studies have shed light on the organization of the mental lexicon process of bilinguals and the effect of interlingual homophones and homographs, English-Portuguese false cognates, and cognate effect on the lexical access of bilinguals. In particular, the studies suggest that interlingual homographs have lexical representations in both languages, and that false cognates and cognates have a higher processing cost and longer reaction times, respectively. These results have important implications for linguists, education professionals, and bilinguals, as they demonstrate the influence that language has on the lexical access of bilinguals. This includes the effect of one language on the other, or the effect of both languages on the bilingual's ability to access words. Nonetheless, these studies can be further expanded. As stated previously, Nogueira's (2022) study had limitations due to the small number of participants and is being considered a pilot study for the present study, requiring additional experiments with a bigger group of individuals. She explored cognates stimuli in her studies, and a more in-depth analysis of these stimuli is examined in the present study.

The present study is entitled "The translation process of Brazilian Portuguese-English cognate words," and is limited to Translation Studies from the perspective of Psycholinguistics. The present study aimed to investigate the cognitive processes involved in the recognition of words and lexical access in a language decision task, as well as whether there was a repetition priming effect in a translation task with cognate words. More specifically the following objectives were addressed in the present study: 1) To evaluate the processing cost of

Brazilian Portuguese-English cognate words compared to non-cognate words in a language decision task. 2) To investigate if there were repetition priming effects of cognate words in a translation task. Inserted in the field of Translation Studies and Psycholinguistics, the following questions were raised in the present study: 1) Is there a difference in the cost of processing cognate words between Brazilian Portuguese and English compared to non-cognate words in a language decision task? 2) Is there an effect of repetition priming of cognates in a translation task? Following these questions**, t**he following hypotheses for the present study were brought up: H1 -The processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task; H2 – There are repetition priming effects of cognate words in the translation process. Next, the configuration of the text of this research, which consists of five chapters, is indicated.

Chapter 1, Introduction, consists of contextualizing the theme of this research, its problematization and justification, the objectives, the research questions and the hypotheses that support the two experimental tasks in real time (online) carried out in this research.

Chapter 2, Theoretical Conceptions, contains the theoretical aspects that support the present study. This chapter is divided into seven secondary subsections. Subsection 2.1 Translation in Teaching and Learning a Second Language examined the issue of whether using translation in second language classes is beneficial or not in a teaching and learning environment. Next, in the subsection 2.2 Cognates and Translation examined the conceptualization of cognates and their use in translation. Subsection 2.3 The Psycholinguistics of translation examines translation from a psycholinguistic perspective.

The purpose of the section 2.4 Bilingual Lexical Access Models is to explore how various models of bilingualism account for lexical access, or specifically, how words are activated or retrieved within a language. A comprehensive discussion of various lexical and processing models, considering their particularities in terms of assimilating new words and recognizing words during the translation process was provided. After that, subsection 2.5 Lexical Access and Cognates discussed studies about the effects of cognates on the lexical and syntactic access of bilinguals. In subsection 2.6 Effects of Cognates on the Bilingual Translation Process, the aim was to understand and relate the cognate effect with the processing of translation in the bilingual mind. It highlights some experimental studies. Subsection 2.7 Effect of Repetition Priming in Bilingual Translation revisits the theoretical conceptions about the conceptualization, the effects and the implications regarding the repetition priming in the translation process. Subsection 2.8 Translation - Proficiency, Accuracy and Reaction Time examines the role of proficiency and accuracy and how they are related to reaction times in the experiments.

In chapter 3, Methodology, the choices, and the methodological means which were followed throughout the investigation are pointed out. It indicates the nature of the research, the participants involved, the research instruments, how the corpus was selected and composed, and the data collection procedures, as part of the proposed experiments.

The descriptive and inferential statistical analysis of the experiments, as well as their results and discussion are addressed in chapter 4 followed by final remarks in chapter 5, where the present study is concluded.

The organization of the chapters that make up this study and the contextualization of our object of study have been introduced. I present, in the sequence, the Theoretical Conceptions that support the present study.

2 THEORETICAL CONCEPTIONS

Despite translation being part of our society throughout human history, the scientific investigation of translation emerged in the 1950's. Ferreira and Schwieter (2015) state that "the pioneers were linguists primarily interested in linguistic aspects of translation; that is, in relationships between linguistic systems and the reality they describe, between the linguistic systems as such, and between source texts and target texts as linguistic assemblies".

Translation under the light of its communicative function was considered by some authors such as Nida (1964). That point of view led him to a significant departure from a purely linguistic analysis of relations between source texts and target texts, and into the idea of distinguishing between 'formal equivalence', which is linguistically based, and 'dynamic equivalence', which is communication oriented as pointed out by Ferreira and Schwieter (2015).

Several researchers through a wide range of theories and approaches have made significant contributions over the years to the development of Translation Studies as an autonomous academic field. According to Ferreira and Schwieter (2015), these early academic activities in the field of translation were part of the humanities and involved reflection, theory, and translation critique rather than empirical research, which is the focus of cognitive science.

In the early 1990s, two main developments gave impetus to empirical research. The first was the emergence of 'process research', pioneered by Krings (1986) and Lörscher (1991) based on Ericsson and Simon's Think-Aloud-Protocol (TAP) paradigm from psychology. This was the first major contribution of psychology to the study of written translation (FERREIRA; SCHWIETER, 2015).

The increasing involvement of translation practitioners and trainers of translators and interpreters in research was another important driving force of empirical research in Translation Studies. According to Ferreira and Schwieter (2015, p. 5),

> It was directed less towards theory and more towards practical issues having to do with training and with professional practice such as quality perception, translation tactics (commonly referred to as 'strategies' in the literature: see Gambier 2008, on this terminological issue), translation competence, language differences, and their practical impact.

In the introduction of their book, Li and Lei (2019) inform us that research in cognitive translation studies has increased significantly over the last 10 years. They add that "translation process research (TPR) was found to be an area that had received the most research attention since 2010, and the total number of publications on TPR almost doubled that of corpus translation studies”. Consequently, it is reasonable to anticipate further development and growth of TPR as a field of research in translation studies in the years ahead.

Translation Process Research (TPR) as a research field has developed over the last 40 years, from the initial use of think-aloud protocols as the main research instrument to the subsequent adoption of Translog combined with screen recording techniques and technologies, to the use of eye trackers, to the application of neurological and neuroimaging tools such as the electroencephalography (EEG), the positron emission tomography (PET), the functional near-infrared spectroscopy (fNIRS), and the functional magnetic resonance imaging (fMRI). As the research instruments have become more sophisticated, so too have the topics and issues addressed under the umbrella of Translation Process Research and Cognitive Translation Studies, such as the psychological aspects of translation and interpreting, the cognitive mechanisms of interpreting, the application of translation technologies, and the development of machine translation algorithms (LI; LEI, 2019, p. 5).

In my study, I add to the discussion of translation and its cognitive processing by employing an experimental methodology in real time, making use of the free software PsyToolkit (STOET, 2010, 2017), which provided information on the accuracy and reaction time of the participants performing two experiments: a language decision task and a translation task. I explain the details in the methodology section. Yet, there is another aspect concerning translation that I ought to consider. I discuss translation studies and its evolution through theoretical and experimental research over time. The issue of translation in teaching and learning a second language also needs to be addressed, which is what I do in the subsequent section.

2.1 Translation in teaching and learning a second language

Throughout history, different beliefs about what language teaching is and how it should take place have alternated, strongly influencing the relationship between language teaching and translation. I believe translation is a valuable tool for teaching a second language. According to Oxford (2007), translation can enable learners to gain a deep understanding of the language they are studying, as it encourages them to think about the structure and meaning of the language. By translating a text, learners can also gain a greater appreciation of the culture behind the language, as they are forced to consider the nuances of the source language. Oxford (2007) also suggests that translation can be used to support the development of learners’ writing and speaking skills, as well as to reinforce grammar and vocabulary. He argues that, if used incorrectly, translation can lead to a lack of communicative fluency, as learners may become overly reliant on directly transferring meaning from one language to another. He also cautions against using literal translation too frequently, as this can make learners overly reliant on word-for-word translations, rather than being able to communicate meaning in a natural way. By examining the different types of translation that can be employed, such as literal translation, free translation, and communicative translation, teachers can have a valuable insight into how translation can be adapted to suit a range of modern teaching contexts. However, in a second language classroom, the debate as to whether translation should be used is still ongoing.

There are many arguments in favor and against translation in the L2 classes. From the Grammar-Translation Method to the present day, translation, ignored for a while in different teaching methods, is now recognized as a communicative task (LAVIOSA, 2014, p. 141). It has played an important role in the learning and teaching of foreign languages and so I believe that it still has full relevance in the classroom when used as a learning tool and it deserves space in foreign language learning and teaching. I agree with Lopes (2019) statement that pedagogical translation is a necessary skill in any L2 teaching and learning curriculum. However, due to the lack of specific materials on translation as a pedagogical tool for learning a second language (L2), it is up to the teacher to plan and implement the translation exercises, as, in theory, they are the person who best knows the competence level of their students. The teacher could use translation exercises to help the students understand the differences between the two languages. Exploring similarities between languages is also crucial in effective language teaching. According to White and Horst (2012), cross-linguistic awareness can help teachers plan exercises that facilitate vocabulary acquisition in second language learning. In fact, they define cross-linguistic similarities awareness (CLA) as the ability to reflect on the similarities and differences between languages. This explicit and declarative instruction encourages learners to compare their first and second languages and activate prior knowledge to learn new words efficiently.

Given the extensive vocabulary needed to communicate proficiently in a second language such as English, it may not be feasible to teach all the necessary vocabulary in a typical 60-90 minute class held once or twice a week. According to Nation (2006), for an ideal coverage of 98% of written text in English, an 8,000-9,000 word-family vocabulary is required, and 6,000-7,000 families for spoken text. To tackle this dilemma, teachers can activate learners' knowledge of English words that they may already possess due to their knowledge of their first language through cross-linguistic similarities awareness. Therefore, it is imperative for language teachers to be aware of both the similarities and differences between languages to plan and implement effective vocabulary exercises for language learners.

In line with Nguyen's (2019) findings, cognates can facilitate awareness of linguistic similarities between the target language and the student's native language, bridging the two languages. This awareness offers benefits such as aiding students in identifying connections between the languages' grammar points, vocabulary, and structures. Strategies to integrate cognate words into language learning can be applied for optimal efficacy. Wang and Li (2015) suggest the bilingual immersion approach, while Fabbro (1999) proposes the contrasting approach. Additionally, Garcia and Wei (2014) recommend the task-based approach, which requires students to use both languages to complete given tasks.

Cognates can serve as an interesting way to introduce translation in the L2 classes and to combine two languages to increase the effectiveness of language learning. Therefore, cognates and translation are the topic of my next discussion.

2.2 Cognates and translation

An interlingual connection that has been extensively studied in psycholinguistics is the cognate words or L1–L2 translation pairs that share both form and meaning. Due to their cross-linguistic similarity, the learning of cognates and false cognates is an interesting object of study for psycholinguistic and second language acquisition (SLA) research. In addition, understanding the extent to which the learning of orthographic cognates can benefit from explicit teaching is highly relevant to instructed contexts because it can help to inform the design of materials and pedagogical approaches such as specific strategies to inhibit the access of cognates in the other language, for example.

Kroll *et al.* (2017) examined the inhibitory processes involved in bilingual language comprehension and the use of cognates. The authors conducted a series of experiments to investigate how bilinguals activate cognates and how they inhibit the activation of the incorrect language. The authors found that bilinguals rely on a variety of inhibitory processes to control access to cognates. These processes include paying attention to particular words or phrases and inhibiting competing words in the same language, as well as inhibiting words in the other language. They also found that the amount of time a bilingual had been exposed to the language was related to the level of inhibition they had of competing words in the other language. This suggests that more exposure to the target language could potentially help bilinguals better control the activation of cognates in the other language. The authors suggest that their findings have implications for the teaching of second languages. They suggest that providing learners with more exposure to the target language, as well as providing them with specific strategies to inhibit the access of cognates in the other language, can help to improve their language comprehension. Bialystok and Yang (2014) found that bilinguals engage in inhibitory processes when processing language, which may be useful in facilitating the comprehension of language in both languages. This has important implications for bilingual language acquisition and development, as well as for bilingual education.

Grosjean (2019) suggests that this inhibitory process could be used to help bilinguals acquire new language skills more effectively, as well as to facilitate the use of both languages in everyday communication.

Kroll, Dussias, and Bice (2019) further suggest that this finding may have implications for the development of second language teaching strategies that focus on the integration of both languages in order to maximize the effectiveness of language learning.

The experiments proposed in the present study explore the use of cognates in a language decision and translation task. Therefore, a more in-depth discussion on cognates is necessary. Second language (L2) learners encounter three types of words that differ in terms of the extent of their formal and semantic similarity to their first language (L1): cognates, false-cognates, and non-cognates (OTWINOWSKA *et al*., 2020). Both cognates and false cognates bear formal orthographic similarity to their corresponding L1 forms, but this similarity involves shared meaning only for cognates (e.g., Portuguese "positivo" and English "positive" refer to the same concept, whereas Portuguese "magazine", and English "magazine" do not).

Cognates have been considered as easy vocabulary items for L2 learners due to their apparent similarities (ELLIS; BEATON, 1993). Toassi and Pereira's (2019) study presented positive results via a translational task involving cognate words in English-Portuguese. Participants from a less privileged community, who were mostly adults and had never studied English, accepted to participate in an English task consisting of translating cognate words with varying degrees of orthographic similarity overlap from English to Portuguese. They had their first contact with English through cognate words, and more than 50% of the words presented to them were correctly translated into Portuguese. Despite initially believing that learning English was impossible for them, they were able to successfully complete the task. Their study also revealed that “cognate words might work as a motivational factor to make people inspired to learn a second language”. Despite the positive outcomes with cognates in the learning process of a second language, Echeverría (2017) pointed out it is not easy to find textbooks that explain what a cognate means or activities that help with their recognition or use. She argued that “a number of introductory Spanish language textbooks such as Dos Mundos, Nexos, Imagina, Pura Vida, among others, present limited explanations of cognates hidden at the bottom of some pages, assuming that the information lacks importance or application.” Various authors have debated whether cognates facilitate learning or not. For example, Tonzar, Lotto, and Job (2009) found that cognates are an effective tool for improving the accuracy and speed of reading comprehension. Antón and Duñabeitia (2020) concluded that cognates synonyms can impede word learning. Through two experiments, the authors demonstrated that participants were less successful in recalling the definitions of words with cognate synonyms than those without synonyms. They suggest that this is due to the fact that synonyms are perceived as semantically similar, leading to interference in the learning process. Muscalu and Smiley (2019) concluded that cognates can provide a benefit in language processing, but only in certain contexts. The results of the experiment suggest that cognates may provide a benefit when the two languages are processed separately. However, when the two languages are processed simultaneously, the lexical facilitation effect of cognates is followed by a sublexical interference effect for non-cognates. This suggests that cognates may not always provide the same benefit in bilingual language processing. Otwinowska *et al* (2009) concluded that the use of cognates can help to reduce the amount of time and effort learners need to spend on learning new words and can also help to improve the ability to comprehend and produce language, and that they can also aid in better understanding of texts.

Due to the relevance of cognates and the scarce information concerning them and their effects on second language acquisition (SLA), I will start the discussion on this subject by examining its etymology, definition, and the several concepts many scholars have on this subject, as well as the cognitive processing involved in the lexical access of cognates and its implications for the teaching of languages.

In linguistics, cognates refer to words that are related to one another and share the same linguistic derivation, while in law they refer to a relative. Understanding cognates helps us draw similarities between different languages, allowing us to also see how the languages themselves have evolved over time. The Lexicon powered by Oxford Dictionary provides us with the following definition: ‘**cognate**, LINGUISTICS: (of a word) having the same linguistic derivation as another; from the same original word or root (e.g., English is, German ist, Latin est, from Indo-European esti). FORMAL: related; connected - "cognate subjects such as physics and chemistry" - related to or descended from a common ancestor.’ According to most estimates, about 60% of the words in English are of Latin or Greek origin (NATION, 1990), and many of these have cognate equivalents in Portuguese, Spanish (and other Romance languages). However, it cannot be assumed that potentially helpful similarities will be recognized. The site dictionary.com states that

> about 80 percent of the entries in any English dictionary are borrowed, mainly from Latin. Over 60 percent of all English words have Greek or Latin roots. In the vocabulary of the sciences and technology, the figure rises to over 90 percent. About 10 percent of the Latin vocabulary has found its way directly into English without an intermediary (usually French). (www.dictionary.com)

This means that even though English is derived from many languages, most of the words used in English are from Latin and Greek. This can make it difficult for people to recognize potentially helpful similarities between the two languages, as many of the words are not easily recognizable as having a common root or origin. Additionally, even if a person can recognize that a certain word originates from Latin or Greek, they may not be able to accurately identify the meaning of the word due to the fact that many words have evolved and changed over time.

I discussed the role translation plays in language learning, and the use of cognates and their conceptualization. I now examine translation from a psycholinguistic perspective.

2.3 The psycholinguistics of translation

Beginner students translate texts into their mother language L1 when reading before performing a written or oral production in L2 regarding that same text he or she just read (DUCASSE-LEGENDRE, 2013). One should have in mind that the student is actually performing a different kind of reading on that text, namely, translation reading. Reading is an activity that is both perceptual and cognitive. It is perceptual in the sense that “reading requires input of (visual) sensory information, and it is cognitive in the sense that reading comprehension requires the identification, interpretation and organization of sensory information” (HVELPLUND, 2017, p.56). The cognitive processes involved in the identification, interpretation and organization of reading input are not directly available for observation; but manifestations of reading, i.e., eye movements, are available for observation, and they provide some indication of cognitive processing and how a bilingual mental lexicon is organized. The psycholinguistics of translation helps to explain how cognitive processes are involved in the identification, interpretation, and organization of reading input in a bilingual context.

Psycholinguistics of translation looks at how the brain processes and interprets the meaning of a text when it is translated from one language to another. It considers the differences in grammar, syntax, and vocabulary between languages, as well as the cultural and social context of the text. The psycholinguistics of translation also considers how a text may be interpreted differently between two languages, and how a translator can use language to convey a text's meaning accurately and clearly. Examples of this include the use of idioms or slang in a text, as well as the choice of words in a text to convey a certain emotion or tone (HU; LEI, 2015). In order to carry out these tasks, a bilingual individual must activate systems and subsystems related to grammar, phonology, spelling, semantics, and acquisition, with respect to accessing and using vocabulary. The following subsection provides a comprehensive discussion of various lexical and processing models, considering their particularities in terms of assimilating new words and recognizing words during the translation process.

2.4 Bilingual lexical access models

Bilingual lexical access models are models that describe how bilingual individuals access the different languages they know. The models focus on how bilinguals use their knowledge of one language to access the second language (ELSEN *et al.*, 2020). Bilingualism, and in particular the bilingual mental lexicon, has been the focus of an increasing amount of experimental investigation over the last three decades. There are numerous reasons for this upsurge of interest in the process of bilingual word recognition and the system that manages it; I discuss at least two of them. It raises issues that are not present in monolinguals, such as when bilinguals read or listen in two languages, how do they distinguish words from one language or the other. Furthermore, "if monolingual and bilingual word recognition reflects a common underlying processing system, bilingual research offers new ways of testing hypotheses derived from the monolingual domain" (DIJKSTRA; VAN HEUVEN, 2002). At the same time, our understanding of how the monolingual system works can be improved by an analysis of the bilingual word recognition system. In fact, if one assumes that recognition of words in different languages is subserved by one system, we should consider if word recognition in one language can be adequately studied apart from other-language knowledge. An additional reason for investigating bilingual word recognition is that there are practical implications of this research for educational purposes, for example, how to teach a foreign language more effectively in the classroom. Finally, "because words are the basic building blocks of sentences, it is important to understand how words are recognized in a bilingual context in order to understand how sentences are parsed by bilinguals" (DIJKSTRA; VAN HEUVEN, 2002). For all these research issues, it is an important goal to reach a comprehensive understanding of the bilingual word recognition system.

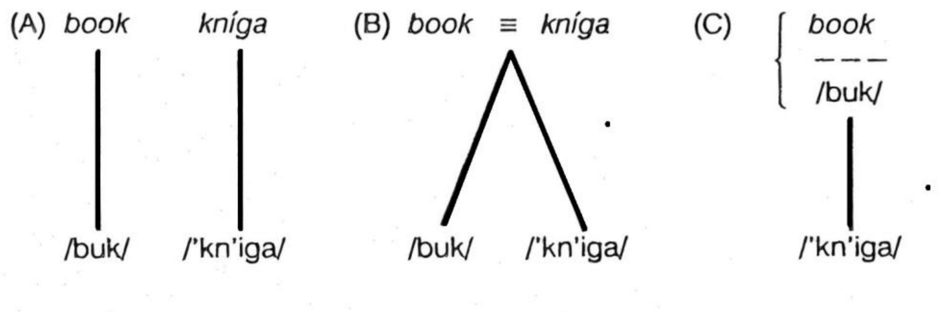
The purpose of this section is to explore how various models of bilingualism account for lexical access, or more specifically, how the activation or retrieval of words takes place within a language. Thanks to the fact that human memory involves the process of acquiring and retaining information for later retrieval, the current aim is to examine the mental storage system that facilitates this process in bilinguals.

The notion of monolingual and bilingual mental lexicons has long intrigued linguists who investigate cognitive aspects of language processing and psycholinguistics (CANGIR, 2018). To explain the interaction of the two languages during lexical processing in its entirety, many models have been developed and proposed over the years, with differing representations. In 1953, Weinreich proposed one of the earliest models of this kind, which Cangir (2018) explains how it was categorized:

> "He categorized the word knowledge as (a) coordinative, (b) compound, and (c) subordinative. At the coordinative level, a word in L1 and L2 do not share either conceptual or form representation. At the compound level, on the other hand, L1 and L2 word counterparts have the same conceptual representation but a different formal representation. It is at the final, subordinative level that both form and conceptual representations of word knowledge intersect in the bilingual mental lexicon." (CANGIR, 2018, p. 227)

The proposed model illustration can be seen in Weinreich (1953). See the illustration in Figure 1:

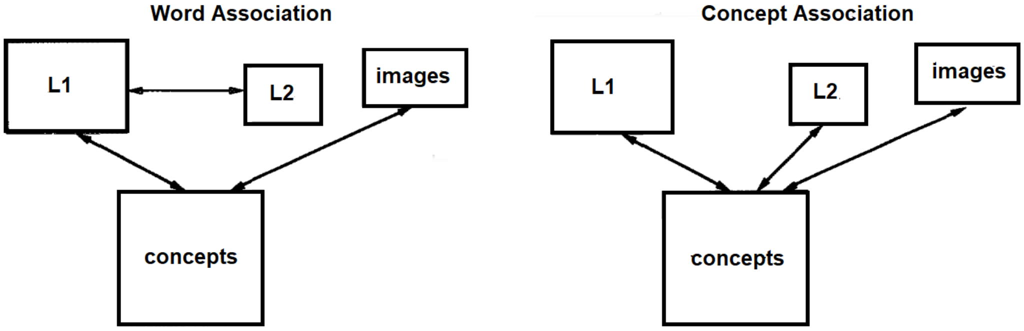
Figure 1: Organizations of word knowledge in bilinguals in A coordinative, B compound and C subordinative.



Source: Weinreich (1953)

Weinreich's representation of the bilingual internal lexicon set off a new perspective and laid the foundations for the Word and Concept Mediation Model by Potter *et* *al.* (1984). Weinreich's model proposed a direct association between the first (L1) and second (L2) languages at the lexical layer, while the Word Association Model proposed by Potter suggested a direct relationship between the conceptual and lexical representations of the two languages. This overall depiction of the models can be seen in Potter *et al.* (1984). Figure 2:

Figure 2 - Two models of language interconnection in which L2 words are associate to L1 words (word association) or directly linked to concepts (Concept Association).

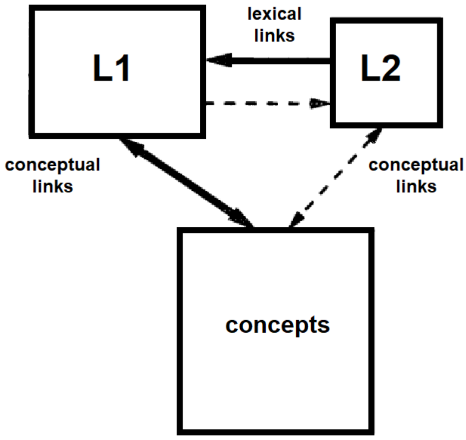


Source: Potter *et al* (1984)

The models discussed above paved the way for a well-recognized and updated model of bilingual mental lexicon that we see in Figure 3. The Revised Hierarchical Model (RHM), from now on referred to simply as the RHM, is a very well-known model of bilingual memory representation. It was a developmental model of language representation originally proposed by Kroll and Sholl (1992; see also Kroll; Stewart, 1994). The translation asymmetries significantly influenced the structure of this model, as observed when bilinguals translated words from one language into another. Specifically, translation of words by bilinguals was faster from the second language (L2) into the first language (L1), as compared to the reverse translation, i.e., translating from L1-L2, a finding that played a significant role in the creation of this model (KROLL and STEWART, 1994).

In the RHM model, the L1 lexicon, or the first language mental dictionary, is larger than the L2 lexicon, since it is assumed that the bilingual would have a larger vocabulary in their native language than in their second language (L2), as seen in Figure 3.

Figure 3 - The Revised Hierarchical Model.



Source: De Groot (2011)

In this figure, as explained by De Groot,

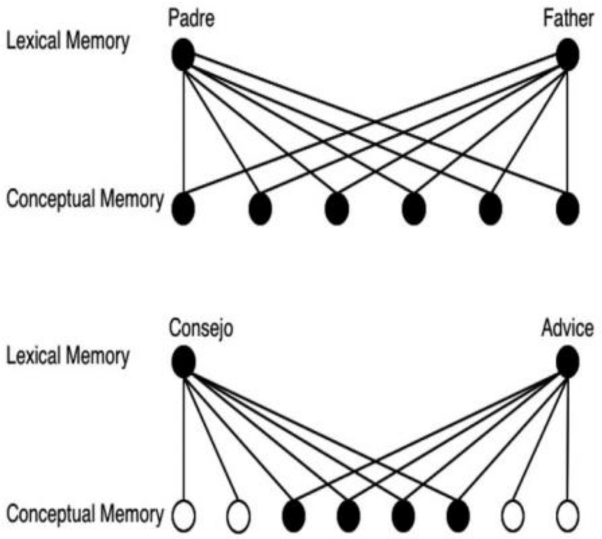
> dashed and solid lines represent weak and stronger connections, respectively. The link between the common L1/L2 conceptual memory store and the L1 lexicon is stronger than the link between the former and the L2 lexicon as a result of the differential command of the two languages, L1 (generally) being the stronger language. (DE GROOT, 2011, p.150)

As the model suggests, there are two separate lexical systems in the bilingual mental dictionary: a lexical system for L1 and another for L2, but a shared conceptual system for both languages. L1 and L2 words are both directly connected to one another at the lexical level and indirectly, via conceptual memory. Furthermore, studies that make use of this model in their interpretations assert that “the strength of the relationship between the lexical and conceptual layers depends on the proficiency of the bilingual, and that L2-L1 direction links appear to be more robust than L1-L2 links” (PAVLENKO, 2009, p. 143).

The strongest link between the first language (L1) and concepts is formed when a child acquires their first language. However, as a person acquires a second language (L2), especially if it happens when the person is older, L2 words will become part of their memory by developing a pathway that is attached to the lexicon of their first language. Basnight-Brown (2017, p. 86) explains that “during the initial stage of L2 learning, the learner heavily relies on the L1 lexical elements, accessing the meaning of an L2 word indirectly, via its translation in L1”. The more exposure to L2 a learner has, the stronger the direct connection between the L2 lexical representation and the common meaning becomes. The solid directional line linking the L2 lexicon to the L1 lexicon describes this process. “The opposing directional arrow between the L1 and L2 lexicon is described as a weaker link since typically this is not the direction in which a bilingual first acquires the translations of the new language” (BASNIGHT-BROWN, 2014, p. 87). Finally, although the link between the L2 and concepts is pictured as weak, the gain of proficiency or fluency in bilinguals may increase that link in strength, as suggested by Kroll and Stewart (1994).

Another very well-known model of bilingual memory representation is the Distributed Feature Model (DFM). It is a widely cited model that accounts for processing differences reported for different word types (DE GROOT, 1992; VAN HELL; DE GROOT, 1998). For example, concrete words are translated faster than abstract words (DE GROOT, 1992) and “concrete translation equivalents show greater semantic similarity (in free association) than abstract translation equivalents” (BASNIGHT-BROWN, 2014, p. 89). Based on these observations, De Groot proposed that concrete and abstract words have different degrees of semantic overlap between translations. In the DFM (see Fig. 4), concrete word translations are described as sharing more conceptual nodes than abstract words.

Figure 4 - Distributed feature model.



Source: Adapted from de Groot (1992).

In regard to the retrieval process that occurs during lexical access, translations for concrete words are faster because more nodes are shared by translation pairs, which is due to the increased semantic overlap between concrete translations.

Basnight-Brown (2014) highlights that the concept of semantic overlap between a word and its translation, upon which the DFM is based, should be carefully considered when attempting to describe how different word types are processed. "The degree of overlap should also be taken into account when examining how words with multiple translations are activated and retrieved from memory," the author states (BASNIGHT-BROWN, p. 93, 2014). The shortcomings of this model are discussed next.

The first shortcoming is that DFM does not specifically detail how the degree of featural overlap may affect the processing of written language compared to spoken word recognition. Moreover, because of a greater degree of featural overlap, the model assumes that concrete items will be recognized faster than abstract items; however, it does not predict much else regarding the full range of bilingual processes. Finally, and perhaps most importantly, “we know that the degree of featural overlap is important for memory representation, but we do not know what information is contained in these features” (BASNIGHT-BROWN, 2014, p. 93).

The models and premises discussed so far have informed us that there are several aspects of bilingual memory representation that need to be addressed as they arise in the studies. The BIMOLA model addressed some more aspects that I will discuss next.

The BIMOLA model (Bilingual Model of Lexical Access) proposed by Grosjean (1989) has two basic premises. The first postulates that bilinguals have independent lexicons between languages, even though they are interconnected. The bilingual only uses one language, so it is independent, but interconnected because, even when in monolingual mode, the bilingual exhibits signs of interference from the other language. The second premise is that, while in monolingual mode, the other language remains activated, but at a very low activation level. Thus, the activation level of the two languages is low. However, when bilingual mode is activated, both languages have a strong activation. In this model, each language has a separate representation of the other, both for phonology and for word form. Despite being independent, both are included in a larger set, allowing for interaction between the languages. This model has contributed to the understanding of lexical access; however, it is a model of recognition of words at the phonological level, which are heard by the bilingual, thus not encompassing visual forms, for instance.

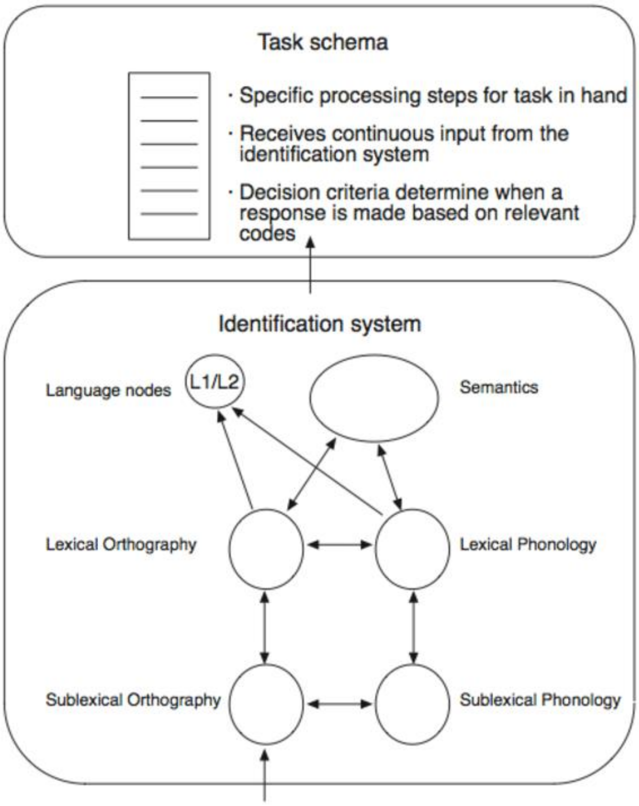
In order to address visual forms, Van Heuven, Dijkstra, and Grainger (1999) developed a model for orthographic word recognition: the Bilingual Interactive Activation (BIA) model. This model supports the hypothesis that lexical access is non-selective and that the bilingual mental lexicon is integrated between the two languages, thus differing from Grosjean's (1989) proposal, in which the lexicons are separated. This model works similarly to the BIMOLA, although the focus differs; while BIMOLA is focused on phonological recognition, BIA is focused on visual recognition of words. The BIA model consists of four levels of representation: letter features, letter, word, and language nodes.

In this model, there are language nodes that collect the activation of words in the language they represent and inhibit active words from the other language. By inhibiting words from the language that is not in use, these language nodes may facilitate the selection of words in the target language after non-selective lexical access has been activated but may not enforce selective lexical access at the start of recognition of a given word. Despite covering many aspects related to word recognition, the BIA model does not take into account certain aspects; for instance, the model does not include the phonological and/or semantic representations of words.

In order to fill this gap in the BIA model, Dijkstra and Van Heuven (2002) proposed the Bilingual Interactive Activations Plus (BIA+) model. This model assumes two basic assumptions. First, it considers that languages are represented in an integrated lexicon, that is, within the bilingual/multilingual brain, languages are interconnected and related during the moment of use of a target language by the speaker. Second, word recognition takes place in a non-selective language perspective; this means that other languages are not turned off when a target language is in use. Although all languages are active in the speaker's brain, one has a stronger activation than the others because it is the language required at that moment. Furthermore, this model includes orthographic, phonological, and semantic representations of words and distinguishes between a word identification system that incorporates linguistic representations and a task/decision system that incorporates non-linguistic task schema specifications. The effects of linguistic context are characterized as the effects of lexical, syntactic, or semantic origin, while the effects of non-linguistic context are those caused by instructions or objectives of the task or even by the expectations of the participant.

The architecture of the BIA+ model consists of four layers of nodes, which are letter features, letters, words, and language (either L1 or L2) (see Figure 5). Therefore, when a word is displayed, "features of the individual letters will be activated, followed by the activation of letters that match those specific features. The activated letters will, in turn, activate words that share orthography in both the L1 and L2" (BASNIGHT-BROWN, 2014, p. 98).

Figure 5 - The bilingual interactive activation (BIA+) model.



Source: Dijkstra; Van Heuven (2002).

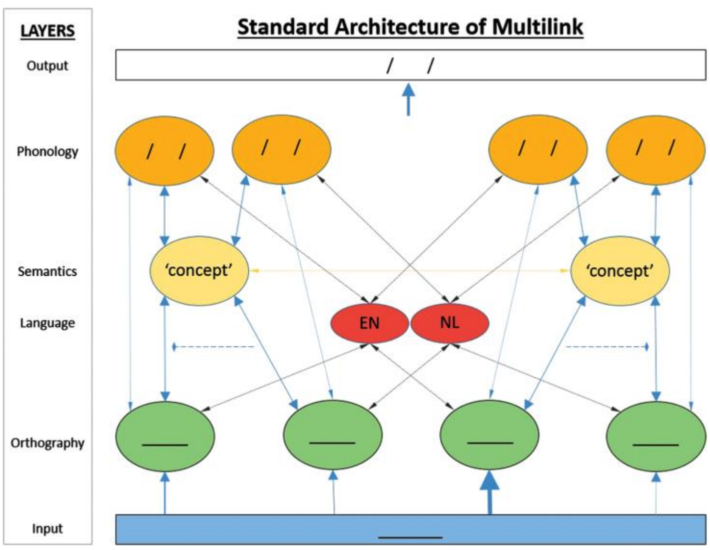
The nonselectivity assumption of the BIA model is supported by "a plethora of data to date" (BASNIGHT-BROWN, 2014, p. 99); however, it is important to bear in mind that this model was originally intended to explain lexical access during word recognition, distinct from models that focus on translation such as RHM. As with any other model created by computer programmers, it has its limitations. Whether it accurately represents how a bilingual mind actually works and has ecological validity is a matter of debate. BIA has been used to study bilingualism in different contexts such as language acquisition, language use, and language attrition. Nevertheless, it is important to note that the model is still in its infancy and many of its predictions have yet to be empirically tested.

In all the models discussed above, as Cangir (2018) indicates, “there has been many attempts to help visualize the bilingual mental lexicon underlining different layers of lexical processing” (p. 229). As research, technology, and insight into the issues involving our minds continue to increase and demand more robust answers, more attempts will be made.

In their paper, Dijkstra *et al*. (2018) stressed that both the RHM and the BIA models have strengths in relation to the points that each model tries to tackle during processing. These models center on the importance of translation, emphasizing that most bilinguals do this process on a daily basis. However, one point the RHM does not fully account for is the translation of cognates and interlingual homographs. In an attempt to make use of some theoretical aspects of the RHM and, at the same time, trying to incorporate those aspects into a localist-connectionist framework, Dijkstra *et al.* (2018) developed a new model, Multilink. One important aspect of this model is that it investigates word translation as it happens in bilinguals, regardless of their levels of proficiency in their L2. Importantly, because translation includes many basic cognitive processes, Dijkstra *et al*. (2018) point out that Multilink is designed to explain recognition, retrieval, and production processes.

Basically, Multilink points out that lexical access is non-selective, while also incorporating elements of the BIA model by distinguishing between phonological, orthographic, and semantic representations. However, it also incorporates elements of the RHM by assuming that the size of the lexicons for each language might be different, based on experience and proficiency level, and that there might be a difference in the links between word form and meaning for L1 and L2. This computational cognitive model, Multilink, integrates basic assumptions between the BIA+ and RHM models (see Figure 6). In summary, this model can be "defined as a precise, operationalized, and quantitative representation of reality in a restricted domain of human information processing" (DIJKSTRA *et al*., 2018, p. 659). The authors go on to say "Model-to-model comparisons show that Multilink provides higher correlations with empirical data than both IA, a model that has been used to simulate orthographic processing in visual word recognition, and BIA+ models" (DIJKSTRA *et al*., 2018, p. 659).

Figure 6: Multilink



Source: Dijkstra *et al.* (2018)

Proposed by Dijkstra *et al*. (2018), the Multilink model includes a task system that makes it possible to simulate the processing of words in psycholinguistic and lexical decision tasks; orthographic and semantic priming effects; word naming, production, and translation; and similarity effects by monolinguals and bilinguals in semantic categorization tasks at different frequencies. In other words, the characteristics of the Multilink model (DIJKSTRA *et al*., 2018) are reflected in the design of the two tasks, language decision (Experiment 1) and translation (Experiment 2) of the present study. Concerning computational models, we point out their contributions to the implications relevant to the facilitation and interference effects referring to bilingual lexical access. As Pu *et al.* (2019, p.1) state: "Determining the exact nature of bilingual lexical access remains an important question given the ramifications for its use in bilingualism research" (PU *et al.,* 2019, p. 1). The Multilink model is in its early stages, and it is important that it continues to be tested in future simulations and under different conditions, with specific attention given to how it might address the processing challenges posed by lexical ambiguity and multiple translations across languages. Nevertheless, the Multilink model appears to have promising potential for corroborating bilingual word processing based on connectionist principles (BASNIGHT-BROWN, 2014, p.100).

All the bilingual models examined in this section draw our attention to different aspects of bilingual memory. Because of their specific limitations, these models are not able to account for the full range of bilingual data and processes known to date. Basnight-Brown (2014, p. 102) states, "It is imperative that future models that are proposed have the ability to account for the dynamic shifts that occur during second language acquisition." Therefore, future models must account for the influence that the second language exerts on the mother tongue (L1) as the person becomes increasingly fluent in the L2, the cultural conceptualizations acquired from the L2 and their impact on the L1, the priming effect of the L2 on the L1 in terms of language structure, and the tip-of-the-tongue effect, to mention a few dynamic changes that can happen when one becomes proficient in another language. Thus, continuing the discussion on translation as a cognitive process, in the next sections I will discuss cognates and lexical access and the translation of cognate words, and the influence of these words on the Bilingual Translation Process.

2.5 Lexical access and cognates

The name "lexical access" is given to the process that allows us to retrieve lexical items, when necessary (FIELD, 2003), that is, the process by which we access our lexicon to recognize one or more words that are presented to us. Dijkstra (2005) informs us that the mental lexicon is the database containing all of the words in the mind of the language user. As to the type of lexical information, it can be orthographic (spelling), phonological (sound), or semantic (meaning). There are two main questions that ongoing bilingual lexical research focuses on. One has to do with the representation and organization of two languages in bilingual memory; the other is concerning the access of these words during language processing. I examine the lexical access of cognates.

To study the effects of cognates on the lexical and syntactic access of bilingual Portuguese-English speakers, Guedes and Ramos (2012) used a series of experiments. In the first experiment, participants were given a list of Portuguese and English words and asked to identify cognates. The results showed that participants were able to identify cognates with a high degree of accuracy. The authors concluded that bilingual Portuguese-English speakers have a good understanding of both languages, which allows them to easily identify cognates. In the second experiment, the authors tested the effects of cognates on the lexical access of bilingual Portuguese-English speakers. The participants were asked to identify words from a list of Portuguese and English words. The results showed that participants were able to identify Portuguese words more quickly when they were cognates of English words. The authors concluded that the presence of cognates facilitated the lexical access of bilingual Portuguese-English speakers. In the third experiment, the authors tested the effects of cognates on the syntactic access of bilingual Portuguese-English speakers. The participants were asked to complete sentences with words from a list of Portuguese and English words. The results showed that participants were able to complete sentences more accurately and quickly when they contained cognates. The authors concluded that the presence of cognates facilitated the syntactic access of bilingual Portuguese-English speakers.

Exploring the process of lexical access in bilinguals when presented with Portuguese–English cognates and interlingual homographs, Carreiras and Perea (2006) conducted an experiment using native English and Portuguese speakers, who were asked to identify the language in which a given word was presented, either as an audio or visual stimulus. The authors found that both cognates and homographs were easier to recognize than non-cognates and non-homographs, suggesting that bilinguals can access lexical information from both languages faster than if they were presented with non-cognates or non-homographs. This is due to the fact that the lexical information of both cognate and homograph words is shared across languages, making them easier to recognize. Carreiras and Perea (2006) also found that cognates were easier to recognize than homographs, suggesting that the presence of a shared spelling between the two languages contributes to the speed of lexical access. This finding is supported by previous studies that have shown that bilinguals have an advantage in recognizing cognates compared to non-cognates. Previous studies that have explored the advantages of cognates for bilinguals include Gollan *et al.* (2005) and Kroll *et al.* (2005). Gollan *et al.* (2005) found that bilinguals had an advantage in recalling cognates compared to non-cognates, while Kroll *et al.* (2005) suggested that bilinguals had an advantage in recognizing cognates over non-cognates. Both studies provide evidence that bilinguals are able to access lexical information more quickly when presented with cognate words.

Costa *et al*. (2000) examined the relationship between bilingualism and lexical access. They explored the idea that bilinguals may experience interference from language-specific selection of phonemes when accessing cognates. The authors conducted an experiment in which they tested the recognition of cognates in Italian-Spanish bilinguals.

The experiment tested whether the phonological similarity between cognates affects recognition. To do so, the authors tested recognition of cognates with the same phonological form and cognates with different phonological form. The authors found that recognition was faster for cognates with the same phonological form, suggesting that phonological similarity affects recognition.

In addition, Costa *et al*. (2000) tested whether the language-specific selection of phonemes interferes with cognate recognition. To do so, they tested recognition of cognates with the same phonological form in the language of origin and foreign language. The authors found that recognition was faster for cognates with the same phonological form in the language of origin, suggesting that language-specific selection of phonemes can interfere with cognate recognition.

Costa and Sebastián-Gallés (2014) examined the phenomenon of cognate effects in bilingual word recognition. Cognate effects are a phenomenon in which bilinguals have an advantage in recognizing words that are related to each other across two or more languages. This article provides an overview of the research on cognate effects in bilingual word recognition and discusses the implications for bilingual language processing. First, the authors provide an overview of the literature on cognate effects, including studies that have investigated the effects of cognates on word recognition in different language combinations. The literature on cognate effects suggests that they arise from various language-specific and bilingual processes in the bilingual brain. These processes include the use of language-specific and bilingual representations of the words, the use of shared orthography, lexical-semantic overlap between the languages, and the influence of language-specific and bilingual processes on lexical access and retrieval. They note that cognates are more easily recognized than non-cognates, and this effect is greater in bilinguals than monolinguals. They discuss how cognate effects can vary depending on the language combination, as well as the type of task and the type of cognate. Next, the authors discuss the cognitive mechanisms that are involved in cognate effects in bilingual word recognition. They note that the effects of cognates on word recognition can be attributed to different mechanisms, such as lexical access, semantic processing, and cross-language integration. They also discuss the role of context in cognate effects, noting that contextual information can help to facilitate the recognition of cognates. Finally, the authors discuss the implications of cognate effects for bilingual language processing. They note that the presence of cognate effects can help to explain how bilinguals are able to process two languages simultaneously. They also note that the presence of cognates can help to facilitate the acquisition of a second language. Overall, this article provides a comprehensive overview of cognate effects in bilingual word recognition. It discusses the literature on cognate effects, the cognitive mechanisms involved, and the implications for bilingual language processing. It provides an important contribution to the literature on bilingual language processing and serves as an important resource for researchers in the field.

De Groot and Kroll (1997) also examined how bilinguals represent and process lexical items in their two languages. They looked at the difference between cognates and noncognates. The study used the Stroop task to measure the differences in how bilinguals process cognates and noncognates. Stroop task is a psychological test used to measure cognitive functions such as selective attention, reaction time, and mental flexibility. It involves a list of words presented in different colors and the participant must identify the color of the word, rather than its meaning. The results showed that bilinguals' performance on the task was significantly different for cognates and noncognates. These results suggest that bilinguals have different lexical representations for cognates and noncognates, and that cognitive access to cognates is facilitated.

From these studies, we learn that cognates can facilitate lexical access in bilinguals, allowing them to recognize words more quickly. Additionally, cognate recognition is affected by phonemic selection and language-specific features. Lastly, cognate effects may differ depending on the level of language proficiency and the context in which they are used.

I discussed cognates and lexical access. Another area I discuss now is the effect of cognates on the translation process. It follows next.

2.6 Effects of cognates on the bilingual translation process

Kahraman and Oztop (2020) investigated the phenomenon of cognate facilitation in translation. They analyzed literature on this phenomenon, starting with its definition and progressing to its theoretical foundations and effects on translation.

The authors define cognate facilitation as “a process in which the presence of cognates in the source text and/or in the target language facilitates the translation process” (KAHRAMAN and OZTOP, 2020, p. 22). They noted that the presence of cognates can improve the translator’s performance in several ways, including increasing their confidence in the translation and providing them with a better understanding of the source language. The author then went on to discuss the theoretical underpinnings of this phenomenon, noting that it is based on the idea of transfer, which is the ability of an individual to transfer knowledge from a source language to a target language. The authors also discussed the effects of cognate facilitation on translation performance. They noted that, while cognates are generally found to have a positive effect on translation, there is still some debate as to the extent to which they improve performance. The authors cited several studies which have examined the effects of cognates on translation performance. These include Chesterman (1997), Götz and O’Brien (2004). These studies have found that cognates can improve accuracy, fluency, and speed in translation, while other studies, such as Bjørge (2001) and Hinkel (2003) have found that they can have a negative effect on accuracy.

Cognate Effect in translation was also discussed by Sawyer (2010). The author argued that the Cognate Effect is an effective way to translate words and phrases that can’t be accurately translated using literal translations. He began by discussing the history of the Cognate Effect in translation, which dates back to the early 19th century. The author then provided detailed examples of the Cognate Effect in several translated works, including a French novel and a Spanish poem. He also discussed the benefits and drawbacks of using the Cognate Effect in translation, such as increased accuracy and speed, as the translator can quickly recognize and use words that are similar to the original language. The drawbacks of using the Cognate Effect in translation include the potential for mistranslation or misinterpretation of the original text. Additionally, the Cognate Effect can also lead to a “lazy” translation process, as the translator may rely too heavily on the Cognate Effect and not take the time to accurately translate the text. Finally, the Cognate Effect can also lead to a “dumbing down” of the text, as the translator may not use the most appropriate words or phrases to convey the original meaning. He concludes by noting that the Cognate Effect should not be used as a "crutch" in translation, but rather as a tool to improve accuracy and understanding.

In order to explore the effects of cognates on translation tasks, Klein *et al.* (2016) conducted a psycholinguistic study using bilingual and monolingual participants. The study was broken down into three experiments, each with its own objectives and methodology. In the first experiment, bilingual and monolingual participants were presented with English-German cognates and asked to translate them into either English or German. The results of this experiment showed that bilinguals performed significantly better than monolinguals on translation tasks with cognates, suggesting that cognates can help facilitate language learning. In the second experiment, bilingual and monolingual participants were presented with English-German pairs of non-cognate words and asked to translate them into either English or German. The results of this experiment showed that bilinguals and monolinguals performed similarly on translation tasks with non-cognates. This suggests that the advantage of bilinguals over monolinguals on translation tasks was due to their ability to recognize cognates. In the third experiment, bilingual and monolingual participants were presented with English-German pairs of words (some of which were cognates and some of which were not) and asked to decide whether the pairs were cognates or not. The results of this experiment showed that bilinguals performed significantly better than monolinguals in recognizing cognates, suggesting that bilinguals have a better understanding of cognates than monolinguals.

The impact of translation tasks on language processing from a psycholinguistic perspective was investigated by O'Brien (1998). He discussed the idea that translation tasks can reveal the underlying structure of language, as well as the nature of language processing. He noted that translation tasks can be used to investigate the degree of automatization in language processing, as well as the limits of the processing capacity. He argued that translation tasks can provide valuable insights into the cognitive processes involved in language comprehension and production. In addition, O'Brien investigated the effects of translation on the accuracy and speed of language processing. He focused on the idea that translation tasks can be used to measure the degree of automatization in language processing.

Previous research found that translation tasks can influence various aspects of language processing. For example, Miller and Rubin (1984) conducted a study examining the process of lexical access, which is the process of retrieving words from memory. They found that translation tasks can affect lexical access, as they can lead to a higher rate of word retrieval. K.R. Gregg (1991) conducted a study examining the impact of translation on lexical representation, which is the way words are stored in memory. He found that translation tasks can lead to changes in lexical representation, such as an increase in the amount of information recalled. Meyer (1987) and MacWhinney (1989) conducted studies examining the effects of translation on syntactic processing, which is the process of constructing sentences from words. They found that translation tasks can affect syntactic processing, resulting in changes in the way sentences are constructed. MacWhinney and O'Brien (1992) conducted a study examining the degree of automatization in language processing. They found that translation tasks can provide insight into the level of automatization in language processing, as they can reveal the limits of the processing capacity.

Braun and Lanza's (2018) article provides an in-depth analysis of the psycholinguistic perspective on cognates in translation. Cognates are words that have a similar origin and meaning in different languages, such as "carpentry" in English and "charpenterie" in French. The authors began by discussing previous research on the topic and noting the limitations of past studies. These limitations included the lack of a comprehensive theoretical framework to explain the cognitive processes involved in cognate recognition and translation, as well as the lack of empirical evidence to support the findings of previous research. Additionally, the authors noted that previous studies have largely focused on one language pair and have not considered the cognitive processes involved in recognizing cognates in multiple languages. They then presented a new theoretical framework that considers the cognitive and psycholinguistic processes involved in cognate recognition and translation. The authors argued that cognate recognition is a cognitively demanding process, which involves the activation of both the source and target languages. This means that in order to recognize a cognate, the brain must access the meaning of the source language and then apply it to the target language. For example, when someone reads the English word "carpentry" and then reads the French word "charpenterie", the brain must recognize the similarity between the two words and then access the meaning of each one in order to understand the translation. Furthermore, Braun and Lanza (2018) proposed that the recognition of cognates can be facilitated by the presence of certain psycholinguistic processes, such as semantic priming and the use of conceptual structures. Semantic priming is a process in which the recognition of one word activates the meaning of related words in memory. For example, if someone reads the English word "carpentry", this may activate the meaning of related words such as "wood" and "tools". The use of conceptual structures refers to the way in which the brain organizes information in a hierarchical, structured way. For example, if someone reads the English word "carpentry", they may also activate a conceptual structure that includes related concepts such as "building", "woodworking", and "construction". These findings can be used to develop new strategies for translation, such as the use of semantic priming to help facilitate cognate recognition.

I concluded this topic on cognates and translation by mentioning semantic priming. In the following section, I will go into greater detail on the priming effect, specifically repetition priming.

2.7 Effect of repetition priming in bilingual translation

Priming can be defined as a cognitive phenomenon whereby exposure to a prior stimulus, referred to as a prime, has either a positive or negative effect on a response to a subsequent stimulus. It takes place when one stimulus facilitates, influences, or obstructs the processing of information. According to Cherry (2021), there are a few different types of priming in psychology. These include semantic priming, which occurs when a semantically relevant word, such as "nurse," promotes access to or decisions about the word "doctor." Semantic priming effects are some of the most reliable findings in cognitive psychology, and have been reported for a variety of tasks, including lexical decision (wherein participants are presented with words and nonwords and must decide whether each is a word), perceptual identification, and speeded word reading (naming). Repetition priming is the increased efficiency that results when a task is conducted with a set of previously presented stimuli as opposed to performance with new stimuli, and the improvement reflects implicit memory gained the first time a stimulus was presented. Perceptual priming occurs when the processing of the perceptual aspects of a stimulus (e.g., its visual or auditory form) increases the subsequent response time to the same material. Conceptual priming is a type of repetition priming in which the subsequent reprocessing of the stimulus occurs at the level of its meaning or content. Lastly, masked priming involves presenting a visual prime followed by a visual mask in the same or nearby position. Typically, the time between prime and mask is short (about a few tens of milliseconds). The present study has the objective of investigating if there were repetition priming effects of cognate words in a translation task. Therefore, I will examine the literature on the topic next.

Kononova and Rodriguez (2018) conducted a study in which they recruited 28 Spanish-English bilinguals to participate in a translation task. Each participant was shown a series of Spanish sentences, followed by an English translation of the same sentence. The participants were then asked to provide a translation of the same sentence back into Spanish, with the repetition of the sentence serving as the priming stimulus. The results of the study showed that repetition priming had a significant effect on bilingual translation. Specifically, the participants were faster and more accurate in translating the sentences when the same sentence had been repeated. Furthermore, the participants' accuracy was higher when the sentences were repeated within a short period of time, suggesting that the repetition priming effect was stronger when the repetition occurred in a short amount of time. The results of this study suggest that repetition priming can be an effective method for improving bilingual translation. By repeatedly exposing bilinguals to a stimulus, they are able to become more familiar with the words and syntax of the target language and are able to translate the text more accurately. This has important implications for language learning, as repetition can be used as a tool to help language learners become more proficient in a second language. Furthermore, the results of this study suggest that repetition priming is an effective method for improving bilingual translation, even when the repetition occurs in a short amount of time.

In another study, Lambert, Bloch, and Romani (2018) set out to examine the brain activity associated with this process, using event-related potentials (ERPs). ERPs measure the electrical activity of the brain in response to specific events, such as the presentation of a stimulus. The researchers conducted an experiment to measure the ERPs of bilingual Spanish-English speakers as they translated sentences from Spanish to English. The participants were presented with pairs of sentences, one in Spanish and one in English. For one set of sentences, the Spanish sentence was the same as the English sentence; for the other set, the Spanish sentence was different from the English sentence. The participants' brain activity was then measured as they translated the sentences. The results showed that the participants had faster reaction times and greater accuracy when translating the sentences that were the same in both languages. This suggests that repetition priming was occurring, as the participants were more familiar with the sentence pairs that were the same in both languages. The ERPs also revealed that the participants had an increased amount of activity in the left frontal lobe when translating the same sentence pairs, suggesting that this region of the brain is involved in the repetition priming of bilingual translation.

To compare the effects of repetition priming in a bilingual context and a monolingual context, Kononova and Rodríguez (2016) conducted a series of experiments in which native Spanish speakers and native English speakers read stories written in Spanish and English. They measured the participants’ reaction time in translating the stories from one language to another. The authors found that repetition priming effects were stronger in the bilingual context than in the monolingual context. Specifically, the authors found that repetition priming effects were stronger in the Spanish-to-English translation task than in the English-to-

Spanish translation task. This suggests that repetition priming is more effective in a bilingual context than in a monolingual context. Furthermore, the authors found that the repetition priming effect was strongest when the language of the original story was close to the language of the target story. This suggests that the proximity of the languages plays a role in the strength of the repetition priming effect.

Díaz and Swainson (2016) examined the effects of bilingual translation and repetition priming on eye-tracking patterns. Their study was conducted on 24 bilingual speakers who were asked to read sentences in their native language and then asked to read a translation of those same sentences in their second language. The study found that eye-tracking patterns were affected by both bilingual translation and repetition priming. The authors first introduce the concept of "lexical priming", which is the process by which repeated exposure to a word increases activation of that word in the brain. The authors then discuss the effects of bilingual translation on eye-tracking patterns, noting that bilinguals often process words differently in their two languages. Bilingual translation resulted in the participants spending more time fixating on words in the second language than in the first. This was due to the fact that bilinguals often process words differently in their two languages. Additionally, repetition priming was found to have an effect on eye movement patterns, with participants spending less time fixating on words when they had been repeated in the same sentence. This effect was more pronounced when the words were repeated multiple times

These studies suggest that repetition priming can have a significant effect on bilingual translation. Specifically, repetition priming may facilitate translation processes, leading to faster and more accurate translations. Additionally, these studies suggest that repetition priming has different effects in different languages, and that the effects can be measured with eye-tracking, ERP, and other cognitive measures. I conclude the theoretical conceptions considering the factor proficiency, accuracy, and reaction time on translation.

2.8 Translation - proficiency, accuracy, and reaction time

Examining the role of reaction time in translation proficiency and accuracy, Montañez and García-Mateo (2017) through their study of 44 Spanish-speaking students, found that translation accuracy was significantly correlated with reaction time, suggesting that accuracy in translation is associated with deeper processing. They noted that "translation is a complex cognitive process" which involves the simultaneous interpretation of source language (SL) information and formulation of target language (TL) information. The study employed a computer-based translation task (TRAP) to measure reaction time and accuracy in translating from Spanish to English. The authors also found that accuracy is associated with the use of cognitive and metalinguistic strategies. The authors concluded that "reaction time can provide useful information about the levels of proficiency and accuracy in translation."

In another article investigating the impact of translation proficiency and reaction time on translation accuracy, Gómez and García (2015), used an experimental study to investigate the effects of proficiency and reaction time on accuracy in translations from English to Spanish. The study included forty-three volunteer participants who were divided into two groups: one with higher proficiency in English-Spanish translation and the other with lower proficiency. The participants were asked to translate a set of texts from English to Spanish under two conditions: with a time limit (high-pressure condition) and without a time limit (low-pressure condition). The results showed that translation accuracy was significantly lower in the high-pressure condition than in the low-pressure condition. Further, the results showed that translation proficiency had a significant effect on accuracy in both conditions. In the high-pressure condition, the higher-proficiency group achieved significantly higher accuracy than the lower-proficiency group. In the low-pressure condition, the higher-proficiency group achieved significantly higher accuracy than the lower-proficiency group, but the difference was not as large. These results suggest that translation proficiency is an important factor in determining translation accuracy. Moreover, the results demonstrate that reaction time has an effect on accuracy as well. In the high-pressure condition, participants with higher proficiency in translation were able to maintain higher levels of accuracy despite the short time limit. This suggests that reaction time can be an important factor in determining accuracy in translations. Overall, this article provided evidence that both translation proficiency and reaction time influence translation accuracy. This has implications for both the teaching of translation and the assessment of proficiency in translation. As the authors concluded, "translation accuracy is a complex concept that is affected by a variety of factors, including translation proficiency and reaction time."

Sánchez-Garrido and Báez-González (2013) explored the role of reaction time (RT) in the accuracy and proficiency of translation. The authors posited the hypothesis that RT can be used as a reliable indicator of translation accuracy and proficiency. To test this hypothesis, the authors conducted an experiment in which Spanish-English bilinguals were asked to translate a set of Spanish sentences into English. The authors measured the participants' RTs and compared them to the accuracy of their translations. The authors found that there was a significant correlation between the participants' RTs and the accuracy of their translations. They noted that the participants who had longer RTs tended to have less accurate translations. They also noted that the participants who had shorter RTs tended to have more accurate translations. The authors concluded that RT can be used as a reliable indicator of translation accuracy and proficiency. To further examine their hypothesis, the authors conducted a second experiment in which the same Spanish-English bilinguals were asked to translate a set of English sentences into Spanish. Once again, the authors found a significant correlation between the participants' RTs and the accuracy of their translations. They concluded that RT is a reliable indicator of translation proficiency in both directions. Overall, the authors found that RT can be used as a reliable indicator of translation accuracy and proficiency. They noted that the participants who had longer RTs tended to have less accurate translations and the participants who had shorter RTs tended to have more accurate translations. The authors concluded that RT can be used to assess translation proficiency in both directions. As the authors state, "The results of this study demonstrate that RT can be a reliable indicator of translation accuracy and proficiency in both Spanish-English and English-Spanish directions."

In view of its relevance, this phenomenon was investigated in the present study. The methodology used in the present experiments is explained in the next section.

3. METHODOLOGY

In this chapter, I describe in detail the methodological course taken in this research, from the elaboration of the corpus to the procedure for collecting data from the experiments that were conducted. First, I present the general and specific objectives, as well as the research questions and hypotheses that motivated the present study. Next, I present the research procedures, such as the recruitment of participants, the instruments, the corpus, and the data collection procedures of the experiment.

3.1 Objectives

3.1.1 General objective

The present study aimed to investigate, from a psycholinguistic perspective, the cognitive processes such as attention, perception, memory, and inhibitory processes involved in the recognition of words and lexical access in a language decision task, as well as to determine whether repeated exposure to the same words in different languages can lead to faster and more accurate translations.

3.1.2 Specific objectives

1) Evaluate the processing cost of Brazilian Portuguese-English cognate words compared to non-cognate words in a language decision task.

2) To investigate if there were repetition priming effects of cognate words in a translation task.

3.2 Research questions

1) How does the processing cost of Brazilian Portuguese-English cognate words compare to non-cognate words in a language decision task?

2) Is there a repetition priming effect of cognates in a translation task?

3.3 Research hypotheses

H1 - The processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task.

H2 – There are repetition priming effects of cognate words in the translation process.

Subsequently, the research procedures are explained in subsection 3.4.

3.4 Research procedures

In this research, I used an experimental methodology in real time, through the use of the free software PsyToolkit (STOET, 2010, 2017). I used it to put into practice two experiments, which provided us with information about the participants' accuracy and reaction time when doing a language decision task (Experiment 1) and a translation task (Experiment 2).

In Experiment 1, I used cognate and control words between the Brazilian Portuguese-English language pair as stimuli for the proposed tasks. I established the following conditions for the language decision task: CGP (cognate words written in Brazilian Portuguese), CGE (cognate words written in English), CTE (control words in English) and CTP (control words in Brazilian Portuguese). Cognate words are words that have a similar form and meaning in two languages. For example, the English term "universe" and the Portuguese word "universo" are two cognate words used in our study. As these words have the same meaning, the CGP and CGE conditions meant that they were presented in our experiment in both languages, sometimes in Portuguese and sometimes in English.

In Experiment 2, we used English cognate words classified as old cognate words (OCG) and new cognate words (NCG). These two conditions reflect the fact that I used 26 cognate words (OCG) from the previous experiment, Task 1, and 26 new cognate words (NCG) that had not been used in the previous task, so I could compare reaction time and accuracy between the two conditions. These words were spelled out in English.

Considering the need for online processing tasks, "since the lexical processing needs of bilinguals in Brazil are still reasonably foreseen in the use of offline processing tasks" (TOASSI *et al*., 2020, page 3), in this study I used the software PsyToolkit that performs online experiments with reaction time and accuracy, as explained by Stoet (2010, 2017). Thus, it is important to detail the output of this software: for each participant, a text file was be generated (see Image 1) with the information requested when creating the task.

Image 1- Text from Psytoolkit

```
Arquivo    Editar    Exibir

1 Lista01 " p " 36 primo 36 CTP 5 NA 10.4 português 2 2 638 1 2
1 Lista01 " a " 4 ator 4 CGP 4 26.3 71.9 português 2 2 568 1 2
1 Lista01 " r " 70 screen 70 CTE 5 23.4 NA inglês 1 1 692 1 1
1 Lista01 " t " 26 universo 26 CGP 8 25.3 46.8 português 2 2 720 1 2
1 Lista01 " i " 68 month 68 CTE 5 95.2 NA inglês 1 1 565 1 1
1 Lista01 " c " 54 birthday 54 CTE 8 97.2 NA inglês 1 1 621 1 1
1 Lista01 " i " 21 religion 21 CGE 8 13.9 31.6 inglês 1 1 626 1 1
1 Lista01 " p " 22 interesse 22 CGP 9 51 119.3 português 2 2 569 1 2
1 Lista01 " a " 2 acidente 2 CGP 8 81.3 101.6 português 2 2 627 2 1
1 Lista01 " n " 29 amanhã 29 CTP 6 NA 5.7 português 2 2 700 2 1
1 Lista01 " t " 18 pânico 18 CGP 6 21.8 12.6 português 2 2 681 2 1
1 Lista01 "   " 31 corpo 31 CTP 5 NA 158 português 2 2 578 1 2
1 Lista01 " c " 28 palavras 28 CTP 8 NA 103.7 português 2 2 609 2 1
1 Lista01 " o " 25 union 25 CGE 5 21.8 76.5 inglês 1 1 674 1 1
1 Lista01 " d " 48 caminho 48 CTP 7 NA 108.3 português 2 2 1023 1 2
          " e "
```

Source: own authorship

In this experiment, the software showed the experimental block in the first column, then the code that the participant chose for identification. The code was followed by the line number that identifies the experimental sentence, target_word, ID, stimulus identification number, condition: referred to the conditions CGE,CGP,CTE,CTP, n_letters, number of letters in the word, freq_Ing: English word frequency, freq_port: Portuguese word frequency, answer: whether it was Portuguese or English, Answerkey1, Answerkey2, RT: Reaction time (RT) measured in milliseconds (ms), STATUS: number 1 corresponded to correct answers, number 2 corresponded to errors, and number 3 indicated that the participant had exceeded the response time limit, which in this task was 3 seconds, KEY, in that order.

It is worth noting that the effectiveness of the PsyToolKit software (STOET, 2010, 2017), an instrument used via the Internet, was compared to E-Prime 3.0, (an instrument used in laboratories) (KIM; GABRIEL, GYGAX, 2019). The authors compared results obtained through a replicability study, for the same paradigm, and concluded that the data brought forth by the PsyToolKit software (STOET, 2010, 64 2017) were valid. Thus, this instrument offers valid data on reaction time and accuracy compared to E-Prime 3.0. According to the authors

> The results indicated that PsyToolkit is a viable method for conducting both general and psycholinguistic specific experiments that utilize complex response time tasks, with effects found to replicate for both response choice and response time. (KIM; GABRIEL; GYGAX, 2019, p. 2).

In this perspective, we can infer that our experiments provided accurate information about the identification or recognition of a word from the recording of reaction time and accuracy in both the language decision process and the translation process in a controlled environment.

3.5 Participants

Participants in the survey were invited to take part via a message sent through the WhatsApp social network app. They were informed that the study would be conducted online and that they would require a laptop or desktop computer, as the tasks could not be completed using a cellphone. After agreeing to participate in the study, they were given a link to the PsyToolKit software (STOET, 2010, 2017). All subsequent experimental steps were carried out using that link.

The present study was conducted with eighteen participants. However, one participant had to be excluded because her language proficiency was too low, and she did not comprehend the instructions on how to perform the task. Therefore, seventeen participants remained. They were instructed to create a code containing two letters and two numbers to identify them. Ten women and seven men participated in the survey, all of them with Brazilian nationality. Nine participants worked in schools, of which eight were teachers. There were four students, a programmer, an environmental analyst, and a retiree among them. Only one participant had not yet finished their graduation. The age group of the participants varied between 19 and 59.

The participants indicated their levels of proficiency in English language in the four skills (listening, speaking, writing, and reading) by estimating each of the skills as very bad, bad, fair, functional, good, very good, or excellent. They answered their English was very good in the reading skill and good for the other three skills. They also took a receptive English test which was used to assess their proficiency in English. This test is part of the blog of the Test Research and Development Institute at the University of Leipzig in Germany (Institute for Test Results and Test Development - https://itt-leipzig.de/?lang=en). The scores of the participants in the test had a mean of 81%, with a minimum of 63% and a maximum of 99%. An interesting fact is that eight participants started learning English in their teens, seven when they were still children aged between 8 and 12, and two other participants started learning English as young adults.

Next, in Subsection 3.6, "The Corpus," I examine the elaboration of the corpus in order to detail not only the cognate words, the main object of this research, but also the frequencies of these and of the control words in the Brazilian Portuguese-English language pair.

3.6 The corpus

A set of cognate and control words was selected to carry out the language decision and translation tasks of the present study. I used the Open Lexicon - SubtlexUS for the English words. SubtlexUS is a database containing word frequencies based on English and American movies and TV series subtitles (51 million words in total). For the Portuguese words, the Léxico do Português Brasileiro – LexPorBR was used. It is a lexical database for Brazilian Portuguese developed by researchers at the Institute of Computational Linguistics at the University of São Paulo, Brazil. LexPorBR contains information on over 200,000 words and their meanings, including information on their frequency, syntactic category, and semantic features. The corpus of the present study consisted of 208 words in total: 26 cognate words written in Brazilian Portuguese (CGP), 26 cognate words written in English (CGE), 26 control words in Brazilian Portuguese (CTP), and another 26 control words in English (CTE), as shown in Table 1. The criteria used to determine if the words in the table were cognates was based on their similarity in form and meaning across languages. Generally, cognates are words that have a common origin and share similar forms and meanings in different languages. In the case of Portuguese and English, many cognates exist due to their shared Latin roots. For example, the word "acadêmico" in Portuguese and "academic" in English share a similar form and meaning because they both derive from the Latin word "academicus". Similarly, the words "acidente" and "accident" share a similar form and meaning because they both derive from the Latin word "accidens". Other factors that can be used to determine cognates include shared phonetic and semantic features, as well as similarities in spelling and pronunciation. There were also 52 distracting words and another 52 confounding words that I used in Experiment 2, the translation task, as seen in Table 2. All the selected words were nouns. The main differences between confounding and distracting words are their orthographic relevance to the task and their potential to interfere with the participant's ability to correctly identify and translate the target word. Confounding words were carefully selected to be related to the target word in some way, which may make them more difficult to distinguish from the target word. Distracting words, on the other hand, were chosen to be unrelated to the target word and may be more likely to interfere with the participant's ability to identify and translate the target word accurately.

Table 1 – Language decision task stimuli list

CGP (cognate words written in Portuguese)	CGE (cognate words written in English)	CTP (control words in Portuguese)	CTE (control words in English)
acadêmico	academic	sabedoria	meetings
acidente	accident	palavras	birthday
alarme	alarm	amanhã	apple
ator	actor	medo	woods
autor	author	corpo	amount
confusão	confusion	carteira	blessings
droga	drug	fluxo	size
efeitos	effects	criança	charity
exame	exam	bolsa	worm
fruta	fruit	primo	minds
galáxia	galaxy	volante	cooler
inseto	insect	anseio	thighs
melão	melon	lousa	cuffs
memória	memory	cliente	corner
minuto	minute	estilo	couple
música	music	pessoa	month
palácio	palace	caderno	effort
pânico	panic	pressa	screen
planta	plant	receio	stone
proteção	protection	correria	breathing
região	region	espírito	machines
revisão	revision	caminho	writings
série	series	linha	button
trator	tractor	índole	pathway
união	union	clima	issue
universo	universe	registro	midnight

Source: own authorship

Table 2 - Translation task stimuli

Confounding words	Distracting words
academia	acordo
atacante	vidente
alerta	alegria
fator	labor
autos	pauta
contusão	cordão
drama	dragão
eleitos	defeito
enxame	enxerto
frota	frango
galeria	galinha
incesto	insulto
pilão	sótão
maioria	melodia
minuta	maroto
músico	museu
paladar	pedaços
pinico	panela
plantão	pilha
projeção	português
reunião	relação
revista	redação
serra	saldo
trato	extrato
visão	razão
diversos	inversos
aumento	documento
unidades	ansiedade
legendário	dicionário
eletricista	eletrônico
inscrição	introdução
transmissão	antevisão
excesso	ingresso

mar	bar
beleza	bula
gripe	grito
histeria	novela
luta	liga
viagem	virgem
objeto	produto
realização	atividade
comparação	condenação
transe	trabalho
utilidade	humildade
inflamação	intimação
metamorfismo	ginástica
momento	alimento
revelação	legião
quesito	enquete
reação	opinião
comida	começo
depoimento	treinamento

Source: own authorship

It is worth mentioning table 2 does not show the cognate stimuli because they are the same as in table 1. The frequency of the words is an important factor, which will be addressed in the following subsection.

3.6.1 Corpus frequency

There are some precautions that should be taken with regard to word frequencies when choosing words for an experiment. According to Schmitt *et al*. (2001):

> care should be taken to ensure that the distribution of word frequencies is representative of the language being studied; the word frequencies used in the experimental task should be appropriate for the language level or type of text being studied; the word frequencies used in the experimental task should be balanced; and the word frequencies should be monitored throughout the experiment to ensure that

> they remain consistent and that they do not change unexpectedly or have any unintended effects.

Having these precautions in mind, there were challenges regarding word frequency. The norms for delimiting the cut-off point for more frequent and less frequent words in a language need to be established according to the corpus of the language under study; that is, the same parameters of an English corpus cannot be transposed to other languages, such as Brazilian Portuguese, as these have different compositions.

According to Van Heuven *et al.* (2014) frequency counts are the most adaptable measure, but they have one major drawback: the meaning of the frequency measure is determined by the size of the corpus. As a result, authors have looked for a standardized frequency measure, an index with the same interpretation across all corpora collected. As of now, frequency per million words (fpmw) has been the most widely used standardized frequency measure. However, this measure could lead to a misunderstanding of the word frequency effect. The lowest number in Kucera and Francis' (1967) word frequencies was 1 fpmw since their corpus contained just one million words. This led to the notion that 1 fpmw is the lowest frequency possible. However, Van Heuven *et al.* (2014) state this is no longer the case for larger corpora. Interestingly, over 80% of the word types in SUBTLEX-UK corpora have a frequency of less than 1 fpmw. Moreover, over half of the word frequency effect occurs below 1 fpmw, with very little variation above 10 fpmw. The frequency effect of lexical decision times ranging from 0.1 fpmw to 1 fpmw is similar to, or greater than, the effect of lexical decision times ranging from 1 fpmw to 10 fpmw. The authors argue that a logarithmic modification of frequency measures, which is commonly used, solves this problem; however, for frequencies less than one, the logarithms of fpmw turn negative, which uninformed users tend to avoid. Because of these characteristics, fpmw as a standardized measure might mislead users. To make the word frequency effect easier to understand, Van Heuven *et al.* (2014) came up with a list of requirements

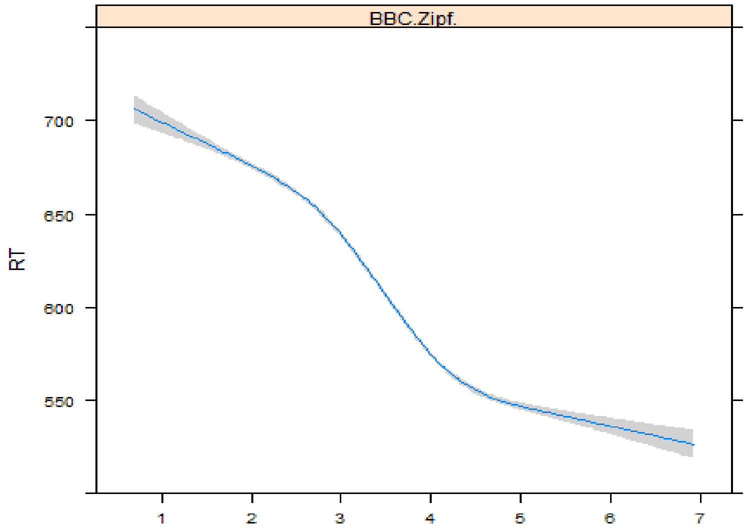
> These are the elements we saw necessary:
>
> 1. It should be a logarithmic scale (e.g., like the decibel scale of sound loudness). 2. It should have relatively few points, without negative values (e.g., like a typical Likert rating scale, from 1 to 7). 3. The middle of the scale should separate the low-frequency words from the high frequency words. 4. The scale should have a straightforward unit. Once we know what the scale should look like, it is not so difficult to come up with a good transformation. In particular, when we

> take the log10 of the frequency per billion words (rather than fpmw), the scale fulfills the first three requirements.

In order to satisfy the first three requirements on the list, log10 (frequency per million words) + 3 was used. To meet the fourth condition, Van Heuven et al. (2014) suggest naming the new scale the Zipf scale in honor of George Kingsley Zipf, the American linguist who initially examined the patterns of word frequency distribution and created a law that bears his name (Zipf, 1949). The unit of measurement on this scale is the Zipf, and it ranges logarithmically from 1 (for very low frequency words) to 6 or 7 (for high frequency content words, as well as some function words, pronouns, and verb forms like "have"). Calculating Zipf values is simple, as it equals either log10 (frequency per billion words) or log10(frequency per million words) + 3. Thus, a Zipf value of 1 corresponds to words with frequencies of 1 per 100 million words, a Zipf value of 2 corresponds to words with frequencies of 1 per 10 million words, a Zipf-value of 3 corresponds to words with frequencies of 1 per million words, and so on. As such, it is easy to determine the frequency of a word on the Zipf scale.

The authors of the study plotted the lexical decision response times (RTs) for known words (accuracy > .67) in the British Lexicon Project (N = 19,487) to illustrate how the word frequency effect corresponds to the Zipf values. In the figure presented below, it can be observed that the word frequency effect is now well-centered in relation to the word frequency scale, with values of 1-3 denoting low frequency words and values of 4-7 indicating high frequency words.

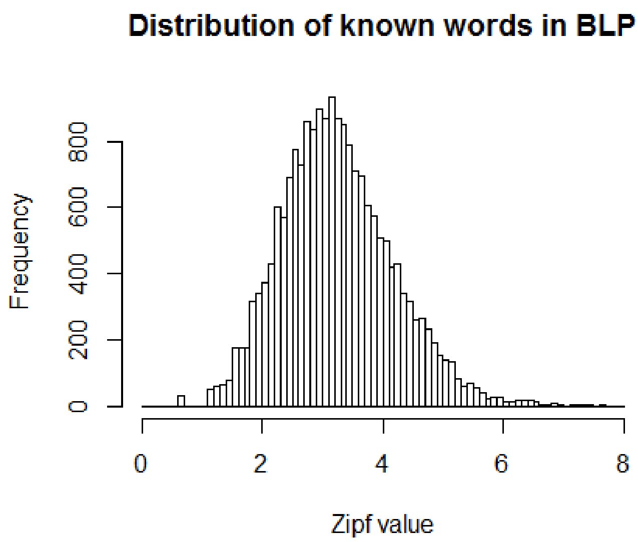
Graph 1- Zipf value vs RT



Source: Van Heuven *et al.* (2014)

Frequently, a criticism is made regarding frequency values below 1 pmw, suggesting that these words are unfamiliar to participants. To address this concern, the British Lexicon Project can be examined. By only considering words that received a positive response from over two-thirds of participants, the resulting distribution as a function of Zipf values is as follows:

Graph 2 - Zipf value vs Frequency



Source: Van Heuven *et al.* (2014)

Once again, it is evident that the distribution is well-centered on the scale.

The scale proposed by the authors met the methodological demands of this study, since it allowed for projections to be made from a specific language and, also, because it clearly defined the parameters to be considered as a cut-off point to stipulate how frequent words are. Both SubtlexUS and LexPorBR provide frequencies in pmw and Zipf scale on their respective websites. The comparison between Zipf scale and SubtlexUS and LexPorBR applied in the corpus of this study is shown in tables 3 and 4.

Table 3 - Zipf scale frequency

Cognates	Zipf scale	Cognatos	Zipf scale
academic	3,7	acadêmico	3,4
accident	4,9	acidente	5
alarm	4,5	alarme	3,9
actor	4,4	ator	4,9
author	3,9	autor	5,2
confusion	3,9	confusão	4,6
drug	4,7	droga	4,5
effects	4,1	efeitos	4,9
exams	3,5	exames	4,8
fruit	4,3	fruta	3,9
galaxy	3,8	galáxia	3,4
insect	3,5	inseto	3,4
melon	3,6	melão	3
memory	4,7	memória	4,8
minute	5,6	minuto	4,4
music	5,2	música	5,3
palace	4,3	palácio	4,4
panic	4,3	pânico	4,1
plant	4,4	planta	4,2
protection	4,4	proteção	4,7
region	3,7	região	5,5
revision	2,8	revisão	5,1

Table 4: Frequency in SubtlexUS and LexPorBr

Cognates	subtlwf	Cognatos	freq_orto/M
academic	4,7	acadêmico	2,5
accident	81,3	acidente	101,6
alarm	29,8	alarme	7,2
actor	26,3	ator	72
author	21,2	autor	169,1
confusion	7,1	confusão	38,9
drug	45,2	droga	34,1
effects	12,7	efeitos	86,7
exams	13,4	exames	30,7
fruit	21,7	fruta	7,6
galaxy	6,7	galáxia	2,4
insect	3,2	inseto	2,6
melon	4,3	melão	1,1
memory	48,6	memória	64,8
minute	377,5	minuto	26,3
music	151,7	música	182,3
palace	19,2	palácio	23,3
panic	21,8	pânico	12,6
plant	27,6	planta	14
protection	23,5	proteção	54,4
region	5	região	297,7
revision	0,6	revisão	119,3

series	4,3	série	5,2	series	20,2	série	167
tractor	3,6	trator	3,5	tractor	3,7	trator	2,8
union	4,3	união	4,9	union	21,8	união	76,5
universe	4,4	universo	4,7	universe	25,3	universo	46,8

Source: own authorship

The words in Tables 3 and 4 are part of the stimuli used in the present study. It is interesting to note how easy it is to compare the frequency of words in Portuguese and English when the Zipf scale is applied. This is because Zipf values range from 1 to 7, with the values 1-3 indicating low-frequency words (with frequencies of 1 per million words and lower) and the values 4-7 indicating high-frequency words (with frequencies of 10 per million words and higher) independent of the corpora used. Besides word frequency, another issue to be addressed is the length of words. This is the topic of the next subsection.

3.6.2 Corpus - Length of words

In a language decision task experiment the length of the words (the number of letters in the words) can have a relevant impact on the results. Zorzi and Dux (2012) made a study that focused on the influence of word length on decision making in a language task. The study consisted of a task in which participants had to choose between two possible responses, one containing a short word and the other containing a longer word. The task was designed to explore the influence of word length on decision making in a language task. The study found that participants were more likely to select a response with a shorter word. The authors hypothesize that this is due to the fact that shorter words are easier to process and recall than longer words. They suggested that this effect may be due to the increased cognitive load associated with longer words. The authors also discussed how this finding may be related to the concept of cognitive fluency, which is the ease with which information is processed and remembered. They suggested that the fact that shorter words are easier to process and remember than longer words may lead to an increase in cognitive fluency, which in turn leads to the selection of shorter words.

To work around the influence of the number of letters in the words used in this study, the complexity of the words chosen was considered to ensure that the words were neither too difficult nor too simple. Furthermore, words of comparable length were used in the tasks; for example, the words "drug" (4 letters) and "droga" (5 letters); "universe" (8 letters) and "universo" (8 letters); "information" (11 letters) and "informação" (10 letters). In Experiments 1 and 2, the word length ranged from 4 to 12 letters. Another aspect that could influence the results was also investigated in this study: orthographic similarity, which I will address next.

3.6.3 Corpus - Orthographic similarity

The orthographic similarity of the Brazilian Portuguese - English cognates were calculated according to a measure described in Van Orden (1987, p. 196). This measure 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

By entering and submitting two words in a form provided by a website (https://www.subjectpool.com/quest/reading/spelling_similarity.php), a value is returned for "Graphic Similarity" (GS). The formula of the Graphic Similarity equals 10([(50F + 30V + 10C)/A] + 5T + 27B + 18E). Orthographic Similarity is the ratio between the GS of Word One with itself and the GS of Word One and Word Two (VAN ORDEN, 1987).

In Portuguese, there are several alphabet signs that do not exist in English, such as Á, É, Ê, Í, Ó, Ô, and Ú (all of which are vowels), and Ã and Õ (which are both nasal vowels). These alphabet signs were not considered when the orthographic similarity between Brazilian Portuguese and English was calculated. The table comparing all the 26 Brazilian Portuguese – English cognate words are shown in Table 5.

Table 5: Cognates orthographic similarity

Cognate in English	Cognates in Portuguese	ortographic_similarity
"academic"	"acadêmico"	867,4
"access"	"acesso"	770
"accident"	"acidente"	782,5
"activities"	"atividades"	882,6
"actor"	"ator"	801
"air"	"ar"	563,3
"alarm"	"alarme"	857,1

"apartment"	"apartamento"	790,9
"author"	"autor"	855,3
"blouse"	"blusa"	566,2
"calendar"	"calendário"	776,7
"comedy"	"comédia"	697,5
"competition"	"competição"	683,6
"confusion"	"confusão"	679,2
"department"	"departamento"	820,2
"drug"	"droga"	487,7
"effects"	"efeitos"	785,7
"electricity"	"eletricidade"	733,2
"exams"	"exames"	855,3
"fruit"	"fruta"	600
"galaxy"	"galáxia"	774,4
"group"	"grupo"	620
"history"	"história"	727,1
"image"	"imagem"	766,2
"information"	"informação"	656,4
"insect"	"inseto"	653,3
"instruction"	"instrução"	620,2
"interest"	"interesse"	843,8
"legion"	"legião"	653,3
"list"	"lista"	732,2
"melon"	"melão"	600
"memory"	"memória"	578,9
"metabolism"	"metabolismo"	829,7
"minute"	"minuto"	736,6
"movement"	"movimento"	714,4
"music"	"música"	539
"palace"	"palácio"	550,3
"panic"	"pânico"	539
"plant"	"planta"	766,2
"project"	"projeto"	691,4
"protection"	"proteção"	654,4
"question"	"questão"	660,4
"reality"	"realidade"	621,4
"region"	"região"	653,3
"religion"	"religião"	782,5
"series"	"série"	553,3
"television"	"televisão"	799,2
"tractor"	"trator"	862
"transit"	"trânsito"	793,8
"union"	"união"	600
"universe"	"universo"	782,5
"university"	"universidade"	693,5

Source: own authorship

3.7 Research instruments

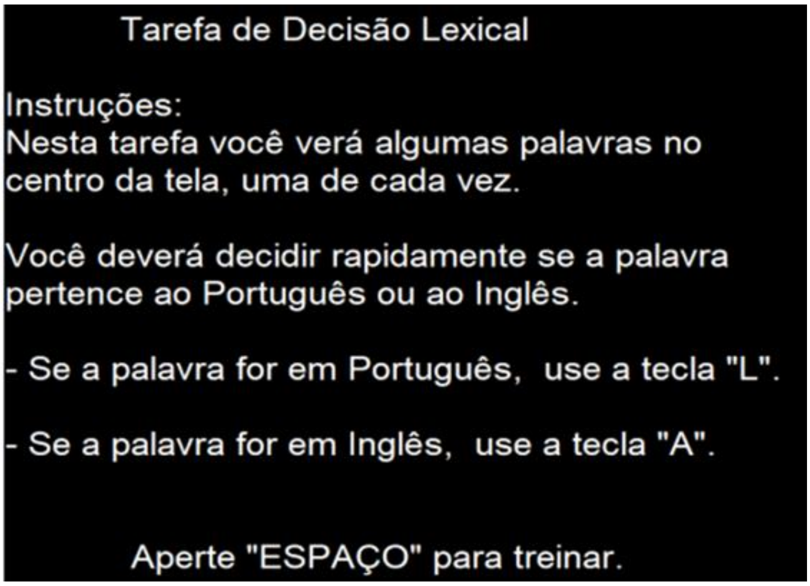
In this subsection, each instrument used in the research is demonstrated and detailed through screenshots taken from the screens and referring sites. In addition, the access links for Experiments 1 and 2 as well as the Receptive Vocabulary Test from the Test Research and Development Institute at the University of Leipzig (Institute for Test Results and Test Development - https://itt-leipzig.de/?lang=en) are provided. The instruments used in Experiment 1 - Language Decision Task are then illustrated and described in depth.

3.7.1 Experiment 1 - task 1 - language decision

Lexical decision tasks are procedures used in many psycholinguistic experiments to measure how quickly people can classify stimuli as words or nonwords. A language decision task is similar to a lexical one; however, in a language decision task, the participants classify stimuli as belonging to a particular language, such as Portuguese or English words, as in our experiment. The dependent variables in all experiments of this nature are the same: reaction time and accuracy. The purpose of a language decision task is to measure how quickly and accurately people can process language. This type of experiment can be used to study a variety of topics, such as language acquisition, language processing, and language comprehension. I used it to study the effects on language processing of cognate words between Brazilian Portuguese and English compared to non-cognate words.

When participants accessed the link of the experiment, read and accepted the consent form, they filled in a questionnaire and were then directed to the task on PsyToolKit (STOET, 2010, 2017). They saw a greeting image, which contained the first instruction of the experiment (Image 2).

Image 2 - Greeting screen



Source: own authorship

Image 2 gave the instruction in Brazilian Portuguese informing participants they should press the "L” key when they saw a word in Portuguese and the "A" key when the word was presented in English. This task was used for the collection and analysis of data from Experiment 1. It was alternated in two different models, defined as Experiment 1A - Task 1A and Experiment 1B - Task 1B, due to the fact that keyboard commands were toggled for each language. Experiment 1A considered that, by pressing the "A" key, the participant would be deciding that the word presented on the computer screen was in Brazilian Portuguese, and the "L" key, to indicate that the word presented on the computer screen was in English. On the other hand, Experiment 1B had the computer keyboard commands with the opposite idea to the previous one, that is, when pressing the "A" key, it would indicate the word in English, and the "L" key would indicate the word in Brazilian Portuguese. This procedure was adopted to avoid the effect of the dominant hand on the participants' reaction.

In the following image (Image 3), the fixation cross is presented. It was shown in the initial screen, at a speed of 500 milliseconds, before each stimulus.

Image 3 - Fixation cross

Source: own authorship

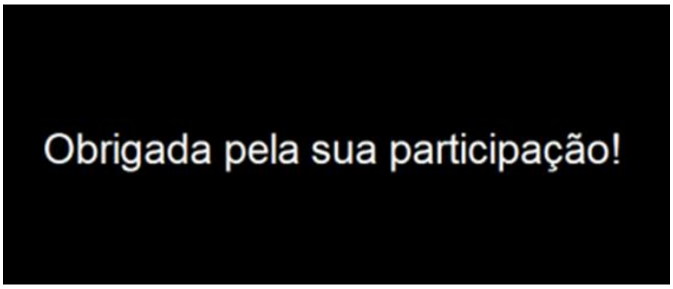
The next image (Image 3) shows an example of a stimulus presented in the middle of the screen for 3000 ms and at a random order for each of the participants. It is worth mentioning that there was a training session containing ten words before the actual task to familiarize the participants with the procedures. The participants had to answer 78 trials. The whole task took less than 5 minutes to be done. The key the participant stroke in the computer keyboard was recorded by Psytoolkit software (STOET, 2010, 2017) and converted in numerical values of 1 or 2 so that the accuracy of the answers could be analyzed later.

Image 4 - Example of a stimulus

Source: Own authorship

When the participants finished their task, they saw a thanking image (Image 5).

Image 5 - Thank you image



Source: own authorship

The participants were directed to the second task immediately when finishing the first one. I discuss how the second part of the experiment was done in the next subsection.

3.7.2 Experiment 2 - task 2 – translation

This task demanded that the participant choose a correct translation for a word they saw in the middle of the computer screen, just as they did in Experiment 1 (see Image 3). Half of the words they saw in the middle of the computer screen were from Experiment 1 (OCG) spelled out in English; these were used to check for a repetition priming effect in the translation. The other half were words they had not seen before (NCG) also spelled out in English. I present a screenshot of one of our trials in Image 6. In this screenshot, I highlight an English cognate word in English and the three response options that corresponded to the following commands: "A", for the word on the left side of the screen; "G", for the word in the middle of the screen; and "L", for the word on the right side of the screen. As in the previous task, I provided a training session before the actual task to familiarize the participants with the procedures. In this task the stimulus was presented for 5000 ms before moving on to the next word. The participants had to answer 52 trials. The whole task took less than 5 minutes to be done. The key the participant stroke in the computer keyboard was recorded by Psytoolkit software (STOET, 2010, 2017) and converted in numerical values of 1, 2 or 3 so that the accuracy of the answers could be analyzed later.

Image 6 - Screenshot of Task 2A - Experiment 2

Source: own authorship

3.7.3 Receptive vocabulary test – English

The Receptive Vocabulary Test lasts 30 minutes and is timed on its own website (blog). This test is part of the blog of the Test Research and Development Institute at the University of Leipzig in Germany. It is a well-respected provider of psychometric tests and assessments. TRDI has developed a wide range of reliable and validated tests, such as the Test of Cognitive Abilities, the Test of Interpersonal Skills, and the Test of Work-Related Skills. In addition, TRDI has been involved in research on the reliability and validity of different tests, such as the German version of the Personality Inventory for DSM-5 (PID-5-D). The institute is headed by two directors, a group of five coordinators, and ten collaborators, including two departments. The blog offers vocabulary tests for fifteen different languages. These vocabulary tests fall into two types: productive and receptive. I used the receptive vocabulary test in our research because participants were not requested to write or speak anything; they used receptive reading comprehension skills, in this case, reading words in English or Brazilian Portuguese in order to make a decision or choose a correct translation. I emphasize that all tests are free of charge.

3.7.4 Research questionnaire

The research questionnaire had sixteen questions regarding the biographical, language, and technological information requested from each participant. It was answered on the Psytoolkit (STOET, 2010, 2017) website right after the participant accepted the consent form. The biographical information dealt with the participant's identification (a code of two numbers and two letters), age, gender, place of birth, nationality, occupation, and whether they were right-handed, left-handed, or both. Concerning the linguistic information, the instrument had questions about the level of education, age when the participant started learning English, and the place of their English learning (immersion, with friends, at home, at school, at work, or self-learning).

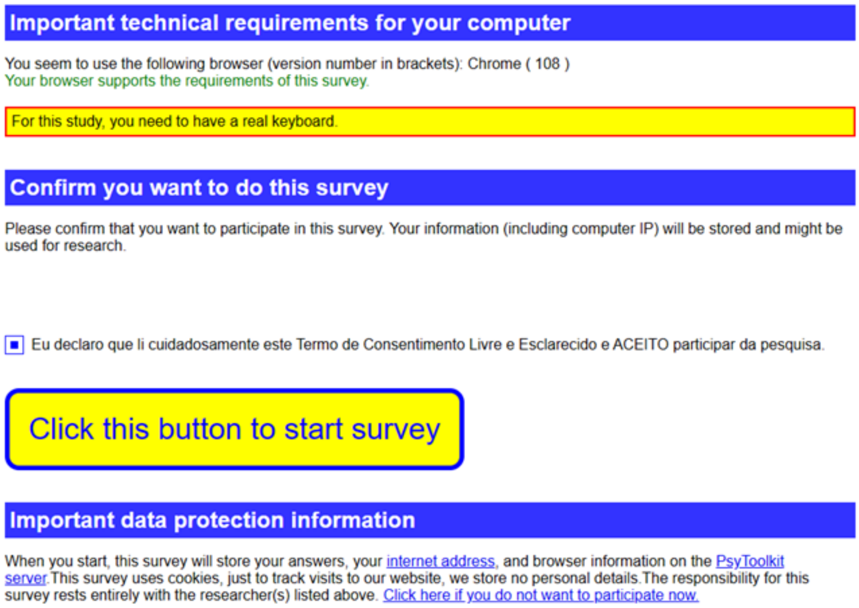
In this topic, I also checked the participant's perception about their proficiency level in the four skills. I also collected information about knowledge of other languages besides Portuguese and English, indicating which languages they knew and estimating their level of knowledge (very bad, bad, fair, functional, good, very good, or excellent). The last topic, technological information, consisted of acquiring data on the type of machine, operating system, browser, mouse, and keyboard used by the participant during this survey, as this could interfere with the quality of data collected by the Psytoolkit software (STOET, 2010, 2017). In the subsequent subsection 3.8, I discuss the data collection procedures in this research.

3.8 Data collection procedures

After validating the instruments designed for this research with a pilot test carried out by participants from the Phonetics and Multilingualism Laboratory (LabFoM) research group, I started the procedures for data collection by inviting people to participate via a social networking application (Whatsapp). Eighteen people accepted to participate, but one participant had her data discarded because she did not understand how to do the experiments.

According to the participant’s schedule, I sent them the link to start the data collection. The first step the participant had to do was to read and accept the Consent Form (Image 7).

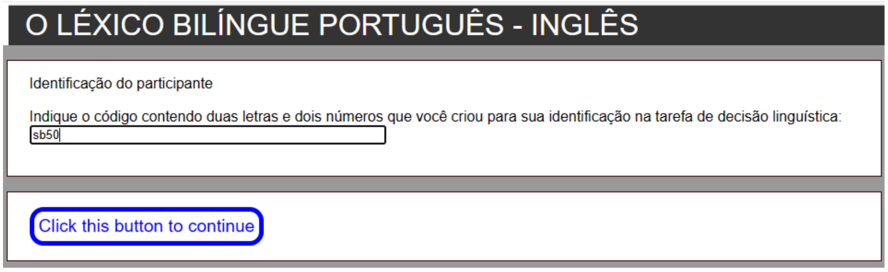
Image 7 - Consent form



Source: own authorship

After confirming the acceptance, the participant was requested to create a code of two letters and 2 numbers (Image 8), which was the step 2.

Image 8 - Code creation



Source: own authorship

Next, step 3, the participant filled in a questionnaire as already mentioned in subsection 3.7.4 Research Questionnaire. As soon as the questionnaire was filled in, the participant was ready to start the tasks (Image 9).

Image 9 - Start Button

Source: own authorship

The fourth step consisted of the language decision task, Experiment 1. This task consisted of a training phase, in which ten words, classified as cognate words in English, control words in English and control words in Brazilian Portuguese, were presented for the participants to become familiar with the task itself, which would follow after training. The task was constituted by 78 words (trials) with the same classification of the training words, i.e., 26 cognate words, 26 control words in English and 26 words in Brazilian Portuguese, in Arial font, size 40.

The fifth stage of this research consisted of the translation task, Experiment 2. As in the previous stage, this experiment had a training phase. Ten words classified as cognates in English and, control words in Brazilian Portuguese, were arranged for the participants to familiarize themselves with the task itself that would follow after the training. To carry out the task sequences, I used the font Arial, size 60, for the stimuli and Arial, size 40, for the three response options. The task consisted of providing the correct translations for fifty-two cognate words spelled out in English. For each of these words, participants were presented with three possible answer options in Brazilian Portuguese to choose from.

The last stage dealt with a receptive English vocabulary test by the Institute for Test Results and Test Development at the University of Leipzig (Institute for Test Results and Test Development). As soon as the last task was finished, the participant was directed to the English vocabulary test site. This vocabulary test, in the form of a quiz, lasted thirty minutes, delimited by its access site. This task consisted of five levels of proficiency, with thirty items for each level, where each item contained six options to choose the correct one. At the end, the participant submitted their answers and had access to the number of correct answers by level of proficiency and the general percentage of correct answers. The test results were not compiled through the PsyToolKit (STOET, 2010, 2017), therefore I asked the participants to send them by email or WhatsApp social media.

Having completed the discussion regarding the methodology of the present study, I proceed with the analysis of the experiments in the next section, results and discussion.

4. RESULTS AND DISCUSSION

The current research intended to examine, from a psycholinguistic point of view, the cognitive processes involved in the recognition of words and lexical access at a word level in a language decision task, as well as whether a repetition priming effect was present in a translation task with cognate words and how repetition may impact our ability to access and translate words. Specifically, the objectives were to: 1) assess the processing cost of cognate Brazilian Portuguese-English words compared to non-cognate words in a language decision task; and 2) examine if there were repetition priming effects of cognate words in a translation task.

The present study used an experimental methodology with the free software PsyToolkit to conduct two experiments. Experiments 1 and 2 used cognate and control words between the Brazilian Portuguese-English language pair as stimuli. Experiment 1 had four conditions: CGP (cognate words written in Brazilian Portuguese), CGE (cognate words written in English), CTE (control words in English) and CTP (control words in Brazilian Portuguese) and Experiment 2 had two conditions: old cognate words (OCG) and new cognate words (NCG). The NCG condition was composed of 26 new cognate words that had not been used in the previous task. The experiments compared reaction time and accuracy between the two conditions. This study was conducted with 17 participants who were invited to participate via WhatsApp and who were required to have a laptop or desktop computer. The results provided information about their accuracy and reaction time, which were the two dependent variables of the study.

The detailed results of these experiments are presented in this chapter, which is divided into three main subsections. Subsection 4.1, "Experiment 1 – Language Decision Task," presents the analysis and results obtained in Experiment 1, a language decision task involving word recognition in the Brazilian Portuguese-English language pair. Subsection 4.2, "Experiment 2 – Translation Task," presents the analysis and results obtained in Experiment 2, a translation task that aimed to investigate the effect of repetition priming on cognate words. Subsection 4.3, "Discussion of the Results," presents the discussion of the results for both experiments in this research, in addition to making an interlocution between these results and those in the literature.

The results and analyses for the two variables Reaction Time (RT) and Accuracy are reported in two subsections, 4.1 Language Decision Task and 4.2 Translation Task, containing the descriptive and inferential statistical analyses. Experiment 1 is discussed next.

4.1 Experiment 1 - language decision task

Experiment 1 was designed to answer the following research question: How does the processing cost of Brazilian Portuguese-English cognate words compare to non-cognate words in a language decision task? I raised Hypothesis H1, which stated that the processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task. To verify this hypothesis, I collected data of two variables Reaction Time (RT) and Accuracy. Next, I present the analysis of the first dependent variable of this experiment: Accuracy.

4.1.1 Analysis – variable: accuracy

In this subsection, I present essential information from the data compiled by the PsyToolKit software (STOET, 2010, 2017), which was used to demonstrate, program, and execute research and cognitive psychological experiments. In this section, I explain and illustrate the data and results regarding the variable accuracy obtained from Experiment 1, in subsections 4.1.1.1 and 4.1.1.2, through analyses, graphs, and tables developed in descriptive and inferential statistics.

4.1.1.1 Descriptive statistics

The data were compiled in the PsyToolKit software (STOET, 2010, 2017), which generated a text file for each of the eighteen participants in this research, containing information on the number of correct answers, number of errors, and four trials that exceeded the response time limit of three seconds. I exported these data, which consisted of 1,404 lines, to a table in Excel format.

This table, in Excel format, was read and analyzed in the RStudio software (RStudio 2022/07/02 BUILD 576 "Spotted Wakerobin" Release (2022/09/06) for Windows Mozilla/5.0 (Windows NT 10.0; Win64; x64) QtWebEngine/5.12.8 Chrome/69.0.3497.128 Safari/537.36). Rstudio is used for developing and running R code, facilitating collaboration, debugging, and producing reproducible reports. It is widely used in the data science community for data analysis, visualization, and predictive modeling. It can also be used for statistical computing, predictive analytics, machine learning, and deep learning. As to the R code, it is a programming language used to write scripts and programs used in data analysis and statistical computing. It is designed specifically to make complex data analysis easier and more efficient. It is widely used in the field of data science and is the foundation for many statistical software packages. After having the data read and analyzed in the RStudio, the results were ready to be discussed.

The results of the dependable variable, status 1 or correct answers, compiled in this table matched the total number of 1261 correct answers, 62 errors (i.e. status 2), and 3 answers that exceeded the 3-second limit for a possible answer. These data that exceeded 3 seconds were equivalent to 3 trials with status 3, meaning 3 responses that were excluded from the data considered as incorrect answer. In the RStudio software, the table appeared as follows before status 3 was deleted:

Table 6 - Status data

1	2	3
1261	62	3

Source: own authorship

Table 6 showed that only 3 trials were above the response time limit (3s) because they were marked as "3". Therefore, I created a subset with only correct answers (1) and errors (2). This new data set has 1323 trials instead of 1326.

I created a status table (Table 7) based on condition and transformed these values into a proportion, since the number of trials with controls was greater than with cognates. Specifically, there were 26 cognate words and 52 control words, with 26 words in English and 26 words in Brazilian Portuguese for each category.

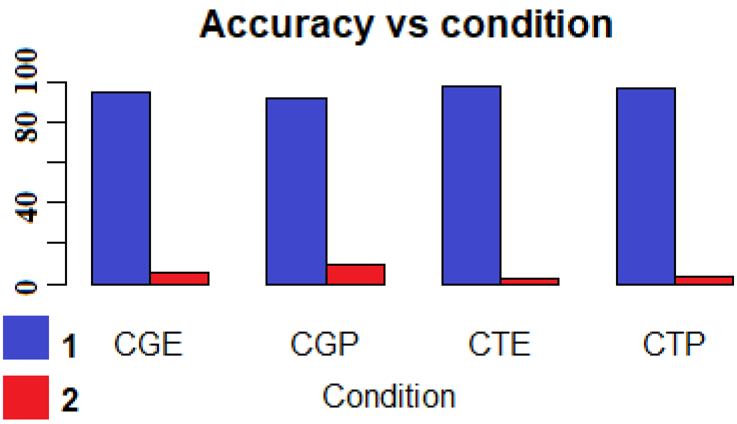
Table 7 - Proportion table

	CGE	CGP	CTE	CTP
1	94.1%	91%	97%	96.3%
2	6%	9%	3%	3.6%

Source: own authorship

When examining Table 7, it becomes apparent that the number of correct answers (represented by status 1) is significantly higher than the number of errors (status 2). Additionally, the data reveals that out of the four predetermined conditions, accuracy was highest in the control group for English (CTE), followed by the control group for Portuguese (CTP). The proportion table (Table 7) further illustrates that accuracy was greater for non-cognate words, the CTE and CTP conditions, in comparison to the cognate words (CGE and CGP conditions). Graph 3, which depicts accuracy versus condition, provides a clear and informative visualization of the results for this dependent variable.

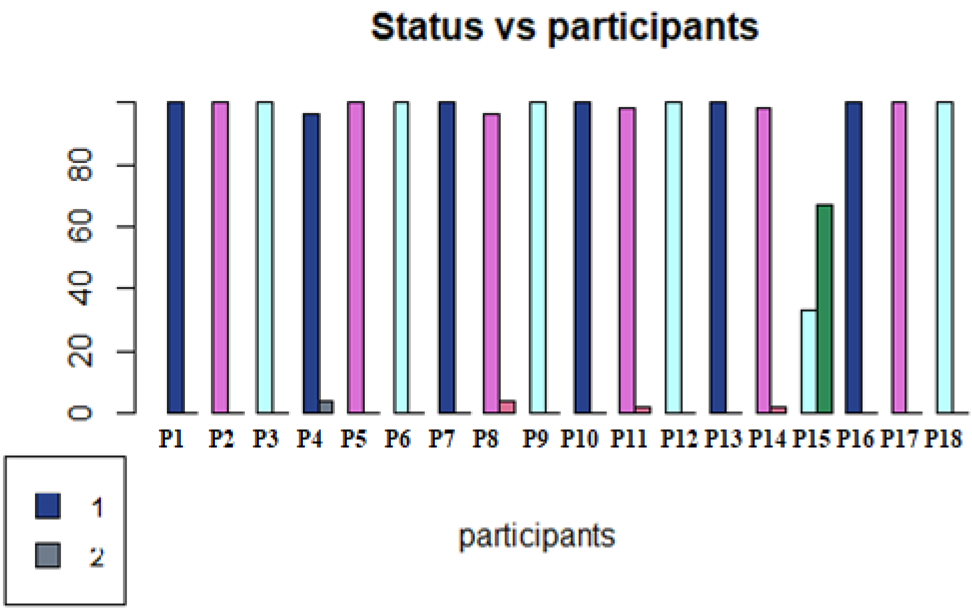
Graph 3 - Accuracy versus condition



Source: own authorship

To visualize the accuracy per participant, Graph 4 provides even more specific information than Graph 3.

Graph 4 - Status per Participant



Source: own authorship

According to Graph 4, participant P15 exhibited a higher number of incorrect answers than correct ones. This may be attributed to several factors, such as inadequate proficiency in the English language, as evidenced by their 33% score on the English test, or a lack of comprehension regarding the task requirements. Consequently, the data from this participant was excluded from the analysis.

After presenting the results of the descriptive statistics for Experiment 1, language decision task, the next step is to conduct inferential statistics on the dependent variable of accuracy. This analysis aims to determine whether the observed difference in accuracy between the CTE and CTP conditions is statistically significant when compared to the other conditions.

4.1.1.2 Inferential statistics

I ran a Generalized Linear Mixed Effects Model (glmer) to investigate whether there were significant differences in accuracies between the conditions. I used the formula “<-glmer (data=d2, STATUS ~ condition + (1|participants) + (1|ID), family=binomial(link="logit"))” in the RStudio software. In this formula, data = d2 is the data set used for the analysis, and "STATUS" represents the dependent variable, while "condition" represents the independent variable of interest. The formula also includes two random effects terms, "(1|participants)" and "(1|ID)," to account for variability between participants and within-subjects, respectively.

The intercept represented the baseline condition (CGE). Choosing CGE as the baseline condition allows for easier interpretation of the coefficients and reduces multicollinearity issues. When CGE is the reference group, the coefficients for the other conditions represent the change in the log odds of success associated with each condition, compared to the CGE condition. If any other condition were chosen as the reference group, the coefficients for all other conditions would be adjusted accordingly. However, the interpretation of the coefficients would remain the same, as they would still represent the change in log odds of success relative to the chosen reference group. The summary of the results is shown in Table 8.

Table 8 - Status vs Condition

	STATUS vs Condition		
Predictors	*Odds Ratios*	*CI*	*p*
(CGE)	0.04	0.02 – 0.09	**<0.001**
CGP	1.66	0.76 – 3.63	0.201
CTE	0.46	0.19 – 1.11	0.083
CTP	0.58	0.25 – 1.37	0.215
Random Effects			
σ^2	3.29		
τ_{00} ID	0.31		
τ_{00} participants	0.91		
ICC	0.27		
N participants	17		
N ID	78		
Observations	1323		
Marginal R^2 / Conditional R^2	0.046 / 0.304		

Source: own authorship

Table 8 shows the results of the linear mixed effects model with "STATUS" as the dependent variable and "Condition" as the independent variable. The odds ratios and their corresponding confidence intervals (CI) indicate the relative changes in the log odds of success for each condition compared to the CGE baseline condition.

The odds ratio for CGP is 1.66, but with a wide confidence interval (0.76-3.63) and a p-value of 0.201, indicating that the difference between CGP and CGE is not statistically significant.

The odds ratio for CTE is 0.46, but with a confidence interval (0.19-1.11) that includes 1. This suggests that there is no significant difference in accuracy between CTE and CGE conditions. The p-value of 0.083 also suggests that this difference is not statistically significant at the 0.05 level, but it may be significant at a higher significance level.

The odds ratio for CTP is 0.58, with a confidence interval (0.25-1.37) that includes 1. This indicates that there is no significant difference in accuracy between the CTP and CGE conditions. The p-value of 0.215 further supports this conclusion.

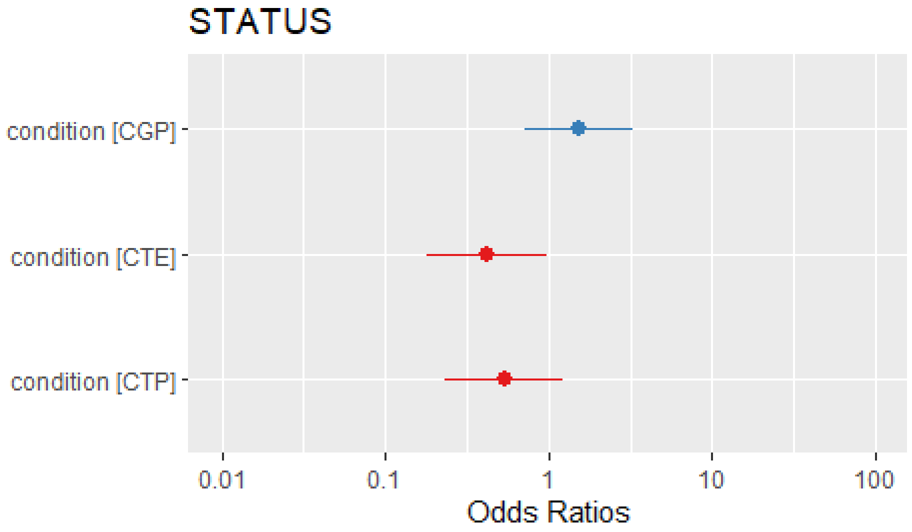
The random effects terms in the table show the amount of variation in the intercepts between participants and within-subjects, respectively. The marginal R2 value is 0.046, indicating that the fixed effects in the model explain about 4.6% of the variance in the dependent variable. The conditional R2 value is 0.304, indicating that the fixed and random effects together explain about 30.4% of the variance in the dependent variable. The difference between marginal and conditional R2 values indicates the extent to which the random effects explain the variance in the dependent variable beyond the fixed effects. In this case, the difference between the marginal and conditional R2 values (0.304-0.046=0.258) suggests that the random effects in the model account for a substantial amount of the variance in the dependent variable that is not explained by the fixed effects.

Overall, the results suggest that the CTE and CTP conditions do not significantly differ in accuracy when compared to the CGE condition.

The results of the analysis do not provide evidence to fully support the hypothesis H1 that the processing cost of cognate words is higher than the processing cost of non-cognate words in a language decision task. In fact, the results suggest that the accuracy in recognizing cognate and non-cognate words did not differ significantly in the tested conditions. Therefore, based on the results, any definitive conclusions about the relative processing costs of cognate and non-cognate words in this particular language decision task cannot be made. Comparing table 8 with a status versus odds ratio plot (Graph 5) can be helpful. While Table 8 provides numerical information, Graph 5 provides a graphical representation of the same information.

Graph 5, status versus odds ratio, displays the estimated coefficients for each of the conditions, along with their corresponding confidence intervals. This plot helps to identify the direction and magnitude of the effects of each condition on the dependent variable (accuracy), and to compare the effects of the different conditions.

Graph 5 - STATUS vs odds ratio

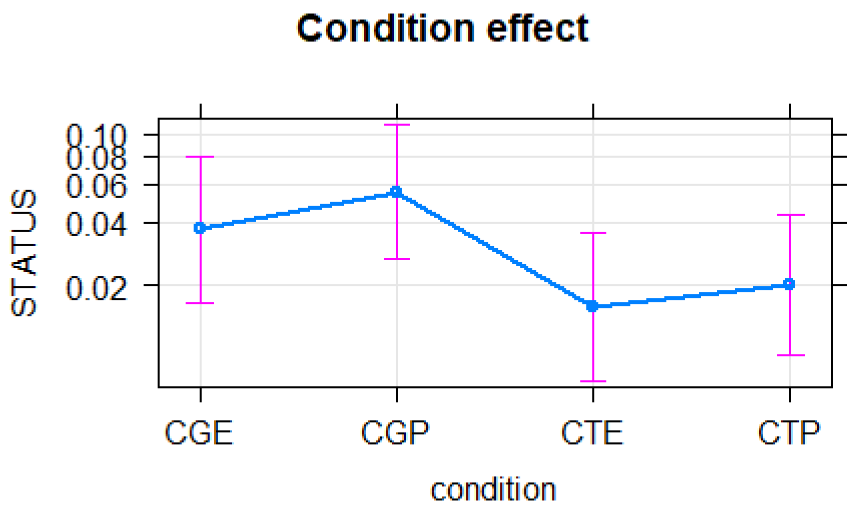


Source: own authorship

The numbers above are the odds ratios for each of the variables CGP, CTE, and CTP. An odds ratio is a measure of association between two variables. The variable condition CTE has the lowest association compared to CGE condition (Graph 6).

Graph 6 shows the estimated effect sizes of each level of the condition variable (CGE, CGP, CTE, and CTP) on the dependent variable (accuracy). From the plot, we can see that the effect size of CGE (the reference level) is much bigger than that of CTE and CTP. This indicates that the accuracy in these two conditions is significantly higher than in the CGE condition. However, the effect size of CGP is bigger than the CGE condition.

Graph 6 - Status vs condition



Source: own authorship

Graph 6 shows that the estimated effect size of each level of the condition variable on the dependent variable (accuracy) is highest for the CGP condition, followed by the CGE and CTP conditions, and lowest for the CTE condition. Having graphs 5 and 6 in mind and relating them to Table 8, it is concluded that cognate and non-cognate words were processed differently in the task. However, we cannot conclude that cognate words incur a higher processing cost than non-cognate words in this particular language decision task regarding accuracy variable. It is worth examining another variable to reach a conclusion on this matter.

I have completed the descriptive and inferential statistical analysis of the dependent variable accuracy, and I now proceed to analyze the dependent variable reaction time (RT).

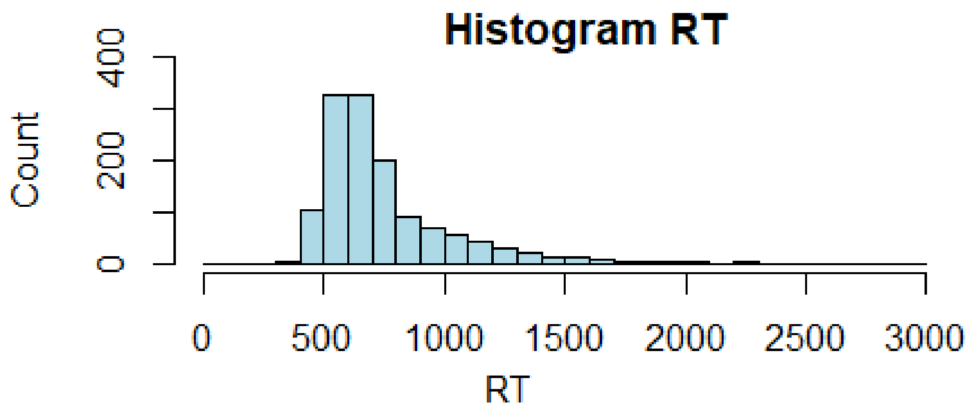
4.1.2 Analysis – variable: reaction time (RT)

In this subsection, I conducted the analysis of the dependent variable reaction time (RT). I discuss key information derived from data compiled in the RStudio software. In Subsection 4.1.2.1, I explain and illustrate the data and results for the variable reaction time in terms of descriptive statistics, and in Subsection 4.1.2.2, I explain and display the data and results for the variable reaction time using inferential statistics.

4.1.2.1 Descriptive statistics

I begin the analysis by presenting a histogram to examine the distribution of the dependent variable RT. A histogram is a visual representation of the data, providing an overview of the spread of values and any patterns or trends in the data. Graph 4 displays the shape of the dataset, which indicates a greater number of participants' reaction times between 500ms and 700ms.

Graph 7- Histogram of Reaction time



Source: Own authorship

Histograms are also useful for identifying outliers and providing other insights into the data that would otherwise be difficult to identify. One feature observed in our histogram is that few data points (outliers) are above the distribution of 1,500ms. These outliers are the dots outside the boxes in the box plot (Graph 7). Further analysis was conducted by creating a Table 9 with more specific information regarding the RT according to the conditions of the experiment.

By analyzing Table 9 – RT Data by Condition generated in the RStudio software, we can observe the reaction time (RT) of each condition – CGE (cognate words written in English) and CGP (cognate words written in Portuguese) – based on the following data: mean, standard deviation, minimum, maximum, and range.

Table 9 - RT- Data by Condition

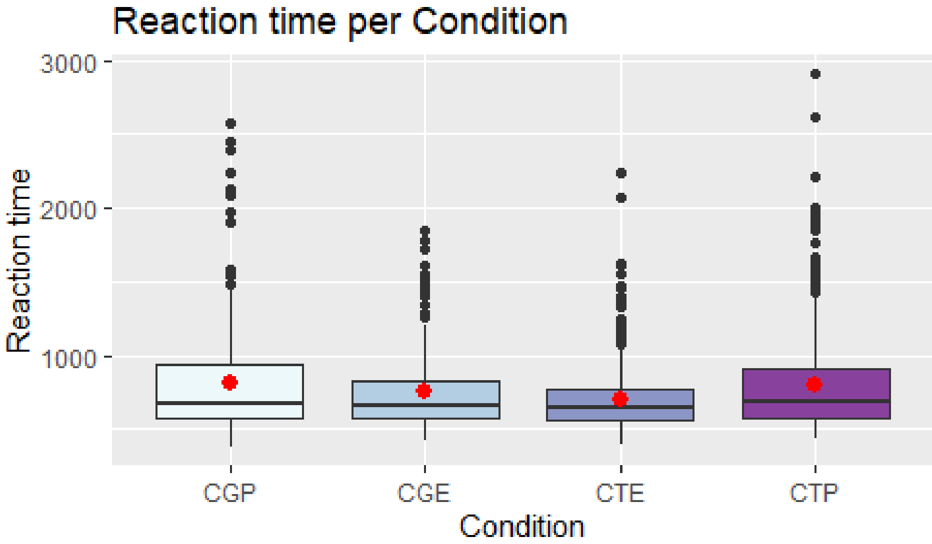
Condition	Mean	(SD)	Minimum	Maximum	Range
CGE	753	273	416	1851	1435
CGP	808	376	381	2581	2200
CTE	703	223	391	2236	1845
CTP	801	339	433	2909	2476

Source: own authorship

Based on these results, I can highlight that Experiment 1's CTE condition obtained the lowest mean RT compared to the other conditions; that is, the RT of this condition was equivalent to a mean of 703, compared to the RT of the CTP condition at 801, the CGE condition at 753, and the CGP condition at 808. Additionally, the standard deviation was also the lowest for the CTE condition. To complement our analysis, I compared the descriptive table with a boxplot (Graph 7).

A box plot is a graphical representation of a set of data that displays the median, quartiles, and range of the data. The median is the middle value of the data set, which is represented by a line that divides the box into two halves, and the quartiles divide the data set into four equal parts. The upper and lower extremes are the highest and lowest values in the data set, respectively. Outliers are values that are significantly higher or lower than the rest of the data set. It is usually represented by a dot outside the box (DUTOIT, 2012).

Graph 8 - RT vs Condition



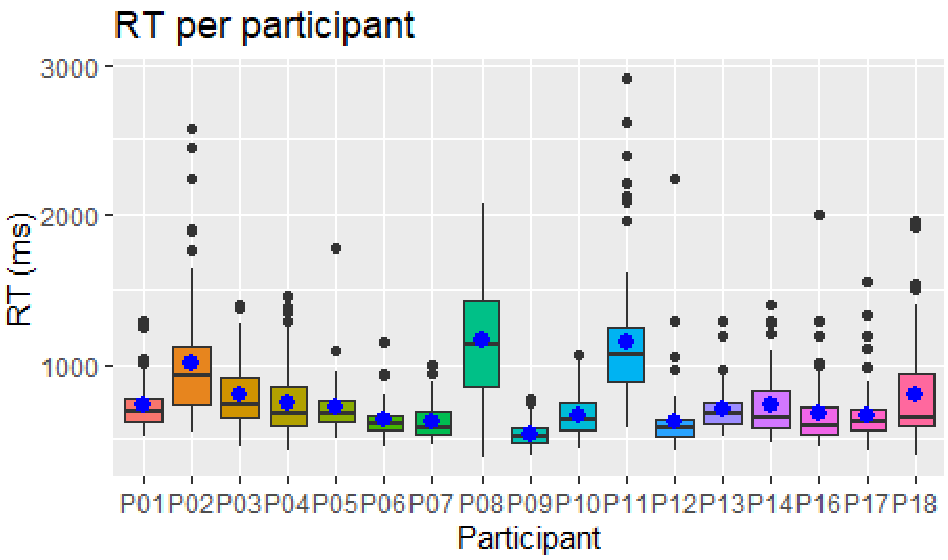
Source: own authorship

Comparing a histogram of reaction time data to a box plot (Graph 8) provides two distinct perspectives on the data, as shown in Table 9. The histogram displays the frequency of values within a given range, whereas the box plot graph visually represents the median, quartiles, and range of the data separated by condition. By analyzing both graphs, we can identify patterns or trends that exist, such as outliers, which are more easily identified in the box plot than in the histogram.

Furthermore, the box plot (Graph 8) provides a visual representation of the median, minimum, and maximum values for each condition, as well as the spread of the data represented by the interquartile range. In contrast, Table 9 offers more detailed numerical information such as the mean and standard deviation for each condition. However, these numbers are better analyzed in the box plot, where we can see that the highest mean of 808 ms occurs in the CGP condition and the lowest mean of 703 ms in the CTE condition, a difference of 105 ms. Interestingly, when examining the median in the box plot, which is represented by a line in the center of the box, the difference between conditions appears to be insignificant, as the line is almost in the same place for all conditions in Graph 8.

Specific information regarding RT of each participant is demonstrated in Graph 9.

Graph 9 - RT per Participant



Source: own authorship

Graph 9 shows that most of participants' RT are between 500ms and 700ms, as already discussed in the histogram (Graph 7) and the box plot (Graph 8). However, Graph 9 allows us to look at specific RT of each participant. For example, Participants P8 and P10 had RT's higher than the others. Remarkably, these participants had low English Test scores of 64%, and 62%, respectively. These are also the lowest scores achieved in the English test. These three findings can therefore be linked to the participants' limited English proficiency. Sánchez-Garrido and Báez-González (2013) investigated the relationship between reaction time (RT) and translation accuracy and proficiency. They found that there was a significant correlation between RT and translation accuracy, with longer RTs associated with less accurate translations and shorter RTs associated with more accurate translations. The authors concluded that RT can be used as a reliable indicator of translation accuracy and proficiency.

In the next step, I will continue my investigation through inferential statistics in order to gain a better understanding of the difference in conditions of the data to check if it is significant or not.

4.1.2.2 Inferential statistics

I ran a linear mixed effects model to see if the differences in reaction time between conditions were significant. Linear mixed effects models are used when there are both fixed and random factors in a given dataset. They are used to model the relationship between a response variable and one or more predictor variables, while taking into account the effects of the random factors. This type of model is especially useful when there is a need to account for the correlation between observations in a dataset. I used the formula "lmmRT <- lmer (data = d2, RT ~ condition + (1|participants) + (1|ID))” from the RStudio software. Using the ID as random effects the model did not converge, there were not enough observations, therefore I made a new model with just the participants as random effects: “<- lmer(data = d2, RT ~ condition + (1|participants))”. The components of the formula are:

1. The data frame 'data' contains the data to be analyzed using linear mixed-effect modeling, a type of regression analysis incorporating both fixed and random effects.

2. The response variable, 'RT', is to be predicted.

3. The predictor variable, 'condition', is used to predict the response variable.

4. The random effect, '(1|participants)', indicates that the response variable, 'RT', will vary depending on the individual participant, and thus, the participants should be treated as a random effect in the model.

This formula is used to fit a linear mixed effects model to data in the data frame d2. The response variable (RT) is modeled as a function of a fixed effect, condition, and a random effect, participants. This function estimates the fixed effect (condition) and the random effect (participants) from the data. The summary of the results is shown in Table 10.

Table 10 – Linear mixed model

	RT vs Condition		
Predictors	*Estimates*	*CI*	*p*
(CGE)	807.92	716.09 – 899.76	**<0.001**
CGP	-55.44	-101.19 – -9.69	**0.018**
CTE	-105.29	-144.91 – -65.67	**<0.001**
CTP	-5.16	-44.82 – 34.51	0.799
Random Effects			
σ^2	60103.39		
τ_{00} participants	32632.02		
ICC	0.35		
N participants	17		
Observations	1323		
Marginal R^2 / Conditional R^2	0.022 / 0.366		

Source: own authorship

The table provides the results of a regression analysis with reaction time (RT) as the dependent variable and four conditions (CGE, CGP, CTE, CTP) as predictors. CGE is the baseline with an RT estimated in 807.92 ms. The estimates column shows the effect size of each predictor on the RT, while the CI column provides the confidence interval around the estimate. The p-value column indicates the statistical significance of each predictor, where $p < 0.05$ indicates a significant effect.

Table 9 provides descriptive statistics of RT for each condition, including the mean, standard deviation, minimum, maximum, and range. These statistics can provide a useful overview of the distribution of RT across conditions and can help identify which conditions have the highest or lowest RTs. For example, from Table 9, we can see that CGP has the highest mean RT (808) and the largest range (2200), indicating that this condition may be more difficult or require more cognitive effort than the other conditions.

However, descriptive statistics alone do not tell us whether the observed differences in RT are statistically significant or whether they are due to chance. This is where Table 10 comes in. The linear mixed effects model in Table 10 examines the relationship between RT and condition while controlling for participant-level variability. By doing so, it can determine whether the observed differences in RT are statistically significant or whether they are likely due to chance. For example, from Table 10, we can see that CGP has a significantly lower mean RT than the reference condition, with an estimate of -55.44 and a p-value of 0.018. This tells us that the observed difference in mean RT between CGP and the reference condition CGE is statistically significant and unlikely to be due to chance. In contrast, the p-value for CTP is 0.799, indicating that the observed difference in mean RT between CTP and the reference condition is not statistically significant and likely due to chance.

The analysis results partially support Hypothesis H1, which states that the processing cost of cognate words is higher than the cost of processing non-cognate words. The regression analysis shows that CGE, CTP, and CTE have a significant effect on reaction time (RT), while the p-value for CTP is greater than 0.05, suggesting that it does not significantly affect RT. The descriptive statistics in Table 9 indicate that CGP has the highest mean RT and the largest range, suggesting that this condition may require more cognitive effort than the other conditions. However, the linear mixed effects model in Table 10 shows that CGP has a significantly lower mean RT than CGE and a significantly higher mean RT than CTE. Therefore, the results suggest that the processing cost of cognates in Portuguese (CGP) is significantly different from non-cognate words (CTE) and cognates in English (CGE), with CGP having a higher processing cost than CTE and a lower processing cost than CGE. Overall, the analysis partially confirms Hypothesis H1, indicating that the processing cost of cognate words in general may not necessarily be higher than non-cognate words.

The descriptive and inferential analysis of Experiment 1 is complete. Experiment 2 is discussed in the following section.

4.2 Experiment 2 – translation task

In this subsection, I detail, illustrate, and explain the data read through the RStudio software. I followed the same procedure as in Experiment 1. The data were compiled using the PsyToolKit software (STOET, 2010, 2017), which generated a text file with the same structure as Experiment 1 for each of the 17 participants in this study. The generated text file contained information on the number of correct and incorrect answers, and 5 trials that exceeded the response time limit of 5 seconds. We exported these data, which consisted of 834 lines, to a table in Excel format.

The Excel spreadsheet was analyzed in the RStudio, and it pointed out a reaction time (RT) of 36 ms on line 530 of the spreadsheet. I decided to delete this trial as it was likely a mistake. Therefore, the final dataset had 833 trials. In the following subsection, we present the results obtained from Experiment 2, which focused on two dependent variables: reaction time (RT) and accuracy. The first one to be discussed is accuracy, which we will proceed to discuss next.

4.2.1 Analysis – variable: accuracy

In this subsection, I describe how the data regarding the first variable, accuracy, was analyzed for the two conditions contained in this study: new cognate words (NCG), words not used in Experiment 1, and old cognate words (OCG), which were used in Experiment 1. Next, we present the results described through descriptive and inferential statistical analysis for Experiment 2, Translation task. We begin with descriptive statistics.

4.2.1.1 Descriptive statistics

We ran the function "table" in the RStudio software and asked for a table with accurate, inaccurate, and out-of-time answers indicated as numbers 1, 2, and 3, respectively.

Table 11 - Status

1	2	3
872	6	5

Source: own authorship

We saw in table 11 that only 5 trials, as already mentioned, exceeded the response time limit because they were marked as "3". Therefore, we created a subset with just accurate (1) and inaccurate answers (2). This new set has 878 trials instead of 883. It can be difficult to evaluate raw values in a table. Therefore, we made a table of accuracies per condition and transformed these values into proportions to obtain table 12.

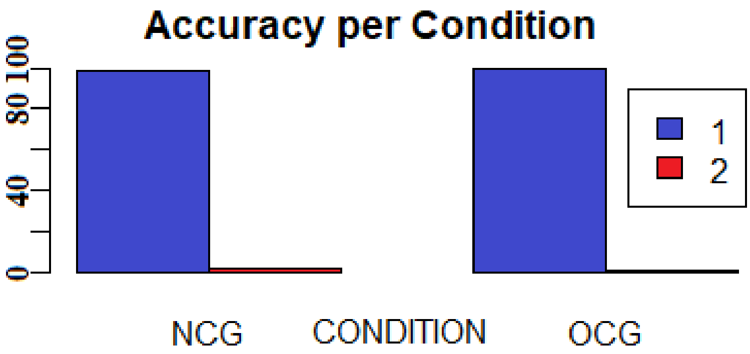
Table 12 - Accuracy and error percentage

	NCG	OCG
1	98.8%	99.7%
2	1.1 %	0.2%

Source: own authorship

We can see in table 12 a low percentage of mistakes (2) and remarkably similar proportion of correct answers for both conditions: new cognate words (NCG) and old cognate words (OCG). A bar chart of accuracies was created by condition based on these ratios to have a visual insight (see graph 10).

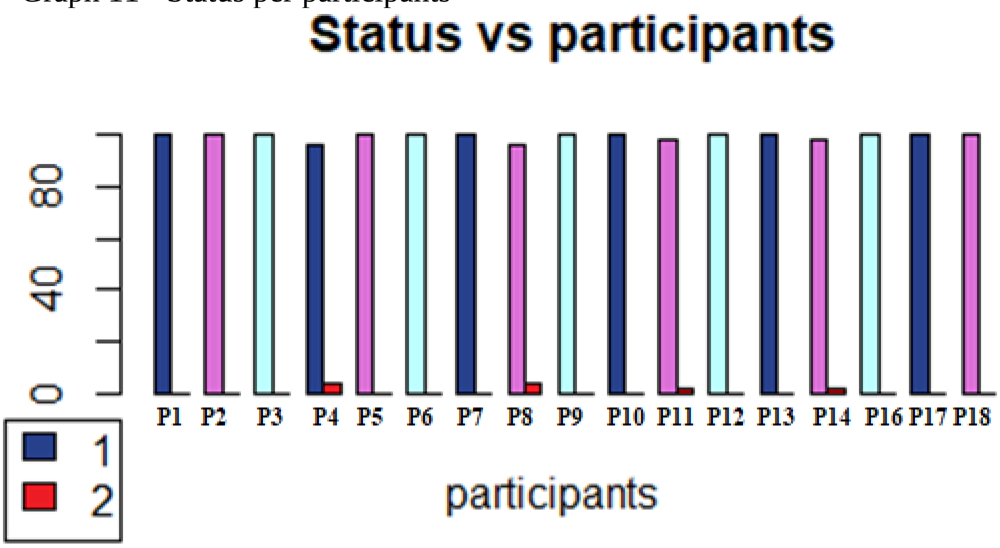
Graph 10 - Accuracy vs condition



Source: own authorship

We can observe in Graph 10 that it is difficult to see that the OCG condition stood out by a little more than 1% in terms of the number of correct answers compared to the NCG condition. To visualize the accuracy per participant, Graph 11 provides even more specific information.

Graph 11 - Status per participants



Source: own authorship

Graph 11 shows that participants had far more correct answers than incorrect ones. Actually, the incorrect answers are only 6 compared to 872 correct answers. According to Gollan and Silverberg (2001), translation tasks can be used to assess a variety of language processing skills, such as lexical access, syntactic processing, and semantic processing. For instance, a translation task can be used to evaluate how quickly a person can access the meaning of a word or phrase, or how accurately they can interpret the meaning of a sentence. Furthermore, translation tasks can be employed to measure how well a person can interpret the meaning of a text in a different language, as well as how well they can transfer the meaning of a text from one language to another. Additionally, translation tasks can be utilized to assess a person's ability to use language in different contexts. For example, a translation task can be used to measure how well a person can use language to express their thoughts and ideas in a different language. Moreover, translation tasks can be employed to measure how well a person can use language to communicate with people who speak a different language. Graph 11 indicates that participants' performance regarding the meaning of words was excellent in both conditions, OCG and NCG.

The results alone do not provide enough information to determine if the difference between the two groups is statistically significant. Additional data and analysis are required to make that determination. To determine if this small percentage is significant, we resorted to inferential statistics, which are presented in the following subsection.

4.2.1.2 Inferential statistics

We ran a generalized mixed model in the RStudio software to determine if the differences in accuracies between conditions were significant. I used the formula "<- glmer (data = b2, STATUS ~ condition + (1|participants) + (1|ID), family=binomial(link = "logit"))" to fit a generalized linear mixed-effects model (GLMM) to the data in the b2 data set. The number of observations was insufficient for this model. It gave an error, therefore I removed the random effects ID and used another formula: "<- glmer (data = b2, STATUS ~ condition + (1|participants), family=binomial (link = "logit"))" The response variable being analyzed was STATUS. The result from this formula is a logistic regression model that predicts the probability of a given participant's STATUS based on the condition they are in. The model provided an estimate of the odds ratio for each condition, which can be used to compare the likelihood of a given STATUS for different conditions. The summary of the model is presented in Table 13.

Table 13 - accuracy vs condition

	STATUS vs Condition		
Predictors	*Odds Ratios*	*CI*	*p*
(NCG)	0.01	0.00 – 0.04	**<0.001**
OCG	0.20	0.02 – 1.69	0.138
Random Effects			
σ^2	3.29		
τ_{00} participants	1.43		
ICC	0.30		
N participants	17		
Observations	878		
Marginal R^2 / Conditional R^2	0.124 / 0.389		

Source: own authorship

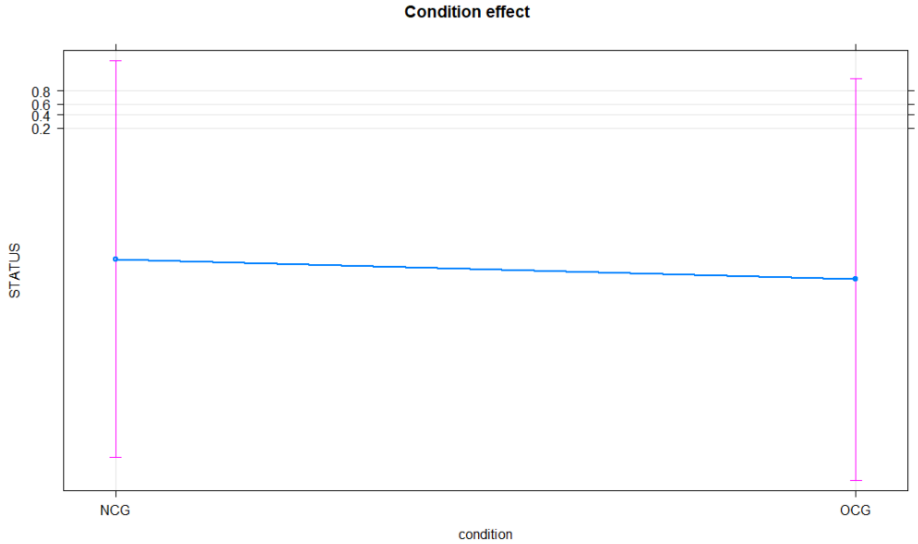
The differences in accuracy between conditions are not significant. This is because the p-value for OCG is 0.103, which is greater than the commonly accepted significance level of 0.05. The confidence interval (CI) reported in Table 13 for the predictor variable "(NCG)" is "0.00 – 0.04", and the confidence interval for the predictor variable "OCG" is "0.02 – 1.69". The CI provides a range of values within which the true population effect size is likely to fall with a certain degree of confidence.

In this case, the confidence interval for the odds ratio of the NCG condition suggests that the true effect of the NCG condition on the odds of a correct translation is very small. The lower bound of the confidence interval suggests that the odds of a correct translation in the NCG condition are close to zero, while the upper bound suggests that the odds are at most 0.04 times higher than the odds in the OCG condition. This suggests that there is little to no benefit to using new cognate words in the translation task regarding accuracy, which was very high in this task.

The confidence interval for the odds ratio of the OCG condition is wider, with a lower bound of 0.02 and an upper bound of 1.69. This suggests that the true effect of the OCG condition on the odds of a correct translation could range from very small (similar to the NCG condition) to much larger than the odds in the NCG condition. However, the non-significant p-value for the OCG condition in Table 13 suggests that there is insufficient evidence to conclude that the OCG condition has a significant effect on the odds of a correct translation.

Overall, the relatively narrow confidence interval for the NCG condition and the non-significant p-value for both conditions suggest that the effect of repetition priming of cognate words on translation accuracy in this study may be weak. This is supported by the high accuracy in both conditions, which suggests that the translation task may have been relatively easy for participants and may not have provided enough sensitivity to detect subtle effects of repetition priming as it is clearly visible in Graph 12.

Graph 12 – Condition effect



Source: own authorship

Graph 12 provides a helpful visual representation of the estimated effect of the condition predictor on translation accuracy. This plot can supplement the statistical information presented in the tables, but its interpretation would need to be confirmed by further analysis of the data and consideration of other factors that may have influenced translation accuracy. Since the analysis of the accuracy variable is now complete, we will proceed to analyze the RT variable.

4.2.2 Analysis – variable: reaction time (RT)

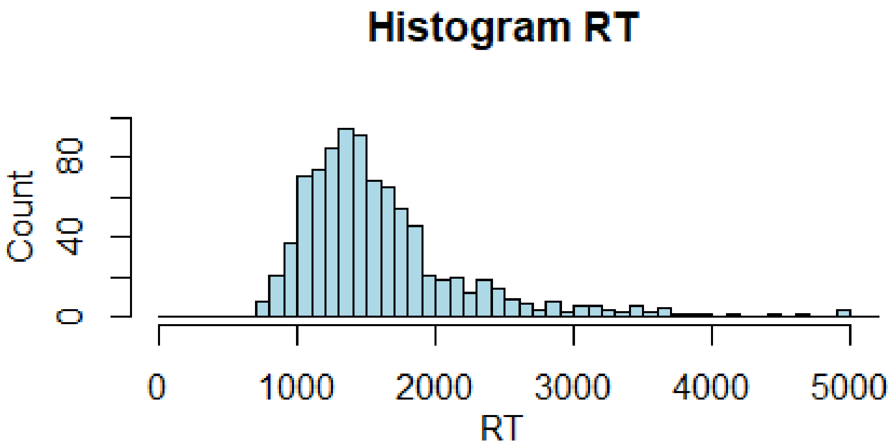
In this subsection, we present information regarding the data compiled by the free software PsyToolKit (STOET, 2010, 2017) used as an online methodological tool. We explain and illustrate the data of the variable reaction time (RT) in the two quaternary subsections

4.2.1.1 and 4.2.1.2 through analyses, graphs, and tables developed using descriptive and inferential statistics with the intention of analyzing the data obtained through Experiment 2 run through the RStudio software. We begin with descriptive statistical analyzes.

4.2.2.1 Descriptive statistics

We begin our analysis by constructing a histogram to examine the distribution of the RT dependent variable. This histogram is a visual representation of the data, which assists us in detecting any patterns or trends in the data, as well as any outliers. It also makes it easier to identify any other information about the data that would be difficult to detect otherwise (See graph 9).

Graph 13 - Histogram



Source: own authorship

What we can observe in the histogram (Graph 13) is that most of the RT data was between 1000 and 2000ms, with very few being after 3000ms. There were more trials within the time limit than in Experiment 1. It is worth mentioning that the histogram did not separate RT by conditions, old cognate words (OCG) and new cognate words (NCG).

Since the histogram provided us with only general RT information, we created a table with more specific information. In Table 14, we can observe the reaction time (RT) of each condition: new cognate words (NCG), words not used in Experiment 1, and old cognate words (OCG). This includes the following data: mean, standard deviation (SD), median, minimum, maximum, and range.

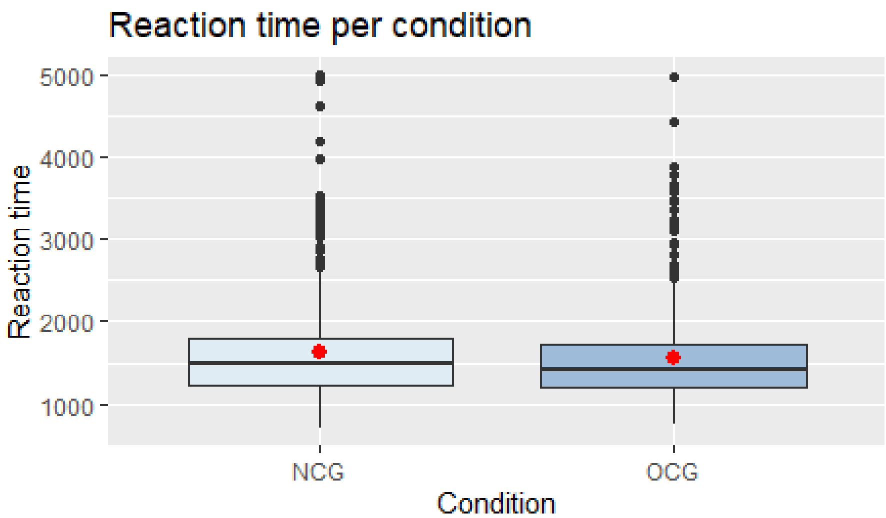
Table 14 - RT data by Condition

Condition	Mean	(SD)	Median	Minimum	Maximum	Range
NCG	1627.2	616.2	1487	710	4989	4279
OCG	1560.2	579.7	1412	761	4963	4202

Source: own authorship

Based on the data in Table 14, the mean, median, minimum, maximum, and range of reaction time are largely similar between the two conditions. However, there is still a slight difference in the mean and median RT between the two conditions. The mean RT for the NCG condition is 1627.2 ms compared to 1560.2 ms for the OCG condition, and the median RT for the NCG condition is 1487 ms compared to 1412 ms for the OCG condition. It is worth comparing the descriptive table 14 with a box plot (Graph 14).

Graph 14 - RT per Condition

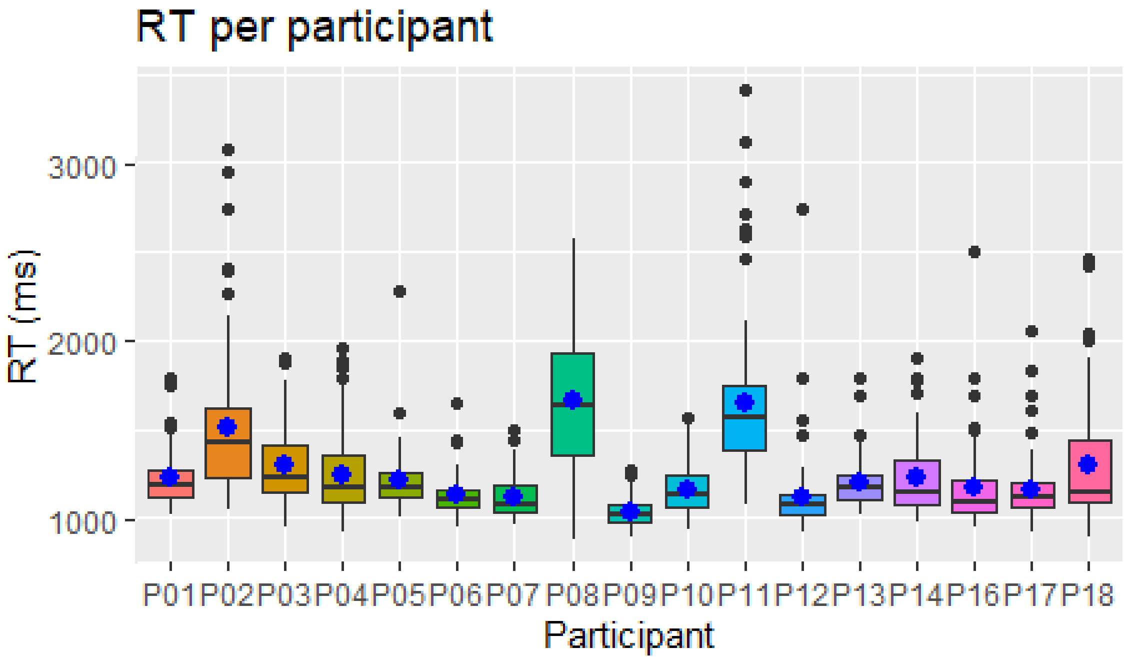


Source: own authorship

This graph is more specific regarding the conditions; visually, we cannot see a large difference between the conditions, but the OCG condition had a lower RT. Examining the median and the mean and in the box plot (Graph 14), represented respectively by a line in the center of the box and a red dot, and comparing it to Table 14, it is revealed that the difference between all conditions might not be significant, as the line is in the same place in the graph. It is also interesting to notice the few outliers in both conditions, NCG and OCG, and compare with the RT axis of the histogram (Graph 13). They both show very few trials (outliers) after

3000ms. The difference between conditions can also be seen among participants, individually (Graph 15).

Graph 15 - RT per participant



Source: own authorship

Graph 15, a histogram, reveals that the majority of reaction time (RT) data falls between 1000 and 2000 ms. Nonetheless, examining individual participant data highlights some noteworthy outliers. For example, P8 and P11 exhibited slower RTs. Interestingly, these two individuals had low scores on the English Test (62% and 33%, respectively), suggesting that their lower proficiency in English may have affected their RT.

Montañez and García-Mateo (2017) conducted a study using Spanish-speaking students to investigate the relationship between RT and translation accuracy. The authors noted that translation is a complicated cognitive process that involves the simultaneous interpretation of source language (SL) information and formulation of target language (TL) information. Their findings showed that RT was significantly correlated with accuracy in translation. In particular, the authors discovered that accurate translations required more extended RTs, indicating that deep processing may contribute to translation accuracy. Furthermore, the study revealed that cognitive and metalinguistic strategies were associated with translation accuracy. The authors concluded that RT could provide valuable information about translation proficiency and accuracy.

However, to determine whether the difference between all conditions is statistically significant, an inferential statistical analysis is required, which is the next step.

4.2.2.2 Inferential statistics

A linear mixed model was used to see if the differences in reaction time between conditions were significant. We used RStudio software to run the formula " <- lmer(data = b2, RT ~ condition + (1|participants) + (1|ID)). This formula is used to analyze the reaction time (RT) of participants in an experiment. It considers the effect of the condition of the participants, as well as the individual differences between participants and the individual differences between items. It is represented in Table 15.

Table 15 - RT vs Condition

	RT vs Condition		
Predictors	*Estimates*	*CI*	*p*
(NCG)	1630.05	1446.44 – 1813.67	**<0.001**
OCG	-65.59	-206.74 – 75.56	0.362
Random Effects			
σ^2	208454.23		
$\tau_{00\ ID}$	54886.62		
$\tau_{00\ participants}$	104826.03		
ICC	0.43		
$N_{participants}$	17		
N_{ID}	52		
Observations	878		
Marginal R^2 / Conditional R^2	0.003 / 0.435		

Source: own authorship

The analysis of Table 15 shows that there is a significant effect of the experimental condition on reaction time (RT), as indicated by the estimates and p-value for the fixed effect of condition. The estimate for the OCG is -65.59 ms, indicating that the mean RT for participants in this condition is 65.59 ms lower than the reference group or baseline condition.

However, this effect is not statistically significant, as indicated by the p-value of 0.362. The analysis also shows that there is significant variability in RT across participants and items, as indicated by the random effects estimates. The ICC (intraclass correlation coefficient) value of 0.43 indicates that a moderate amount of the total variability in RT can be attributed to individual differences between participants and items. The marginal R2 of 0.003 and conditional R2 of 0.435 suggest that the model explains only a small proportion of the total variance in the RT data, but a substantial proportion of the variance that can be attributed to the fixed and random effects included in the model.

From the results of the table, we can see that there is no significant effect of the condition OCG on the outcome variable, which suggests that there may not be significant differences in reaction time or accuracy between the old cognate words and the new cognate words.

However, we can also see that the intercept has a significant effect on the outcome variable, with an estimated value of 1630.05 and a very low p-value, indicating that there is a significant overall effect on reaction time and accuracy that is not explained by the predictor variable of condition OCG.

The overall effect observed in Table 15 may support the hypothesis that there are repetition priming effects of cognate words in the translation process. This suggests that there may be a general priming effect that is not limited to the use of old or new cognate words, indicating that the translation process could be influenced by previous exposure to cognate words, regardless of the context or task in which they were presented. However, further analysis and interpretation of the data is necessary to fully support this hypothesis.

In addition to the analyses presented for hypothesis H2, a post-hoc analysis was conducted where the participants' proficiency was included to further test the same hypothesis. The formula <- lmer(data = b2, RT ~ condition*Proficiency + (1|participants) + (1|ID)) was run in RStudio to examine the relationship between reaction time (RT) and two variables: condition and proficiency. This analysis aims to further investigate the potential effects of repetition priming of cognate words in the translation process. The summary is shown in Table 16.

Table 16: RT vs Proficiency vs Condition

	RT vs Proficiency vs Condition		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	3280.76	2195.67 – 4365.85	**<0.001**
conditionOCG	-625.60	-1114.82 – -136.39	**0.012**
Proficiency	-19.68	-32.46 – -6.89	**0.003**
conditionOCG:Proficiency	6.67	1.09 – 12.25	**0.019**
Random Effects			
σ^2	207284.52		
$\tau_{00\ ID}$	55032.94		
$\tau_{00\ participants}$	76608.70		
ICC	0.39		
$N_{participants}$	17		
N_{ID}	52		
Observations	878		
Marginal R^2 / Conditional R^2	0.090 / 0.444		

Source: own authorship

The table presents the results of the analysis that includes participants' proficiency level as a predictor variable in addition to the condition variable (OCG or NCG) to examine the effect on the reaction time (RT). The results show that both condition and proficiency have a significant effect on RT, while the interaction between condition and proficiency is marginally significant.

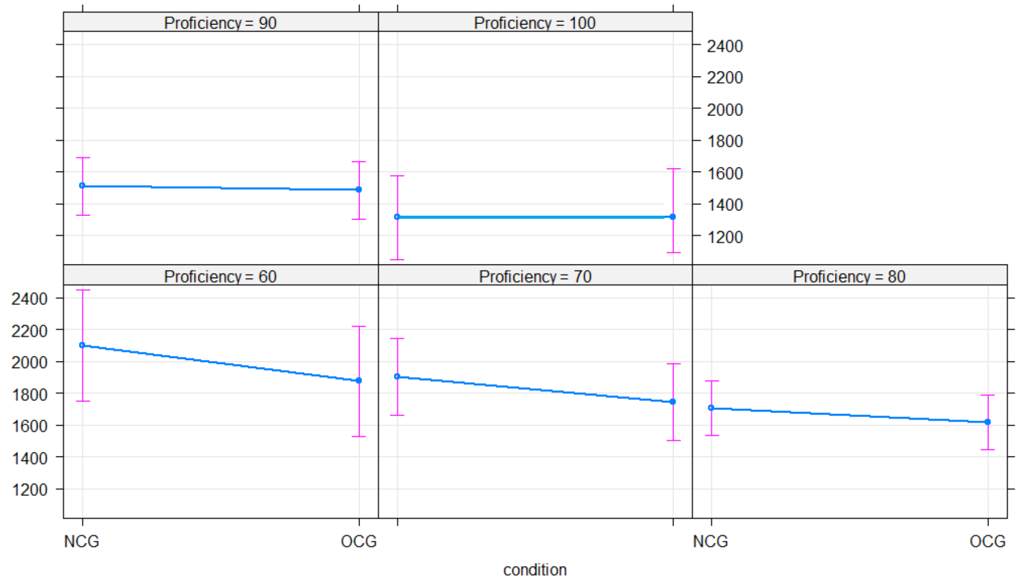
The estimate for the intercept is 3280.76 (CI = 2195.67 – 4365.85, p < 0.001), which indicates the expected RT when both condition and proficiency are zero. The estimate for the OCG condition is -625.60 (CI = -1114.82 – -136.39, p = 0.012), which means that the RT is significantly lower for the OCG condition than for the NCG condition. The estimate for proficiency is -19.68 (CI = -32.46 – -6.89, p = 0.003), indicating that participants with higher proficiency levels have shorter RTs than those with lower proficiency levels. The estimate for the interaction between condition and proficiency is 6.67 (CI = 1.09 – 12.25, p = 0.019), which suggests that the effect of proficiency on RT is stronger in the OCG condition than in the NCG condition.

The random effects show that the variance of the residual term (σ2) is 207284.52, and the variance of the intercept term is 55032.94 for ID and 76608.70 for participants. The intra-class correlation coefficient (ICC) is 0.39, indicating that approximately 39% of the total variance in RT is due to between-group differences.

Overall, the analysis supports hypothesis H2 that there are repetition priming effects of cognate words in the translation process. The results show that the OCG condition leads to significantly shorter RTs compared to the NCG condition, suggesting that previous exposure to cognate words can facilitate the translation process. The significant effect of proficiency further suggests that the translation process may be influenced by an individual's language proficiency, with individuals with higher proficiency levels having a more efficient translation process.

It is important to note that the analysis also revealed high variability within and between participants, as shown by the relatively large random effects variance components. This suggests that other factors beyond those included in the model may be influencing the translation process and should be investigated further in future studies.

Graph 16 - Condition effect vs Proficiency



Source: own authorship

Looking at proficiency = 30 at Graph 16, the effect of repetition priming is evident. The reaction time is high, ranging from almost 3500ms to 3000ms between conditions. As the participants' proficiency increases, the reaction time decreases, and so the difference between conditions. The reaction time for both conditions when proficiency = 100 is the same. Therefore, the data suggest that repetition priming effect ceases when proficiency is at the maximum.

Kononova and Rodríguez (2018) suggest that repetition priming is more effective in a bilingual context than in a monolingual context. This has important implications for translation, as it suggests that when translating from one language to another, prior exposure to the source language can be beneficial in speeding up the translation process. This could be useful for translators and language learners, as it suggests that learning multiple languages can facilitate translation tasks. As we can see from the results in Graph 16, proficiency plays a significant role as well. Therefore, repetition priming could be used more efficiently in translations where the translator is not very proficient.

Having all the analysis completed, the results are discussed next.

4.3 Results discussion

In this subsection, we discuss the results pertaining to Experiments 1 and 2 of this research, whose general objective was to investigate the cognitive processes involved in translation, at the word level, through the repetition priming effect and the recognition and lexical access of cognate words from a psycholinguistic perspective. It is pertinent to underline that the two specific objectives, the two specific research questions, and the two specific hypotheses raised for this study were discussed separately in each subsection referring to each experiment.

4.3.1 Experiment 1 – language decision task

Experiment 1 was designed to answer the following research question: How does the processing cost of Brazilian Portuguese-English cognate words compare to non-cognate words in a language decision task? We raised Hypothesis H1, which stated that the processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task.

Roelofs (2004) examines the relationship between language decisions and reaction times. He explains that language decisions are typically made on the basis of lexical and semantic information, and that reaction time is an important measure of the speed of these decisions. He discusses recent evidence showing that reaction times are sensitive to the context of a language decision task, such as the type of distractor words used and the presence of morphological information. He also outlines new challenges for the field, such as the development of more sophisticated models of language processing, and the further exploration of the context-dependent nature of language decisions.

The linear mixed effects model was used, and the dependent variable was "ACCURACY”. The results showed that there was no significant difference in accuracy between the CGE and CTE or CTP conditions, indicating that the processing cost of cognate words may not be higher than that of non-cognate words in this particular language decision task. The odds ratio for CGP was higher than the CGE condition, but with a wide confidence interval, and the difference was not statistically significant. The random effects in the model explained a substantial amount of variance in the dependent variable beyond the fixed effects. However, comparing Graph 5 and Graph 6 with Table 8 helped to identify the direction and magnitude of the effects of each condition on the dependent variable. Graph 6 showed that the estimated effect size of CGP was the highest, followed by CGE and CTP conditions, and the lowest for the CTE condition. Based on these findings, it is concluded that cognate and non-cognate words were processed differently in the task, but further investigation is needed to determine the relative processing costs of cognate and non-cognate words in this particular language decision task.

Muscalu and Smiley (2019) examined the idea that cognates provide a benefit in bilingual language processing. The authors conducted a word typing task in which bilinguals typed either cognates or non-cognates in their two languages. The results of the experiment showed that there was an initial lexical facilitation effect for cognates. This means that the participants were able to type cognates faster than non-cognates. However, the authors also found that this effect was followed by a sublexical interference effect for non-cognates. This means that participants were slower in typing non-cognates than cognates. The authors concluded that cognates could provide a benefit in language processing, but only in certain contexts. The results of the experiment suggest that cognates may provide a benefit when the two languages are processed separately. However, when the two languages are processed simultaneously, the lexical facilitation effect of cognates is followed by a sublexical interference effect for non-cognates. This suggests that cognates may not always provide the same benefit in bilingual language processing.

In the present study, the two languages, English and Brazilian Portuguese were processed simultaneously. The participants had shorter reaction times with the control words in English, possibly due to an expectation for the experiment to be in the English language. When the words were cognates English-Portuguese and controls in Portuguese there was a conflict in the language decision process and therefore a longer reaction time. It is interesting to note that previous studies from our laboratory (LabFoM) have provided similar results. The results of this experiment agree with the ones of Gadelha and Toassi (2021). They tested 34 interlingual homographic words, 34 control words in Brazilian Portuguese, and 34 control words in English having 23 teachers as participants and PsyToolkit software (STOET, 2010, 2017). Their analyses revealed a higher processing cost for interlingual homographs as well as a repetition priming effect for "old" control words only (non-homographs). This experiment also showed that the cognate facilitation effect was not evident in a word recognition task as the one applied in the present study. In table 17, we can see the results of Gadelha's (2021) study.

Table 17 - Accuracy vs Condition

Números e proporções – Acertos e erros para palavras controle em Inglês e Português Brasileiro – Experimento 1

Nº de Acertos – CI	Nº de Erros – CI	Nº de Acertos – CP	Nº de Erros – CP
391	11	388	57
Proporção (*100) – IN	**Proporção (*100) – PTBr**	**Proporção (*100) – IN**	**Proporção (*100) – PTBr**
97,18%	2,81%	85,30%	14,69%

Source: Gadelha (2021)

We can visualize these results in relation to the control conditions in English (CI) and Portuguese (CP) through the table 16, whose proportions are control words in English (CI) – 97.2% of correct answers and 2.8% of errors compared to control words in Portuguese (CP) – 85.3% of correct answers and 14.7% of errors. The table shows that the correct answers for the control words were CI – 97% and CP – 85% (GADELHA, 2021).

According to the results, Gadelha (2021, p. 9, translation ours) stated:

> We were able to confirm the first hypothesis raised, H1: There are significant effects of interlingual homographs and interlingual non-homographs in a language decision task, reflected in a higher processing cost. And we partially confirmed the second hypothesis, in which H2 – There are repetition priming effects of homographic and non-homographic interlingual words in the translation process, because there was no repetition priming effect for the interlingual homographs (HG). There was a repetition priming effect only, for the "old" control words (CV), non-homographs.

The current study agrees with Gadelha and Toassi (2021), in that both studies found that the corresponding control words in English were processed faster. Furthermore, despite the fact that Portuguese was the mother tongue of all participants in both experiments, English (L2) was more activated than Portuguese (L1).

There are several factors that can contribute to a second language (L2) becoming more activated than a person's mother tongue (L1). These include exposure, motivation, age, and cognitive abilities. Exposure can include living in a country where the L2 is spoken, taking classes, or engaging in activities that involve the language (Krashen, 1982). Motivation to learn and use an L2 can also play a role in how activated it becomes (DÖRNYEI, 2005). Research has shown that younger learners tend to be more successful in learning and using an L2 than older learners, due to their greater exposure and motivation (LENNEBERG, 1967). Additionally, a person's cognitive abilities can also play a role in how activated an L2 becomes, with those with higher cognitive abilities being more likely to be successful in learning and using an L2 (SKEHAN, 1998). In the present study, the engagement in the activity, the motivation to participate in the experiment and the cognitive abilities of each participant can be the factors for L2 to be more active than L1. However, there is no data in the present study to corroborate this as it was not part of our investigation initially.

Through descriptive and inferential statistical analysis of the variable Reaction Time (RT), I found that the CTE condition obtained the lowest RT mean and standard deviation compared to the other conditions, as seen in Table 9 and Graph 8 (BoxPlot) in Subsection 4.1.2.1 Descriptive Statistics. Observing the fixed effects, it can be noted that the comparison of the RT was significantly different for all conditions, with the lowest RT being that of the CTE condition. Interestingly, cognates written in Portuguese (CGP) had a higher mean RT than those in English (CGE). In addition, the RT for the CGE condition was higher than the control in Portuguese (CTP).

It is possible that cognate words in a language may be processed faster in a language than non-cognate words. This is because cognate words share similar roots and meanings, which can make them easier to recognize and process. However, this is not always the case, as other factors such as familiarity with the language, the complexity of the words, the level of proficiency of the speaker, and the context of the words can also influence how quickly they are processed. In our experiment, the context was the fact that the participants had an expectation regarding the translation task and the English test, which could have made the participants more activated for the foreign language (L2) than for their mother tongue (L1) as already discussed. Also, the orthographic similarity and shared meaning of cognates in Brazilian Portuguese and English can slow down their processing. This was partially confirmed as CTE condition has the lowest RT and CGP the highest not only in the present study, but in

Nogueira's (2022) study as well. Nogueira (2022) conducted another study in a similar line of research. Her study was a pilot study for the present one. She looked at the effect of cognate words in a language decision task that included cognates Portuguese-English and their corresponding controls. Her research contained 133 words. She concluded that the participants' reaction times were faster with the English control words. Because there was a conflict in the language decision process, the reaction time was longer for English-Portuguese cognates words than controls words in Portuguese. The conflict in the language decision process was likely due to the participants having to process both languages at the same time. The Portuguese-English cognates presented a unique challenge as they contained elements of both languages, and this was likely more difficult to process than a single language. The participants were likely forced to make a decision between two languages, and this process took longer than it would have for the control words in Portuguese. Therefore, the cognate facilitation effect was not observed in the word recognition test used in her study. In the present study, cognates written in English (CGE) had a lower RT than cognates in Portuguese (CGP). In addition, the RT for the CGE condition was higher than the control in Portuguese (CTP) as already mentioned.

Discussing reaction time as a measure of language processing, Laganaro and Schnider (2003) pointed out its advantages. It included its ability to capture the temporal dynamics of language production, provide a measure that is independent of subjective ratings, and allow for the comparison of the speed of language processing between different populations. The disadvantages include the difficulty in interpreting the results, the potential for confounding variables, and the need for a large sample size. A larger number of trials might have given us more conclusive results in the present study. I will discuss the results of the translation task next.

4.3.2 Experiment 2 translation task

Experiment 2 of this research brought noteworthy results. The objective was to investigate if there were repetition priming effects of cognate words in a translation task. We raised the following question: "is there an effect of repetition priming of cognates in a translation task?" With this question, we raised the second specific hypothesis of this study: "There are effects of repetition priming of cognate words in the translation process." To investigate this hypothesis, it was considered the conditions OCG (old cognate words written in English), stimuli considered old in the sense that they had been seen in Experiment 1, and

NCG (new cognate words written in English), stimuli that were seen for the first time in Experiment 2. They were analyzed for both variables: Accuracy and Reaction Time (TR).

In this study, the accuracy of translation tasks was analyzed for two conditions: new cognate words (NCG) and old cognate words (OCG). The descriptive statistics showed a remarkably similar proportion of correct answers for both conditions. Graphs 10 and 11 provided a visual insight into the accuracy per condition and per participant, respectively. The inferential statistics were used to determine if the differences in accuracies between conditions were significant. The logistic regression model found that the differences in accuracy between conditions were not significant. The study's findings suggest that participants' performance regarding the meaning of words was excellent in both conditions, OCG and NCG. Overall, this study contributes to the understanding of language processing skills and translation tasks.

The results of the analysis regarding RT suggest that both condition and proficiency level have a significant effect on reaction time in the translation process, with the OCG condition resulting in significantly shorter RTs than the NCG condition. This supports the hypothesis that repetition priming effects of cognate words can facilitate the translation process. Furthermore, the significant effect of proficiency level suggests that an individual's language proficiency can also influence the efficiency of the translation process, with those who have higher proficiency levels demonstrating a more efficient translation process.

It is important to note, however, that the analysis also revealed high variability within and between participants, suggesting that other factors beyond those included in the model may also be influencing the translation process. These factors should be investigated further in future studies to gain a more comprehensive understanding of the translation process.

Graph 16 provides further insights into the relationship between condition effect and proficiency level. As proficiency level increases, the reaction time decreases, and so does the difference between conditions. This suggests that the repetition priming effect may not be as pronounced when proficiency levels are higher, and that the effect may cease entirely when proficiency levels are at their maximum.

These findings have important implications for translation, suggesting that prior exposure to the source language can be beneficial in speeding up the translation process. This is particularly relevant in bilingual contexts, where repetition priming may be more effective than in monolingual contexts. Additionally, language learners and translators can benefit from these findings, as they suggest that learning multiple languages can facilitate translation tasks, especially when proficiency levels are lower.

Overall, the results of the analysis provide valuable insights into the factors that influence the efficiency of the translation process. Future studies should aim to further explore the factors that contribute to this variability, including individual differences in cognitive processes and factors related to the translation task itself.

This finding is in line with previous research that has found that repetition priming can enhance translation performance in bilinguals (DIJKSTRA and VAN HEUVEN, 2002). Repetition priming is an important factor in translation tasks, as it helps the participants become more familiar with the source and target languages.

A study by Kroll *et al.* (2006) found that repetition priming of cognate words led to faster and more accurate translations, while repetition priming of non-cognate words led to improved accuracy. Another study by Costa *et al.* (2009) found that repetition priming of cognate words led to improved accuracy, but not necessarily improved speed. These results suggest that repetition priming can be an effective aid in improving translation accuracy. Repetition priming can be a useful tool in language learning and translation by helping to reduce the cost associated with processing non-cognate words. Repetition priming can lead to faster and more accurate translations of cognate words if the person is exposed long enough. In the present study, accuracy was high for both conditions, OCG and NCG. The effect of repetition priming was evident in the translation task. Interestingly, the data comparing proficiency, accuracy and RT suggests that repetition priming effect tends to disappear as participants' proficiency increased.

Guedes and Ramos (2012) concluded that cognates have a positive effect on the lexical and syntactic access of bilingual Portuguese-English speakers. The presence of cognates makes it easier for bilinguals to access both languages, allowing them to understand and produce language more effectively. This research has implications for bilingual language education, as it suggests that the presence of cognates can help to facilitate language learning. This study showed cognates had a positive effect on the translation task as in both conditions the accuracy was high, 95.4% for NCG condition and 96.7% for OCG.

To sum up, the results obtained from Experiments 1 and 2 showed a high level of activation in the L2 in relation to the L1 of both experiments. We were able to show that the difference between the cognate words given in English or Brazilian Portuguese can determine the reaction time to these stimuli. As mentioned in Subsection 2.2.1 of the Bilingual Lexical Access Models, the literature in the field of Psycholinguistics has postulated the existence of a lexicon whose activation presupposes the recognition and interpretation (understanding) of the words stored in the brain, through the mental assimilation that the bilingual delimits through their native language. Three of the five computational cognitive models were reviewed and discussed in Subsection 2.2.1 of the Theoretical Framework chapter, BIA (Bilingual Interactive Activation), BIA+ (Bilingual Interactive Activation Plus) and Multilink, in order to point out the importance of these cognitive models regarding access to the mental lexicon of the bilingual. Within the perspective of these models, it can be inferred that words have multiple translations. Furthermore, both experiments in this research consisted of recognizing spelling and semantics and their respective control words in Brazilian Portuguese and English. The results indicated that there were effects of interference of cognate words in the decision task; however, there were no effects of repetition priming.

The results of this research corroborate the BIA and BIA+ activation models, when referring to non-selective access between two languages (BIA model), and when the word recognition is affected by spelling similarities in lexical and semantic processing by bilinguals (BIA+ model). The Multilink computational model (DIJKSTRA *et al*., 2018) makes it possible to simulate word processing both in psycholinguistic tasks as well as lexical and language decision tasks, orthographic and semantic priming, word naming, production, and translation of words. The design of the two tasks of this study, language decision (Experiment 1) and translation task (Experiment 2) reflected the characteristics of the Multilink model (DIJKSTRA *et al*., 2018).

After explaining the analysis and the significant results we obtained through the two experiments carried out through a methodology in real time (online), Chapter 5 presents our final considerations regarding our study.

5 – FINAL REMARKS

The present study aimed to investigate, from a psycholinguistic perspective, the cognitive processes involved in the recognition of words and lexical access in a language decision task and if there was a repetition priming effect in a translation task with cognate words. A quantitative experimental methodology was employed using PsyToolkit software, and 208 words, including 26 cognate words in Brazilian Portuguese and English, 26 control words in each language, 52 distracting words and 52 confounding words, were used. The results of the language decision task showed that English control words were processed faster and more accurately than other words, while the translation task revealed repetition priming effects of cognate words were evident. The achievement of the present study in the literature review, in the discussions, analysis, and the results presented were immense. The experiments with language decision and translation tasks provided valuable insight into the cognitive processes of language processing from a psycholinguistic perspective, such as the effects of priming and cognate status in the performing of tasks. These findings are of considerable importance for linguists, educators, and bilinguals, as they demonstrate the effect of language on bilingual lexical access. The present study showed how language decision tasks can help to identify potential differences in processing times or accuracy for distinct categories of items (i.e., cognates vs. non-cognates). It also suggested that repetition priming effect may disappear as language proficiency increases. Such findings can be useful in informing translation studies, as they may provide evidence of which strategies are most effective for bilinguals in accessing lexical items in different languages.

I share the same view that Harris (1976) discussed regarding bilingualism. He discussed the implications of bilingualism and translation for education and society, arguing that bilingualism should be fostered and encouraged in schools, as it can lead to increased understanding of different cultures and improved communication between people of different languages. Additionally, he argued that translation can lead to a greater understanding of language, culture, and the world.

Translation is a valuable tool in teaching a second language. It can help learners understand the meaning of words and phrases, as well as the context in which they are used. It can also provide a way for learners to practice the language and become familiar with the grammar and syntax. Translation can also help learners build confidence in their ability to communicate in the new language and enable learners to gain a greater appreciation of the culture behind the language. Translation can also be a great way to review material and assess comprehension (OXFORD, 2007), even more when translating involves cognates.

As pointed out by Nguyen (2019), by using cognates, the teacher can provide students with an accessible way to practice translating words and phrases from the L2 into their native language. This can help to build confidence when attempting more difficult translations. This was evident in the present study since accuracy in the translation task was above 95% in all conditions. One strategy for integrating both languages in order to maximize the effectiveness of language learning through the use of cognate words is by using a bilingual immersion approach (WANG; LI, 2015). Bilingual immersion involves creating an environment where both languages are used simultaneously, allowing students to gain both language skills and understanding of the other language. This approach can be implemented in both formal and informal settings, such as in the classroom, at home, and in the community. Another strategy for integrating both languages in order to maximize the effectiveness of language learning through the use of cognate words is by using a contrasting approach (FABBRO, 1999). This approach involves comparing and contrasting the two languages to help students gain an understanding of the similarities and differences between them. This approach can also be used to help students acquire language skills in both languages. Finally, a strategy for integrating both languages in order to maximize the effectiveness of language learning through the use of cognate words is by using a task-based approach (GARCÍA; WEI, 2014). This approach involves providing tasks to students that require them to use both languages in order to complete the task. This approach can be used to help students gain both language skills and an understanding of the other language.

Klein *et al.* (2016) showed that cognates can help facilitate language learning, and that bilinguals have a better understanding of cognates than monolinguals. By the other hand, bilinguals rely on a variety of inhibitory processes to control access to cognates. These processes include paying attention to particular words or phrases and inhibiting competing words in the same language, as well as inhibiting words in the other language (KROLL *et al.*, 2017). In the present study, the results may indicate that as both lexicons, English and Brazilian Portuguese, were active in the participants' minds, many lexical possibilities were selected concurrently and began competing for identification, indicating an inhibitory effect. As a result, a word in one lexicon must have been inhibited and a word in another language must have been chosen over it. The present study has implications for language teaching and learning. As observed by Kroll et al. (2017), the amount of time a bilingual has been exposed to the language was connected to their inhibition of competing words in the other language. This may imply that additional exposure to the target language may assist bilinguals in better controlling cognate activation in the other language. The relevance for second language instruction might be that increasing learners' exposure to the target language, as well as providing them with specific strategies to inhibit the access of cognates in the other language, can benefit language comprehension as recognizing cognates can help to make language learning easier and more efficient.

In all experiments, the cognitive processes involved in the task of language decision and translation of cognate words revealed a high degree of activity in English (L2) compared to Brazilian Portuguese (L1). Regarding hypothesis H1 - that the processing cost of cognate words is higher when compared to the cost of processing non-cognate words in a language decision task revealed that the cognate facilitation effect was partially confirmed. The results of the language decision task showed that English control words were processed faster and more accurately than the words in the other conditions. In terms of hypothesis H2, there were indeed repetition priming effects of cognate words in the translation process. Consequently, H2 was confirmed. Some other limitations and possible shortcomings of this study are pointed out next.

It was observed that participants with low proficiency in English, according to the test they took, had an impact on reaction time and accuracy of tasks. Therefore, a study with two distinct groups, one with high proficiency and the other with low proficiency, would allow for a more robust analysis of the relationship between proficiency and task performance. Additionally, a study with mature and young participants, as well as children, would be interesting to compare performance in translation and language decision tasks. The present study focuses on tasks at the word level; however, further studies should explore tasks at the sentence level and also in the productive skill. Despite many other factors that could be considered, this research has certainly helped to improve and understand the organization of the mental lexicon process of bilinguals in the fields of Translation Studies and Psycholinguistics as already mentioned in this chapter. The study has implications for language teaching and learning. The study explored how bilinguals recognize words and access their meanings in different languages and how they also rely on inhibitory processes to control access to cognates. The study found that using cognate words can aid in language learning, and that increased exposure to the target language can improve language comprehension.

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